ABSTRACT

Title of Dissertation:	COMPETENT READERS' ONLINE MULTIMODAL READING STRATEGIES USE
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As literacy and reading evolve, it is important to identify and describe the strategies and skills used in constructing meaning. This study examines online multimodal reading (OMR) strategies: those used in constructing meaning from multimodal information sources (e.g., images, audio, written words) on the Internet. Participants read online multimodal texts from a laptop screen and provided verbal reports of their reading processes as they read multimodal texts on the

Internet to learn a scientific topic. I collected and analyzed think-aloud data, using verbal protocol analysis. I cataloged and described their multimodal reading comprehension strategies. The verbal report data were complemented with retrospective interviews focused on participants' accounts of how they read, reader-computer interaction captured in the screen-recording video, and written pre- and post-reading knowledge reports focused on what is learned from OMR. OMR strategies they used were coded and categorized to provide insights into the nature of the competent readers' strategic online multimodal reading. I used the integrated data to create a taxonomy of OMR reading strategies as a key outcome of this study. The results of this study may inform theoretical models of online multimodal reading, as well as instruction intended to foster student learning.

COMPETENT READERS' ONLINE MULTIMODAL READING STRATEGIES USE

By

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Chapter 1: Introduction

1.1 The Importance of Online Multimodal Reading

1.1.1. The Importance of Online Reading in Students' Literacy Development

Students use digital devices, including laptops, tablets, and smartphones, to read, communicate and search for information to learn. It is ordinary to hear students saying, "Let's Google it," "Did you see her Instagram?" or "I uploaded a video yesterday, and I'll do a live chat with my subscribers." Students living in this ubiquitous Internet space are active consumers and producers of information on various online platforms.

Internet use among the United States population in 2020 was 89.8% (Internet World Stats: Usage and Population Statistics, 2020). In 2022, 67.9% of the world population are using the Internet, and this penetration rate has grown by 1,392% since 2000 (Internet World Stats: World Usage and Population Statistics, 2022). There has never existed a technology adopted by so many people, in such a short time, with such powerful consequences for both literacy and life (Leu et al., 2013). Technology development directly affects literacy education since it changes the textual environment in which students read and learn, both in and out of the classroom. Literacy was traditionally defined as being able to read and write, and reading and writing remain essential and foundational skills in today's literacy. However, as digital technology develops and its importance grows, there is a need for an expanded notion of literacy (Rouet, 2006). This new literacy, related to Internet use, necessitates reading and thinking strategies to cope with the increased quantity and complexity of information (Coiro, 2003; Rouet, 2006).

Accordingly, specific skills and strategies are required for online reading and comprehension while encompassing those required for printed texts (Afflerbach & Cho, 2009; Leu et al., 2013; Salmerón et al., 2006). For example, strategies to comprehend, compare, evaluate and integrate knowledge--as well as those for resolving conflicting information--are required for today's Internet readers (Macedo-Rouet et al., 2020). Readers must also understand texts as human artifacts to interpret them as they consider the author's purpose and circumstances (Rosenblatt, 1969; Pressley & Afflerbach, 1995). Therefore, focusing on online reading comprehension strategies in school-based curriculum and instruction is necessary (Kingsley & Tancock, 2014) to provide students with skills to survive, thrive, and engage in Internet environments (Fabos, 2008). Literacy broadly involves reading, writing, speaking, and listening. In this paper, I focus on reading and define literacy as skills, strategies, and abilities to read, comprehend, and use the information to meet specific purposes, which involves making meanings for communication and representation in diverse social contexts (Kalantzis et al., 2016; Leu et al., 2013; Rouet, 2006). Specifically, I focus on literacy using reading strategies for meaning-making from online multimodal texts for academic purposes.

Nationwide educational standards and assessments, such as Common Core State Standards (CCSS; National Governors Association Center for Best Practices [NGA Center] & Council of Chief State School Officers [CCSSO], 2010) and National Assessment of Educational Progress (NAEP, 2022) reflect the inclusion of, or transition to, digital literacy (Kingsley & Tancock, 2014). The CCSS state that digital literacy skills are important for students "to be ready for college, workforce training, and life in a technological society" (CCSSO, 2010, p. 4). To succeed in these aspects of life, students need the ability to "gather, comprehend, evaluate, synthesize, and report on information and ideas, to conduct original research in order to answer questions or solve problems, and to analyze and create a high volume and extensive range of print and nonprint texts in media forms old and new" (p. 4). Meanwhile, the NAEP framework for reading assessment defined reading as an active and complex process that involves understanding written text, developing and interpreting meaning, using meaning as appropriate to type of text, purpose, and situation (National Assessment Governing Board, 2022, p. 3). Although the standards do not focus solely on reading, the enlarged scope incorporates online information reading, comprehending, and using them for proper purposes. The NAEP 2025 Reading Framework (*waiting for citation*) involves greater breadth of digital and multimodal literacy, in lockstep with the increased role of the Internet for learning. Overall, these standards and assessment innovations demonstrate that literacy and Internet use are more integrated into the public policies and curricula that directly impact literacy education (Leu et al., 2013).

1.1.2. Multimodal Reading on the Internet

The advent of digital technology requires students to develop new literacy competencies (Coiro & Dobler, 2007; Cho, 2014; Leu et al., 2013). As noted by Bråten and colleagues, "the exponential increase in the availability and accessibility of multiple and non-traditional texts on almost any topic has changed the landscape of reading in the last decades" (Bråten et al., 2020, p. 28). Related to reading, individuals can gather, produce, and store texts efficiently, and websites offer readers new ways to connect and interact with information as well as each other (Rouet, 2006). The greater ease and speed of access to the mass of Internet information begets the concomitant increase in the erroneous, malicious, false information that a reader may encounter (Alexander, 2020).

Furthermore, "meaning is carried as much multimodally as it is by the words and sentences of traditional literacy" (Kalantzis et al., 2016, p. 5). Social semiotics researchers insist that today's world is changing from "the world told" to increasingly include "the world shown" (Kress, 2003, p. 1). Texts are increasingly multimodal, often accompanied by audiovisual elements in addition to written words (Casey, 2012; Støle et al., 2020; Yelland, 2018). Due to the developed functionality of online platforms and applications, students are exposed to multimodal texts in their daily reading and academic learning. For example, students commonly do their homework by searching and reading multimodal texts on Google, YouTube, Instagram, or Pinterest that combine images, videos, hyperlinks, and words. Because of the increased use of online multimodal texts, successful readers should be able to consume and produce various texts based on visual and multimodal aspects of digital media (Bearne, 2009; Serafini, 2012). Therefore, I focus on online multimodal reading (OMR) in this study, which refers to the act of constructing meaning from multimodal text on the Internet.

Research identifies online reading strategies that students must develop to be proficient online readers, including navigation, searching, source evaluation, and self-monitoring (Afflerbach & Cho, 2009; Anmarkrud et al., 2014; Cho, 2014; Coiro & Dobler, 2007; Goldman et al., 2012). These works provide a basis for examining the intersection between traditional and online reading strategies and determining what strategies support successful online reading (Afflerbach & Cho, 2009; Bråten et al., 2020; Salmerón et al., 2006). While the determinations of commonality and uniqueness with traditional and digital text reading strategies are helpful, many studies do not account for multimodal reading on the Internet since the texts used in these studies are predominantly in words mode. Resultingly, the analyses focused on comprehension and not on multimodal meaning-making. Therefore, OMR needs more attention in the strand of online reading research because it is inevitable that readers engage with multimodal reading when they search and read the information (Støle et al., 2020) because multimodality is one of the significant characteristics of Internet texts.

1.1.3. Benefits of Online Multimodal Reading

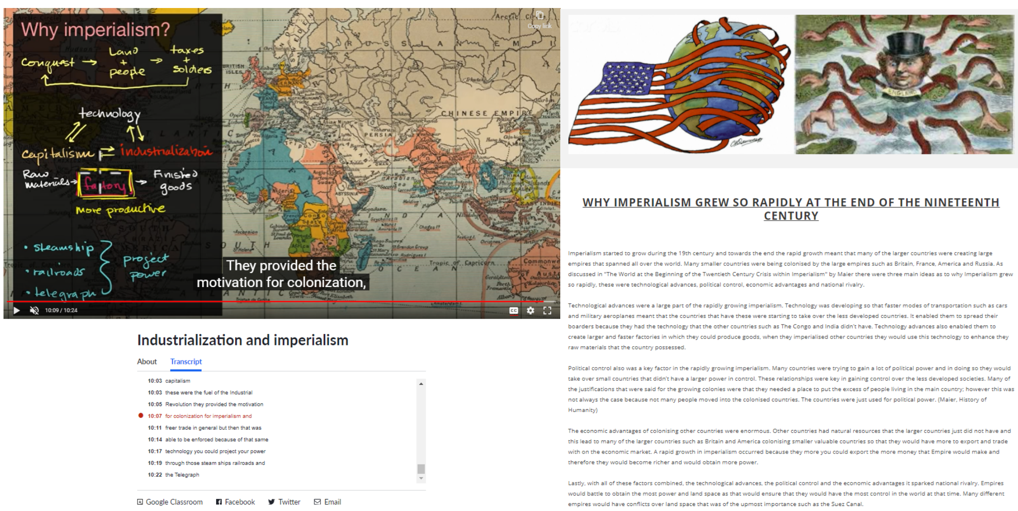
The benefit of multimodality in online text reading rests on two complementary foundations. On the one hand, modes in multimodal text provide readers with various complementary supports (Leu et al., 2013) designed and configured by authors to communicate information effectively (Kress, 2004). Modes may help readers understand texts with different perspectives that unimodal written text cannot provide. For example, suppose a student in a history class wants to understand what imperialism means. In that case, she can learn the concept by viewing multimodal information, including images, cartoons, charts, graphs, and videos, in addition to reading the written description. Although printed multimodal texts have always existed, and even written texts can be considered to have visuality (Szabó, 2016), digital texts on the web often provide diverse and frequent modal options (Mills & Unsworth, 2017).

On the other hand, multimodal texts may support readers to exercise agency by helping them choose the nature of the online information presented to them (Casey, 2012; Sanacore & Piro, 2014). Since online reading provides vast amounts of information in different modes, readers can select modes of representation that fit their reading purposes, task requirements, personal preference or familiarity, or levels of reading proficiency and use texts appropriate for their abilities (Leu et al., 2013). Unlike traditional printed texts characterized by finite modal choices, students can search topics online and choose the apt modes to improve comprehension (Bearne, 2003, 2009). Returning to the previous example, the student searching for and viewing different modes to best understand *imperialism* can click to view image search results and select a political cartoon, in this case, a giant octopus wearing flags, its arms engulfing a world map (see Figure 1). She then reads a written explanation of this concept to supplement this intuitive visual mental representation. If used effectively, modes can offer detailed information which contributes to meaning-making (Alexander, 2005). In sum, multimodal reading differs from the traditional written mode-oriented literacy by presenting different modes, and readers may choose their preference (Jewitt & Kress, 2003). When two or more modes are integrated, "meaning is made in all modes separately, and at the same time, that meaning is an effect of all modes acting jointly" (Kress et al., 2006, p. 1).

Certain modes are more suited to specific information. Often, authors choose modes they believe will best convey information to readers. Meaning and the mode representing the meaning are linked in a relation of aptness, one for the other (Jewitt & Kress, 2003). When they match (i.e., exhibit a high degree of aptness), it helps readers to build mental representation more efficiently and precisely. For example, spatial images and instructions for assembling furniture are more precisely represented by imagery modes (e.g., IKEA furniture assembly instructions). Comprehending information about time sequence, intentions, and causality is more suitable for propositional representation (Cohen, 1983). For example, 'I was late for the class because my car had a flat tire an hour before the class.’ can be adequately expressed with words because it delivers the causality and time sequence in one relatively short sentence.

Figure 1

Online multimodal texts for understanding imperialism (Braithwaite Modern History, 2021; Khan Academy, 2021; imperialism)



There exist possible negative influences of OMR, such as distraction (Rau et al., 2020) and higher cognitive load (Macedo-Rouet et al., 2003), which may counter comprehension. Messy web design exacerbates efficient information gathering and creates a poor user experience. However, educators and researchers cannot avoid the prevalence of multimodality on the Internet and the described benefits. Web 2.0, introduced in the early 2000s, provides a platform for users to publish, post, and share content on the Internet (Sistek-Chandler, 2012). It values users’ active participation and collaboration through social media, blogs, or forums. Text design has become more accessible for online authors, who utilize various modes in their text designs. Highly developed digital tools broaden their choices to insert images, videos, hyperlinks, diagrams, hashtags, or surveys. Given this expansion of the digital multimodal tools, students must understand multimodality in online texts, authors' intention for using certain modes, the meaning of synthesized modes, and reading strategies for understanding multimodal Internet texts. Based on the importance and benefits of OMR, I plan to explore OMR strategies and create a taxonomy that could be used for literacy instructions and assessments of OMR.

1.2 Statement of Rationale

"Reading on the Internet is often complex" (Cho & Afflerbach, 2015, p. 504). A typical online search and navigation provide readers with countless hyperlinked multimodal webpages (List & Alexander, 2017), including music, images, diagrams, or videos, along with different fonts and hyperlinks. It demands general online reading strategies (e.g., meaning-making, navigating, self-monitoring) and multimodal reading strategies. Online readers should be able to comprehend meanings from modes and integrate information from multiple multimodal texts.

Despite the importance of OMR, there is a dearth of research within the overlapping fields of digital literacy, multimodal literacy, and reading strategy. Studies on multimodal literacy within the Internet space are relatively novel due to the latest transition of textual space from print to screen (Mills & Unsworth, 2017; Oh & So, 2018). Thus, research on students' cognitive reading strategies during OMR is scant. Research on OMR strategy is vital for learning since "strategic processing is a proximal cause of learning outcomes" (van Meter & Campbell, 2020, p. 86). There is also a practical need since readers already use online information and communicate through social media. Many studies indicate that students who are often considered digital natives are not necessarily proficient in online reading (Riddell, 2016; Rouet, 2006). Fortunately, strategies are amenable to instruction so that students can be taught to use them effectively (Kingsley & Tancock, 2014; Rouet, 2006). Therefore, teaching students OMR strategies is legitimate and necessary (Ozuru et al., 2009; van Meter & Campbell, 2020) to support them to grow into successful online readers.

Finding OMR strategies and adapting them to instruction will be worthwhile in today's literacy climate. Teachers should be familiar with the digital and multimodal aspects of online reading, but digital literacy instruction cannot rely solely on teachers' exertion (Bearne, 2003). Constructs to teach and assess OMR and related strategies should be provided beforehand so teachers can lean on and direct their instructions (Wyatt-Smith & Elkins, 2008). Thus, research must determine the necessary strategies to build a construct of OMR and provide a curriculum for learners "to be able to approach, navigate, interpret, and discuss the various visual images and multimodal ensembles they encounter in their everyday lives" (Serafini, 2014, p. 44).

Therefore, I plan to examine ten doctoral student readers' OMR strategies as they read online multimodal texts to learn about a new topic. I will collect verbal protocols as primary data and integrate them with reader-computer interaction videos, retrospective interviews, and pre and post-knowledge reports. Given their accumulated training in reading and learning from various texts, I anticipate these competent readers will be a good fit to provide fruitful data on OMR strategies. I will explore these readers' OMR strategies, categorize them, and examine how these strategies influence readers' online multimodal text comprehension. The resulting taxonomy of

OMR strategies may contribute to building constructs that inform reading instruction and assessment.

OMR task effectiveness is important and representative because reading and searching for expository texts on the Internet is one of the most prevalent digital literacy activities. Here, expository texts on novel topics are presented as subjects can read and learn new information like they usually do for learning. Also, classroom reading often involves multimodal text reading. People learn better with words and pictures than with words alone (Mayer, 2020). Digital technology supports teachers in making and providing multimodal texts more easily. Online multimodal texts are prevalent on the Internet since the Internet offers various modes for readers to get information. For example, Google search results show hyperlinked words, images, maps, and videos to help readers navigate. The OMR task in this study includes one of the most typical presentations of modes that are expected to enhance comprehension. Therefore, I believe the OMR task here shows archetypical online multimodal reading.

1.3 Conceptualization of Terms

I found that essential concepts with *the online multimodal reading strategy* need clarification. Although the terms are usually well defined within related research areas, their meaning at the intersection of online reading, reading strategy, and multimodal text reading can vary. Therefore, I provide definitions here to enhance the clarity of the theory and results of OMR. Five definitions of the core concepts are accounted for: (1) reading comprehension, (2) multimodal text comprehension, (3) literacy, (4) online text, and (5) reading strategy. I address them shortly and account for them with theories in the next section.

1.3.1 Reading Comprehension

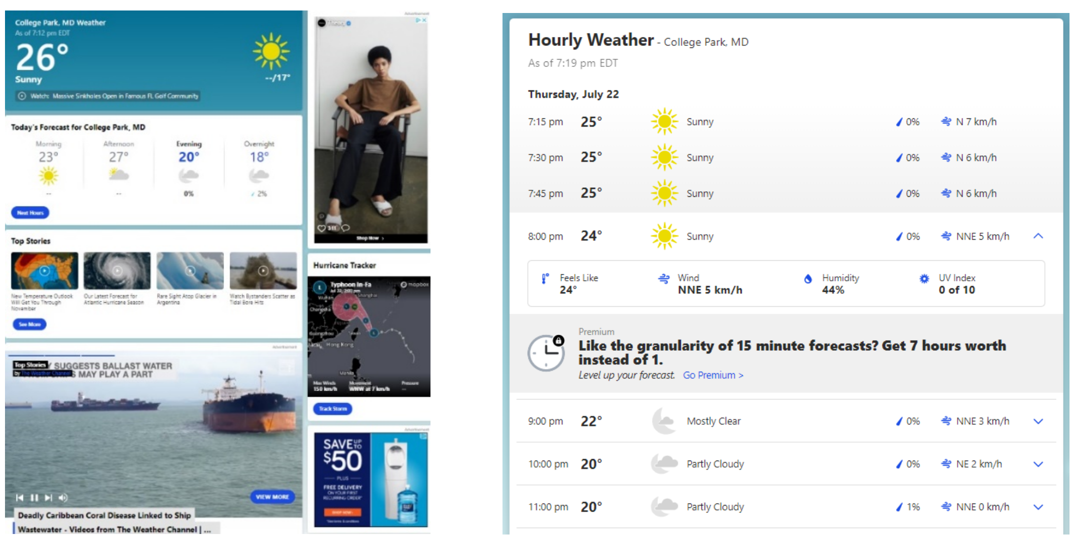
"Reading is the act of constructing meaning from text" (Afflerbach, 2017, p. 28; Kintsch, 1998). The accomplished reading is marked by building a coherent mental representation of a text (Pressley & Afflerbach, 1995). Readers use skills, strategies, prior knowledge, and experience to comprehend what they read to achieve different goals within and outside school (van den Broek et al., 1999). Reading and reading comprehension may differ since reading can only be viewed as the physical act of viewing text. In this study, I used them interchangeably, conceptualizing reading as cognitive meaning-making from the text which includes OMR.

In multimodal literacy theory, reading ranges from decoding words, problem solving, and constructing meaning to meaning-making using modes of representation (Jewitt & Kress, 2003; Kress, 2003; New London Group, 1996). As such, I define online multimodal reading comprehension as the act of constructing meaning from single or multiple multimodal texts on the Internet. It involves meaning-making using two or more modes from one multimodal webpage or different multimodal webpages. For example, viewing an image and a video together on a webpage can be a typical online multimodal reading (OMR). Also, modes can be spread out on different webpages, so listening to music and reading written words to understand a social event can be another example of OMR comprehension.

Online readers typically engage with multiple texts and integrate meanings to accomplish reading goals (Rouet, 2006; Rouet et al., 2011). Sometimes, multiple text reading may occur in a single multimodal text reading because each mode can be regarded as a text itself. Figure 2 is a captured page of weather.com that shows various modes to the readers to inform today's weather. The two texts are typical online multimodal texts that contain written words, icons, pictures, videos, and hyperlinks. I clicked the third cloud icon, which indicates the evening weather, and it led me to the hourly weather table, which is also multimodal, on the right picture. The modes on these texts are all separated texts connected through hyperlinks, and they all deliver meanings respectively. Jointly, I assume that online multimodal reading incorporates multiple text reading.

Figure 2

Two linked online multimodal texts showing today's weather (weather.com, 2021)



1.3.2. Multimodal Text Comprehension

Multimodality as a field of study is concerned with how people use different modes of communication to represent or make meaning in the world (Stein, 2008; 2014). *Modes* are defined as "resources that a culture makes available as the means for making representations and meaning -- speech, writing, image, gesture, music, and others" (Jewitt & Kress, 2003, p.

4). *Multimodal text* refers to texts that utilize a variety of modes to communicate or represent concepts and information (Serafini, 2014). Although I focus on online multimodal texts only, both print and digital texts have multimodal nature utilizing various cultural and semiotic resources to articulate, render, represent, and communicate concepts and information (Serafini, 2014).

In this paper, I regard multimodal text as a text that uses two or more modes. For example, a blog posting on the Internet made up of written paragraphs and images to describe a topic is counted as an online multimodal text. Some studies use the term *bimodal* when two different modes are used (Dalton & Smith, 2012), but I included it to multimodality since the prefix *multi-* means both more than two and more than one (Merriam-Webster, n.d.).

New London Group (1996) contended that all meaning-making is multimodal, and all written text is also visually designed. Indeed, most online texts not only have written words and hyperlinks but also have various configurations using layouts or menus that affect readers' meaning-making. In this study, I focus on online multimodal text reading for academic learning purposes in and out of school. For example, a typical OMR includes searching Google for information, learning about a topic by reading online blogs, and reading online texts to accomplish a reading task. I used this task for the experiment, which is a typical OMR scene for topic learning.

1.3.3. Literacy

In 2004, United Nations Educational, Scientific and Cultural Organization (UNESCO) defined literacy as "the ability to identify, understand, interpret, create, communicate and compute, using printed and written materials associated with varying contexts" (UNESCO, 2004, p. 13). Traditionally, literacy was defined as being able to read and write (Rouet, 2006), rooted in printed text reading as UNESCO portrayed. This definition was modified as technology developed and people's literacy and textual space moved from printed, written texts, and face-to-face communications to digital screen-based virtual, online spaces. UNESCO mentioned in their 2030 agenda that "literacy is now understood as a means of identification, understanding, interpretation, creation, and communication in an increasingly digital, text-mediated, information-rich and fast-changing world" (UNESCO, 2021). This alteration reflects new conceptualizations of being literate, which regards using digital technologies. Thus, "any definition that relies solely on traditional print literacies is inadequate in our consideration of contemporary contexts for becoming literate" (Yelland, 2018, p. 848).

In this study, I follow Leu et al.'s (2004, 2013) new literacies concept as a groundwork for defining literacy since their research was to figure out online research and comprehension, which requires "the skills, strategies, dispositions, and social practices necessary to successfully use and adapt to the rapidly changing information and communication technologies and contexts" (Leu et al., 2013, p. 1163). They used the plural form literacies as an umbrella term to include different forms of literacies in diverse social contexts, including multimodal literacy (Kress, 2003). From the multiple texts and task processing perspective, Rouet (2006) referred to literacy as "the ability to read, comprehend, and make use of complex documents in real life situations" (p. xix). These two definitions are interrelated and are both informative for my ground of research, where I focus on multimodal, multiple texts reading strategies in the online setting represented by the Internet. In combination of the two definitions, I define literacy as the skills, strategies, or abilities to read, comprehend, use, and communicate information delivered through various modes of representation in diverse social contexts. Based on this broad definition, I focus on the literacy of using reading strategies to make meanings from online multimodal texts for academic learning purposes.

1.3.4. Online Text

Online refers to the state connected to, served by, or available through a system, especially a computer or telecommunications system, such as the Internet (Merriam-Webster, n.d.). The *Internet* refers to "an international computer network connecting other networks and computers that allows people to share information around the world" (Oxford dictionary, internet). I integrate *Web,* which is "a system for finding information on the Internet, in which documents are connected to other documents using hypertext links" (Oxford dictionary, world wide web) to the Internet. Reading online unavoidably involves using digital devices (e.g., smartphones, laptops, tablet PCs, smart watches) because these media embody digital information on the readable screen. In this study, I use the term *online* interchangeably with the *Internet*, conceptualizing online text reading as reading texts on the Internet.

"Texts are artifacts that convey an author's communicative intent" (Rouet, 2006, p. 186). Text is an external, symbolic representation of the situation, any linguistic or nonlinguistic sign that communicates meaning, and a tool that allows the reader to construct an integral, cognitive representation of the situation (Hartman, 1995; Rouet, 2006). Rouet (2006) described that the purpose of a text is generally to fulfill a communicative process that authors try to deliver knowledge of a situation to a reader. Since I focus on online multimodal text reading, the nature of the text ranges from single-paged to multiple texts on the Internet. Online texts are usually multimodal, with different modes such as image, audio, video, written words, layouts, hyperlinks, and so on (Støle et al., 2020). I postulate that online multimodal reading inevitably encompasses multiple text reading. In naturalistic online research and reading, people read, compare, and integrate multiple texts dealing with the same issue or phenomenon to get the needed information and understand the idea (Bråten et al., 2016). In sum, I refer to the online text as text on the Internet that is often multimodal and involves multiple text reading.

1.3.5. Reading Strategy

Afflerbach, Pearson, and Paris (2008) defined reading strategies as "deliberate, goal-directed attempts to control and modify the reader's efforts to decode text, understand words, and construct meanings of text" (p. 368). Strategy is the form of procedural knowledge stored in long-term memory and used at will (van Dijk & Kintsch, 1983; van Meter & Campbell, 2020). Deliberate control, awareness, and goal-directedness are keys to the enactment of strategies (Afflerbach et al., 2008). Strategic readers demonstrate flexibility and adaptability to apply strategies to achieve goals as well as monitor the effectiveness of their strategies according to their purposes. They actively seek appropriate strategies to best match the task at hand, expecting a successful outcome (van Meter & Campbell, 2020), although the use of reading strategies does not always entail positive results (Afflerbach et al., 2008).

The individual use of strategies differs according to the readers' developmental levels (Alexander, 2005). Strategies can be acquired through explicit instruction and experience, even if they are unfamiliar and complex at first (Braasch et al., 2013; Johnston & Afflerbach, 1985;

Litman et al., 2017; van Dijk & Kintsch, 1983). Among different reading strategies, I focus on cognitive and metacognitive strategies, which address how internal mental operations apply toward learning or academic performance (e.g., problem solving, reading comprehension, knowledge acquisition). In this regard, I define *online multimodal reading strategy* as “a reader’s goal-directed attempt to construct meaning from multimodal text on the Internet.”

Chapter 2: Literature Review

In this chapter, I synthesize what is known about online multimodal reading (OMR) strategies and how these strategies influence online readers' text comprehension. The OMR strategies found from the body of literature may suggest the coding rules for strategies predicted to be found in the data analysis.

2.1 Method of Review

2.1.1. Search and Selection Procedures

Time Frame for Literature Search

Due to the rapid changes in technology, digital literacy studies reflect the continuing evolution of our knowledge, which also inspired the time of the reviewed literature. Internet technology and World Wide Web today are drastically different from those of the 1990s and 2000s. Bråten et al. (2020) explained that it might be challenging to extrapolate early research findings to the current state of technology because of (1) the rise of the Internet and the proliferation of mobile devices that affected the availability and interconnectedness of digital texts, (2) current readers' increased familiarity with digital texts, and (3) the improved quality of digital screens that close the gap between printed and screen-based readings.

According to the history of the World Wide Web, the Web was invented in 1993, which began the stage called Web 1.0 (Jacksi & Abass, 2019). It was different from today's Internet because its form and functions were elementary, showing readable webpages with raw data from which users could search and retrieve information. The information was static, and readers could not manipulate website designs or information much without a certain level of Web expertise. Since the advent of Web 2.0 in 2004, contemporary online environments are marked by people reading and writing freely on the Internet, participating in online activities through social media, and communicating online. In addition, Web 2.0 has transformed the concept of online texts from static and fixed web pages to user-influenced, modifiable online multimodal texts, which expand to social media texts that enable participants to share information and communicate with each other. Since this era, people have begun perceiving the Internet as a primary platform of information and communication and regard users as active, collaborative participants (Levy, 2009; O'Reilly, 2005). Users' ability to design websites and share information under less control or less expertise contributed to the Internet space replete with user-generated multimodal texts – text quality and trustworthiness set aside – supported by advanced multimodal writing tools for text production. In 2014, Web 3.0 was introduced. It allows users to interact more actively through various digital applications. Computers and artificial intelligence (AI) are also marked by using the Web as a massive database for searching and presenting information that matches individual needs (Jacksi & Abass, 2019). There are archetypical examples of the three Web phases: (1) Britannica Online and personal websites for Web 1.0, (2) Wikipedia, Amazon.com, blogging, Facebook for Web 2.0, and (3) more personalized YouTube algorithms and Google advertisements suggested by AI for Web 3.0 (O'Reilly, 2005; 2007).

Among these stages, the transition to Web 2.0 is meaningful for OMR since it enabled the Web to provide readers with different modes to search and use for online reading and writing. It also made people perceive the Internet as a primary platform to post, interact, and collaborate (Sistek-Chandler, 2012). More importantly, information sharing, often dependent on written words, has been “replaced by other multimedia through the posting and sharing of photos, audio, and video, and even the posting of virtual avatars” since Web 2.0 (Sistek-Chandler, 2012, p. 79). Therefore, I set the literature search brackets from 2004, the year that Web 2.0 was coined, through to the present, 2022, where Web 2.0 and 3.0 coexist, and readers encounter online multimodal texts through different digital devices every day.

Search and Selection of Literature

Based on this reasoning, I conducted a literature search in the electronic databases: *Academic Search Ultimate, Education Source, ERIC, Psychology, and Behavioral Sciences Collection, APA PsycInfo, and Google Scholar*. I limited this search to scholarly, peer-reviewed journals written in English. The search term I used for the first round was: *multi-modal or multimodal or multisensory or multiple; reading or literacy or reading skills; strategy or strategies; online or internet or web or media or digital*. This search provided me with 281 resources initially. I used specific criteria for selecting, and read titles, abstracts, and findings of the studies. Since my study focuses on determining and describing OMR strategies used during Internet reading, my focus was on studies that examined text reading on the Internet, whether they used naturalistic, open Internet reading tasks or a digital platform that resembled the Internet.

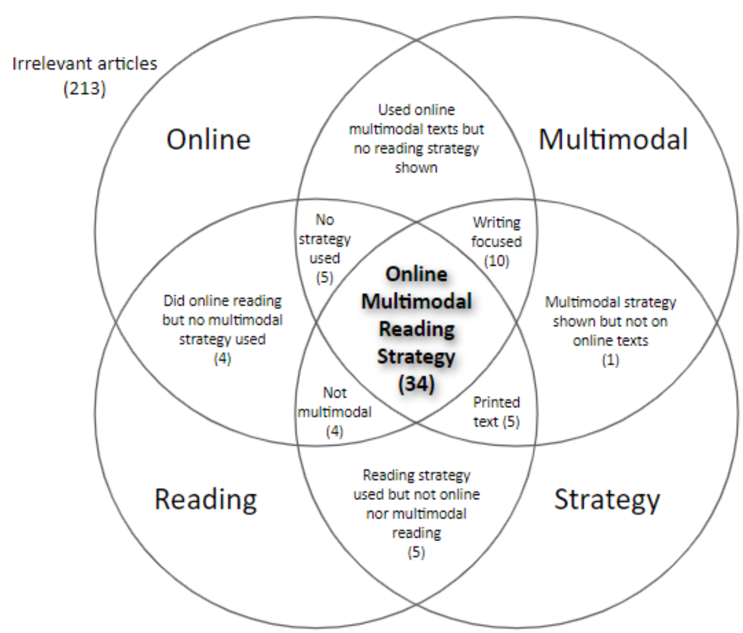
I also determined if inquiry included multimodal reading as (or part of) a task: tasks required participants to read at least two modes together to construct meaning or at least provided the opportunity to choose whether to read single or multiple modes. That is, I excluded the study if an online reading task only used written language mode (e.g., written paragraphs with hyperlinks) even if readers demonstrated online reading strategies. For example, "Investigation of High School Students' Online Science Information Searching Performance: The Role of Implicit and Explicit Strategies (Tsai et al., 2011) was excluded from the final pool because it did not indicate readers read different modes during their online searching although it addressed useful online reading strategies. Automatized reading skills, basic computer operation skills (e.g., scrolling, clicking, opening tabs, typing), or responses to a sensory stimulus (e.g., following colored words without meaning-making, clicking on an image because it is a student's favorite character) were not regarded as strategic OMR either.

Participants' age can be a critical variable in reading strategy. However, I did not limit the consideration of research to specific age levels since this study focused on competent, adult-level subjects that may cover all strategic levels. The country where studies were conducted or the language that participants used did not matter either. Related studies that examined readers with learning or physical disabilities were excluded since it was not the focus of this study. Lastly, I excluded more than two-thirds of the search pool because they only examined online multimodal writing or production. For example, "Pharmacology students' perceptions of creating multimodal digital explanations" (Nielsen et al., 2017) was excluded because it examined students' digital multimodal production assignment.

After eliminating unrelated inquiries, the final pool of the literature was fourteen. Due to the limited pool, I used different terms for the second round of literature search because I found that the concept of online multimodal reading (OMR) has been used inconsistently, sometimes synonymously with hypermedia, multimedia, hypertext, multiple texts reading, and so on. This time I searched *hypermedia or hypertext or multimedia or media or multimodal or multiple texts; reading or literacy; strategy or strategies or strategic or skill*. This search provided five additional studies after the same filtering process. I realized from these searching procedures that many articles used online multimodal texts as reading materials without stating them in the title or abstract. Therefore, I used backward reference searching using the prior search results to expand the pool of articles. As a result, I found thirteen studies that did not explicitly state that they used hypermedia or online multimodal texts but did use them as reading materials. In conclusion, my final pool of literature was 34 articles (see Figure 3). Across the literature, readers' ages ranged from primary (7) to middle school (10), to high school (8), and adults, including undergraduate and graduate (10), with one study using both primary and middle school students as collaborative dyads (Rasmusson & Eklund, 2013).

Figure 3

Venn Diagram Showing Exclusion of the Literature (number of studies)



This Venn diagram shows how I determined the research studies to be included in my literature review. The literature search was guided by the four pillars that are essential for this study: online, multimodal, reading, and strategy. Studies had to be at the intersection of occurring online, subjects reading texts, multimodally, and it should have shown certain strategies. Studies that fit these four criteria were rare because 2/3 of the research were on online writing, and most of the left ones only dealt with digital texts that are downloaded or using only written words.

2.2 Review of Online Multimodal Reading Strategies

My examination of the literature indicated diverse descriptions and definitions of online multimodal reading (OMR) strategies used in online text reading. I analyzed individual research studies: the participants, the research question(s), methods, the reading task(s), and results to describe strategic meaning-making. Once the OMR strategies were located and identified, I used Nvivo software to create a taxonomy of strategies (see Table 1). As a result, I identified six OMR strategies: (1) multimodal meaning-making, (2) multimodal searching, (3) multimodal evaluation, (4) making modal choice, (5) multimodal navigation, and (6) multimodal prior knowledge activation. The names and descriptions of the strategies were not from the authors. Since most of the studies did not focus on reading strategies, I named them when certain patterns of strategic OMR were revealed during the analysis. The examined strategies all involved meaning-making from two or more modes to construct meaning from online texts, following my definition and characterization of OMR. Most studies reported that using these strategies helped participants understand texts better. I used participants' reports as testimonies for the argument that OMR influences readers' mental model construction. These results indicate that OMR strategies are a valuable component of readers' process repertoire and an important aspect of reading education. The taxonomy of OMR shows how readers actively engage with complex online texts to achieve their reading goals. Although there are several prominent studies on OMR, there still are lacking amount of research on OMR strategies which add onto these six types. Also, there are very limited studies that focuses on online and multimodal texts at the same time. These existing research and theory provide strong foundation to further investigate. I believe my study is necessary to open the relative experiments and discussion to explore more about online reading strategies.

2.2.1. Strategies for Multimodal Meaning-making

Readers use multimodal meaning-making strategies during OMR. All six OMR strategies taxonomized in this chapter contribute to readers' meaning-making. However, under the multimodal meaning-making category, I listed strategies that readers used specifically for meaning construction during OMR. Multimodal meaning-making strategies refer to individuals' strategic attempts to understand multimodal texts (e.g., text contents, context under the text, concepts, main ideas) by integrating adjacent modes or making intertextual connections. Multimodal meaning-making involves connecting and integrating different modes to learn from texts. For example, Oh and So (2018) found that undergraduate students constructed meaning using different modes, including videos, written words, and illustrations, and integrated "each modal information to a coherent understanding of the texts" (Oh & So, 2018, p. 68). Since OMR involves reading two or more modes together, the identification of this strategy and that it was the most frequently used type of strategy is not surprising. My analysis of the research indicated overlapping characteristics of this strategy which provide the elaboration for four different aspects of OMR meaning-making strategies: (1) integrating modes to make coherent meanings, (2) making intertextual connections, (3) understanding context, and (4) understanding concepts. Readers used variations of this strategy under the umbrella of multimodal meaning-making. This strategy and the four subordinates were already commonly noted and described in the earlier reading studies. However, it is noteworthy to account for them further in the OMR setting and describe the unique attributes of strategic multimodal meaning-making.

Table 1

Online Multimodal Reading Strategies from the Reviewed Literature

Strategy types	Subcategories of Strategy	Reviewed Study	Grade/Level of education
Multimodal Meaning Making	• Integrating modes to construct coherent meanings	Casey (2012)	6th
		Chan & Unsworth (2011)	6th
		Cho (2014)	17
		Cho & Afflerbach (2015)	17
		Davis & Neitzel (2012)	6th & 7th
		Fitzgerald & Palinscar (2017)	6th
		Goldman et al. (2012)	Undergraduate
		Hamdan et al. (2017)	Undergraduate
		Karchmer-Klein & Shinas (2019)	8th
		Ketabi et al. (2012)	Undergraduate
		Klois et al. (2013)	13
		Lewis & Fabos (2005)	14-17
		Oh & So (2018)	Undergraduate
		Park et al. (2020)	Undergrad/grad
		Salmerón et al. (2020)	4-6
		Smith (2019)	10th
		Wolsey et al. (2015)	5th
		Chan & Unsworth (2011)	6th
	• Making intertextual connections across modes or texts to identify supportive or conflicting ideas among texts	Cho (2014)	17
		Cho & Afflerbach (2015)	17
		Cho et al. (2018)	7th
		Fitzgerald & Palinscar (2017)	6th
		Park et al. (2020)	Undergrad/grad
		Smith (2019)	10th
	• Understanding context or atmosphere by linking and adding up modes	Cho & Afflerbach (2015)	17
		Cho et al. (2018)	7th
		Fitzgerald & Palinscar (2017)	6th
		Karchmer-Klein & Shinas (2019)	8th
		Smith (2019)	10th
	• Integrating modes to understand vocabulary	Goldman et al. (2012)	Undergraduate
		Smith (2019)	10th

Multimodal Searching	• Searching for nonlinguistic visuals to understand concepts	Smith (2019)	10th
		Wolsey et al. (2015)	5th
	• Searching nonlinguistic modes to clarify, elaborate, or complexify meanings	Cho et al. (2018)	7th
		Park et al. (2020)	Undergrad/grad
Multimodal Evaluation	• Evaluating modes to determine task relevance of the information	Brante (2019)	15
		Cho & Afflerbach (2015)	17
		Cho et al. (2018)	7th
	• Evaluating credibility or reliability of the information or website by reading modes	Cho & Afflerbach (2015)	17
		Cho et al. (2018)	7th
		Goldman et al. (2012)	Undergraduate
		Kiili et al. (2020)	5th and 6th
		Klawitter & Hargittai (2018)	Adults
		Kohnen et al. (2022)	8th
		McGrew (2020)	11th
		Salmerón et al. (2020)	4th to 6th
		Wineburg & McGrew (2019)	Undergrad & Adults
	• Evaluate relatedness of information in different modes	Chan & Unsworth (2011)	6th
		Cho & Afflerbach (2015)	17
		Goldman et al. (2012)	Undergraduate
		Oh & So (2018)	Undergraduate
		Salmerón & García (2011)	6th
		Wolsey et al. (2015)	5th
Making Modal Choices	• Choosing modes according to reading purposes and goals	Hovious et al.'s (2020)	8th
		Karchmer-Klein and Shinas (2019)	8th
		Park et al. (2020)	Undergrad/grad
		Smith (2019)	10th
	• Choosing modes according to one's preference to accomplish tasks	Rasmusson & Eklund (2013)	Dyads of 10 and 15

	• Choosing modes according to one's apparent reading ability	Hamdan et al. (2017)	Undergraduate
Multimodal Navigation	• Setting reading paths for multimodal reading	Cho & Afflerbach (2015)	17
		Hamdan et al. (2017)	Undergraduate
		Karchmer-Klein and Shinas (2019)	8th
		Smith (2019)	10th
	• Selecting hyperlinks for multimodal navigation	Delgado et al. (2020)	Undergraduate
		Salmerón & García (2011)	6th
		Riddell (2016)	Highschool 13th
Multimodal Prior Knowledge Use	• Using prior knowledge of multimodal reading	Hovious et al.'s (2020)	8th
		Karchmer-Klein and Shinas (2019)	8th
	• Using reader's own prior knowledge about the topic or the modes	Cho et al. (2018)	7th
		Hamdan et al. (2017)	Undergraduate
		Hovious et al.'s (2020)	8th
		Martin & Wineburg (2008)	Graduate
		Park et al. (2020)	Undergrad/grad

Integrating Modes to Make Coherent Meanings

First, readers integrate modes to make coherent meanings of a topic or a concept. Eighteen out of thirty studies specified participants' use of multimodal meaning-making strategies during OMR in the reviewed literature. Under this category, readers synthesized modes (e.g., written words, videos, visuals, audio) to understand multimodal texts on the Internet. As a typical case, Oh and So's (2018) study showed that college students performed modes integration to understand a topic, the difference between the flat currency and cryptocurrency. One participant watched a YouTube video that contrasted two types of currencies by skipping over portions and pausing the video to read the text presented on it. Another reader located an illustration that compared the two, and he understood that these terms had been determined by supply and demand rules. This multimodal meaning-making strategy helped them better comprehend the concept or the topic more precisely.

Different reviewed studies showed a variety of multimodal integration: using visuals (e.g., image, photo, map, visual overview, slideshows, logo, graph, diagram), sound (e.g., music, background music, voice vocabulary pronunciation), videos (e.g., animation, interview, presentation), and written words (e.g., written sentences, hyperlink, popup vocabulary). From these various mode syntheses, readers typically resorted to a single mode—visual-centered or words-centered reading—and added other modes ancillary to that primary mode to make integrated meanings. For example, visual-centered meaning-making is shown in Hamdan and colleagues' study. A participant said, "I think when I look at the diagram first, I might have better understanding when I read the text" (Hamdan et al., 2017, p. 121). For the written words-centered case, Fitzgerald and Palinscar (2017) observed that a student pair read a written description of liquid nitrogen and supported their understanding with a video to return to reread it to clarify their understanding of the expansion of gases. These types of multimodal reading were the archetypes of OMR as demonstrated in Mayer's multimedia learning theory (2020) which described the cognitive processing using images and written words. Readers chose one mode type and added others according to their preferences or proximity of the modes to make meanings.

What was remarkable was the readers' flexible and purposive mode integration. They "moved from one mode to another, using whatever means necessary to achieve their goal of understanding" (Casey, 2012, p. 44). Debunking the long-standing written words-based reading education (Kalantzis et al., 2016), readers did not confine their reading to words or obligate themselves to begin multimodal reading with written words. Once they were given the reading task, readers thought out the most effective or familiar way to learn the topic and started with the most appropriate mode that might help them accomplish that goal. For example, in a focus group conversation on a multimodal story reading task, participants reported reading written words when describing the storyline, but they interpreted music to understand the character's feelings and atmosphere (Karchmer-Klein & Shinas, 2019). The ability to integrate different modes seemed important in OMR as skilled readers repeatedly used the phrases, 'work together', 'connections between modes,' and 'matching with' when explaining their multimodal reading. The research showed these participants' both shared and distinctive multimodal meaning-making strategies use.

Making Intertextual Connections

Readers made intertextual connections across multimodal texts to make meanings during OMR. This strategy demands readers to make intertextual connections across modes or texts to identify supportive or conflicting ideas among texts (see Table 1). Intertextuality involves the potentially complex ways meanings are constructed through relationships to other texts or modes (NLG, 1996). It represents the relationships among texts or between texts and relevant situations (Perfetti et al., 1999). Intertextual meaning-making is a broader concept than integrating modes because it also covers the relationship among texts. 'Text(s)' in OMR includes an external, symbolic representation, any linguistic or nonlinguistic sign that communicates meaning, and a tool that allows the reader to construct mental representations (Hartman, 1995; Rouet, 2006). Thus, multimodal reading fundamentally incorporates intertextual reading.

Moreover, intertextual reading includes connecting mental representations with historical chains the text draws upon and the transformations of the text (NLG, 1999). Multimodal reading is not free from these cultural, historical chains because every mode may have different intertextual connections with the ongoing reading or any time before the current OMR. Cho (2014) asserted that intertextual reading is an essential strategy for online reading because it entails diverse perspectives and information resources scattered across hyperlinks. Readers should form integrated mental models and source representations (Goldman et al., 2012) that may appear as reading paths and link selections using various modes during OMR.

Six studies specifically focused on and provided detailed accounts of how readers make intertextual connections during OMR, while this strategy generally appeared in the whole literature too. Cho (2014) and Cho and Afflerbach (2015) showed 10th-grade participants' intertextual meaning-making across multimodal sources on the Internet to identify supportive or conflicting perspectives around the obesity issue. Participants read charts, tables, research reports, articles, and numerical information to make intertextual connections. The authors said it was a "critical part of the process of assembling and reconstructing information from different sources into a coherent understanding of obesity issues. Such intertextual connection is a salient feature of the reading path … toward an integrated understanding of the texts" (Cho & Afflerbach, 2015, p. 510). Student pairs learning gas expansion from Fitzgerald and Palinscar's study (2017) also demonstrated intertextual connections by returning to modes that they had read earlier in the reading cycle (e.g., videos, images, simulations) and wove modes into their comprehension to elaborate it (Cho et al., 2018). The authors hypothesized that OMR supports intertextual reading since readers can easily access and return to multimodal texts whenever they want due to the advanced digital tools and functions (Fitzgerald & Palinscar, 2017).

Strategic OMR readers using intertextual meaning-making strategy also connected the modes they are currently reading with outward social issues (Smith, 2019). It is a typical situation model building procedure that readers associate a variety of linkages to “contemporary culture and political issues mediated through multiple modes,” which fosters personal connections to the text (Smith, 2019, p. 212). In Park et al.’s (2020) study, participants “made connections between the texts and themselves, other texts, and world knowledge—in ways that activated their prior knowledge and experiences” (p. 492). These associations are not confined to the modes they are currently reading but expand to their prior knowledge (see 2.2.6) about any activated information sources that are also very different by individual readers (van den Broek et al., 1999). Of note is that as the affordances of OMR allow readers to search for information whenever they need it, intertextual reading becomes more available (Cho et al., 2018) because online searching increases the possible associations with other modes with the ongoing mental representations.

Context Understanding with Modes

Thirdly, readers strove to understand contexts while reading online multimodal texts. They strategically linked modes or added new modes on the associated links (e.g., written definitions, charts, graphs, maps, slide shows, infographics, videos, music) to understand the context inherent in multimodal texts. Here, I use the term ‘context’ to include nuanced atmosphere, mood, or ambiance from the multimodal text. The object of meaning-making may not be clear nor specific in this case. Instead, readers should be able to understand subtle and general context spread out among the modes. This strategy is more typical for narrative or story genres and easily found in children's picture book reading or reading with sounds that imply the situation. For example, gloomy background music, dark background color, and thin fonts may hint the depressing mood described in the text. From the literature, two studies specified examples of context understanding with modes of narrative text reading, while the other three used informative texts.

Multimodal contextualization strategy was typically beneficial to sense the context (atmosphere, mood, or ambiance) from narratives (Karchmer-Klein & Shinas, 2019) or authors' intentions and background (Smith, 2019). Skilled eight-grade readers from narrative multimodal story reading used written words as central to their meaning-making and nonlinguistic modes (e.g., music, images, animated images) to scaffold their understanding of evoked feelings about the story and provided details (Karchmer-Klein & Shinas, 2019). For example, students inferred the changing atmosphere from the music switched from a fast-paced piece to a slow lullaby. They reported that audios supported their understanding of the character's feelings and repeatedly mentioned phrases like "work together, connections between modes, and matching with" (Karchmer-Klein & Shinas, 2019, p. 478). One participant's think aloud reflected his strategy to synthesize music, static images, and words to guess the context: "And then the staticky noise comes again and now its louder music. And I see this picture, which is like trees covered in snow. It looks like it's out a window. So, since the title said this is in Italy, I am guessing this is where they have a house in Italy" (Karchmer-Klein & Shinas, 2019, p. 478). Participants showed multimodal contextualizing patterns twofold: viewing visuals and listening to audios to connect them to the written words, and reading written words first and then using nonlinguistic modes to extend the constructed meaning (Karchmer-Klein & Shinas, 2019). Similarly, when tenth-grade readers attempted to understand literary themes through OMR, visual and aural modes were essential in understanding those themes as nonlinguistic modes served as means for inspiring abstract thinking and thematic explorations of literature (Smith, 2019, p. 211). Students' strategic multimodal contextualization offered a chance to interpret the author's motivations by navigating hyperlinked multimedia to analyze the historical background of the literature. They could get access to the authors' lives and their exigences for writing, which resulted in a more profound contextual understanding of the topic. Only three studies clearly showed context understanding during OMR, but I assume that readers may use it when they read multimodal narratives online.

Other studies showed that participants used this strategy for informative text reading, such as understanding historical climates (Cho et al., 2018) or social issues (Cho, 2014; Cho & Afflerbach, 2015). When a seventh-grade reader tried to understand the Dust Bowl in the 1930s in its historical context, he contextualized the event with images and words and watched interview videos of the witnesses to "create links between the accounts to support his contextual understanding" (Cho et al., 2018, p. 1542). Likewise, a tenth-grade participant read written texts and viewed various images describing children's obesity and poor living conditions. She moved within and between multimodal webpages that incorporated brief articles and images and realized, "Obesity is not necessarily caused by a diet or junk food but is also linked to poverty and living conditions" (Cho & Afflerbach, 2015, p. 510). This reader combined visual modes and written words to sense that such a social issue has more profound causes than it is described only in language.

Vocabulary or Concept Understanding from Modes

Strategic readers integrated modes to learn vocabularies and related concepts during OMR. They read images, used the Google translate function, listened to word pronunciation, and hovered over words to read popup vocabulary to understand the unknown terms. This strategy relatively appeared less under the multimodal meaning-making strategies category. However, it is still an essential basic strategy for all levels of readers since word knowledge may influence overall text comprehension, and various modes may help them learn new vocabulary effectively. For example, from Smith (2019), students did not know what 'Arabic tongue' meant, so they learned it from the popup vocabulary and kept reading. Smith referred to this strategy as "multimodally conceptualizing" and found that the readers viewed multiple images on the Internet to visually brainstorm abstract keywords (e.g., biculturalism, equality, American dream, identity, imperialism) by viewing and assessing images (Smith, 2019, p. 209). These nonlinguistic modes helped readers to hone their understanding of the specific vocabulary or concept meanings. The image searching strategy (see 2.2.2) is related to this strategy as students searched for images of words, scanned through the results, and came across proper images to understand them. For example, students searched for 'imperialism' and found an image of the United States flag encircling the earth. "Seeing, hearing, and discussing literary meaning facilitated their interpretation of specific vocabulary" (Smith, 2019, p. 214). From Goldman et al. (2012), advanced college readers also used this strategy to understand the concept of volcano. One student saw a map while reading words about the location of a volcano that appeared in the text to learn where it is. He also viewed various diagrams and maps on the website and connected the information to the words he was reading. By doing so, he "increasingly attempted to relate the different aspects of a volcanic system" (Goldman et al., 2012, p. 373).

In sum, the goal of the four types of meaning-making strategy — (1) integrating modes, (2) making intertextual connections, (3) context understanding, and (4) concept understanding — was to construct coherent meanings from various modes (Cho, 2014; Oh & So, 2018). Under the same multimodal meaning-making strategy, the synthesis of modes looked different to readers or reading tasks. A typical combination occurred between written words and visual images. Readers synthesized what they understood from written words and applied it to charts, tables, graphs, or diagrams (Cho & Afflerbach, 2015) or vice versa (Fitzgerald & Palinscar, 2017). Readers also listened to aural modes, such as music or videos with songs, to conceptualize themes multimodally (Smith, 2019). Since multimodal meaning-making was the group of strategies that appeared most frequently in the literature, I foresee its potential to be discovered more in-depth or in detail from other OMR studies in the future.

2.2.2. Strategies for Multimodal Searching

Readers used multimodal searching strategies to find the information they wanted during OMR (Cho et al., 2018; Fitzgerald & Palinscar, 2017; Park et al., 2020; Smith, 2019; Wolsey et al., 2015). Multimodal searching refers to searching modes (e.g., images, graphs, maps, videos, written texts) on the search engines (e.g., Google, YouTube, search tabs) purposefully according to the task or the topic. Mode searching often occurs in the middle of reading, but readers may use it from the onset if they can determine what mode type might bring them the best result. There were three different affiliated strategies under multimodal searching: (1) searching for visuals to augment concept understanding, and (2) searching for nonlinguistic modes to clarify or elaborate meanings.

Searching for Visuals to Augment Concept Understanding

This searching strategy refers to searching for visual modes for an initial understanding of concepts. From Wolsey et al. (2015), fifth-grade readers did photo searching to understand scientific concepts. Students were trying to understand what boiling and vaporization mean and began searching for visuals to support their comprehension. They transcended their poor conceptual understanding at the beginning and learned the concept and related terms more deeply. “They looked with precision at just what terms such as boil and boiling point meant and went well beyond everyday definitions to the more precise scientific definitions as they searched for photos they could include in their dictionary entries“ (Wolsey et al., 2015, p. 454). In addition, readers searched for visuals to show their understanding of the definition and ensure they have learned it. This strategic reconfirmation of the concepts helps deeper learning, transforming into their long-term prior knowledge. A teacher reported that “students learned more about the word at the conceptual level than she could have taught them directly” because seeking multimodal resources themselves required the students to critically evaluate how information is related to the word within the content area (Wolsey et al., 2015, p. 456).

Online image searching strategy was noted by Smith (2019) as well. In this research, tenth-grade participants collaboratively practiced visual brainstorming, which means conducting online image searches with keywords to view unlimited images to expand their conceptual understanding. They viewed and assessed multiple images and conversed about them to learn the concept. In addition, strategic readers intentionally searched nonlinguistic modes to inspire abstract thinking and thematic explorations. “Nonlingual modalities served as mediational means for inspiring abstract thinking, collaborative conversations, and thematic explorations” (Smith, 2019, p. 211). For example, students conceptualized themes by listening to music or watching videos. They searched videos on YouTube and found Michael Jackson’s ‘Heal the World,’ which provided a cohesive thread to understand the concept of ‘fear of change.’ Visual and aural modes were critical in their concept learning. Overall, it was noticeable that readers did not limit their mode searching to words and directly practiced visual searching strategies to attain their reading goals.

Searching for Nonlinguistic Modes to Clarify, Elaborate, or Complexify Meanings

Readers searched for nonlinguistic modes of information not only to learn concepts (e.g., material, content) but also to clarify, elaborate, or complexify the meaning they have already constructed. Cho et al. (2018) observed seventh-grade readers’ strategic visual mode searching when readers sought to access specific nonlinguistic sources to complement their knowledge about the historical dustbowl incident, including images (e.g., using search terms ‘photos’ and ‘what did the dust bowl look like?’) and videos (e.g., noticing and locating a survivor interview video link). These readers limited their additional searches to nonwritten modes of information, reporting, “I want to see some picture, and I want to see what the Dust Bowl looked like. So I search for images (typing in the search term “dust bowl”; clicking on image links), and I choose this photo, saying The Dust Bowl” (Cho et al., 2018, p. 1535). This report shows a typical visual mode searching strategy when readers want to clarify their initial understanding of conceptual knowledge or the prior written words reading. As a step further to the initial understanding, the visual/pictorial modes provided supportive, additional information for readers. From this research, strategic online readers knew how to use online, nonlinguistic modes searching for this purpose, making their meaning elaboration process more successful.

This strategy also appeared in Park et al.'s (2020) digital text reading study with international undergraduate students. To get clear and specific information from OMR on tablets, these readers preferred to read multimodal texts on the Internet (e.g., words, images, audio, videos, games). As Karchmer-Klein and Shinas (2019) noted from multimodal contextual meaning-making strategy (see 2.2.1), participants preferred multimodal reading with visual and aural modes, but they still collected important information from written words (Park et al., 2020). They accessed images adjacent to the written words or searched for more images to enhance their understanding of words. For example, one participant searched for images of the furniture in addition to the written information about the desk she was buying to clarify information to make a decision. Another participant frequently accessed videos when reading a recipe because "it was clearer and easier to see the cooking process on video" (p. 491). As readers hone their understanding from modes searching, they sometimes do not end OMR with the initial, basic learning. They search nonlinguistic modes to clarify, elaborate, or even complexify it to delve deeper into the topic to learn more from search results.

2.2.3. Strategies for Multimodal Evaluation

Readers used multimodal evaluation strategies to determine if the text they read was credible or related to their reading purposes. Alexander (2020) described the reasons for a flood of inaccurate or misleading information on the Internet era as (1) an exponential increase in the amount of information and a concomitant increase in the amount of erroneous information, (2) far greater ease and speed of access to information and far fewer filters to monitor the quality of that information, which engenders false, biased, or malicious content, (3) enhanced technological innovations that intentionally fabricate or distort information to mislead readers. Therefore, strategies for readers to evaluate information remain of utmost importance (Alexander, 2020; Fabos, 2008; Leu et al., 2013).

Even if the information is trustworthy, readers must decide whether the text or the modes they read will be useful for their reading tasks. Also, they should be able to discern the relatedness of the information from different modes they are reading during OMR to reach their reading goals effectively. Accordingly, I identified three strategies from the literature: (1) Evaluating task relevance by reading modes, (2) Evaluating credibility by reading modes, and (3) Evaluating relatedness of information in different modes.

Evaluating Task Relevance by Reading Modes

There were two evaluation strategies for determining task relevance: (1) evaluating the usefulness of the multimodal text (Cho et al., 2018; Brante, 2019) and (2) evaluating the design features of the multimodal text (Cho & Afflerbach, 2015). Firstly, readers used the strategy of sourcing through visual inspection with other language markers to evaluate the credibility of information. Brante (2019) examined how high school readers perform sourcing strategies when selecting, reading, and integrating information for a group task. Although most of the sourcing occurred with written words, students also used what the author called *visual inspection*, such as viewing fonts or colors, to find helpful information to examine whether they should use the multimodal text or not. Similarly, a seventh-grade student from Cho et al.'s (2018) study saw images from the News articles about a historical event and evaluated whether it is a useful source that he could use for contextualizing the event or not. He reported, “I think this source [the webpage article] is good. There are pictures. There’s a nice article, and the article looks like it has lots of good facts (p. 1541).” Evaluating website design features was a similar strategy that a high school reader used in Cho and Afflerbach’s (2015) study. This participant carefully viewed websites’ designs to predict the relevance of information she might get. After she felt the website looked okay to read, she initiated reading. She also checked the menus and linked videos to determine the reliability and relevancy of the information. These excerpts show that during OMR, readers use multimodal evaluation strategies to judge the task relevance of the texts they read or going to read by examining the usefulness or design features.

Evaluating Credibility by Reading Modes

It may be harder to locate credible sources on the Internet compared to reading books or newspapers because of differing standards and rules for acceptance. As with traditional print, it is crucial for online readers to find trustworthy texts to accomplish their reading goals. From the literature, readers performed multimodal evaluation strategies during OMR to judge the credibility of the text they faced (Cho et al., 2018; Cho & Afflerbach, 2015; Goldman et al., 2012; Kiili et al., 2020; Klawitter & Hargittai, 2018; Kohnen et al., 2022; McGrew, 2020; Salmerón et al., 2020; Wineburg & McGrew, 2019). In a case study of two college readers from Goldman et al. (2012), a reader used a visual evaluation strategy to decide the website's trustworthiness. The reader said, “There’s a NASA logo in the corner, so it seems this might be a more credited site.” (p. 373). Although all the evaluation sources were in visual mode, the fact that readers used a multimodal evaluation strategy, not only written words, to evaluate online texts was noteworthy. Visual evaluation can be applied to written words, images, videos, layouts, and so on, as these modes are presented visually (e.g., length of written words, paragraph style, the neat layout of the webpage, quality photographs, well-designed thumbnail of a YouTube video with proper running time). Evaluation standards may differ, but strategic readers should be able to decide whether these modes seem credible during OMR. Likewise, 76 diverse American adults used multimodal evaluation strategies when seeking online health information (Klawitter & Hargittai, 2018). These participants negatively evaluated online information's credibility when the text violated their expectations. Especially, they judged webpages' design and aesthetic appearance with other aspects, such as content, length, or domain names to judge credibility. They also looked at logo images (e.g., Harvard Medical School) or advertisement banners around the text to guess if the text is trustworthy or unreliable because it is sponsored. One reported, "it appeared to be a decent, legitimate site, and I based that on appearance, too. It's like you judge people. Sad but true" (Klawitter & Hargittai, 2018, p. 261). This study shows that multimodal, especially visual evaluation of the text or the source of the text, can be a common OMR strategy even for adult online readers.

Participants also performed multimodal evaluation strategies related to embedded videos. A student from Cho et al.'s (2018) study of online historical texts reading purposefully searched for interview videos on the Internet to improve his contextual understanding of the Dust Bowl. He determined that the video was "really a reliable source because they are someone who was in the storm" (p. 1541). He connected links between images, words, and videos to support his understanding. Primary school students could perform multimodal evaluation strategies using videos and written words together. Salmerón, Sampietro, and Delgado's (2020) study showed 207 grade four to six students' multimodal evaluation strategies for deciding what is healthier between tap or bottled water. The authors found that these readers also critically used multimodal sources (e.g., the appearance of the people in the video, voice tones, written transcripts on the video) to evaluate information, albeit imprecisely. The students trusted what the person with a doctor's white coat said more than with a sales manager's outfit. They remembered what the doctor said more than in other videos because they combined the verbal and visual information from the video, making the information more credible. Also, the students were more persuaded to change their side when they listened to the human voice than written texts. The authors viewed that the "authoritativeness of print in early readers may disappear as students read different modes of texts on the Internet outside school" (Salmerón et al., 2020, p. 11).

Evaluating Relatedness of Information in Different Modes

Evaluating the relatedness of information from different modes is one of the initial reading processes in OMR because multimodal reading begins with the awareness of the connections between modes. It is related to the multimodal meaning-making strategies, integrating modes especially, but I categorized this strategy as the evaluation process of modes. For example, readers can determine the gist of the written words and the photo they read after sharing the same topic contents and begin making connections between them. It is a fundamental strategic thought for multimodal reading.

Reviewed studies that specified readers' strategies to evaluate the relatedness of modes showed that during OMR, readers (1) determine the contribution of each modal information (Oh & So, 2018), (2) select hyperlinks to maximize the relationship between what they are reading depending on the cohesiveness of the contents (Salmerón & García, 2011), (3) connect different modes (e.g., diagrams, maps, written words) of information to relate different aspects of a topic (Cho & Afflerbach, 2015; Goldman et al., 2012; Wolsey et al., 2015), and (4) find equivalent or complementary information in words and image (Chan & Unsworth, 2011; Wolsey et al., 2015). This strategy is typically performed when readers try to gather different modes of information spread out on the multimodal webpages according to the semantic cohesion of the information they are looking for. Finding visuals that readers believed matched the scientific terminology they were reading was one of the examples (Wolsey et al., 2015). To do so, readers should be able to find the similarity or differences of the information that modes deliver, understand the meanings, and evaluate the relevancy between the modes to decide whether they want to integrate them. A fifth-grade student reported, “Sometimes you need pictures to explain something difficult. We wanted the picture to be perfect” (Wolsey et al., 2015, p. 456).

However, evaluating the relatedness of multimodal information can be challenging. Chan and Unsworth’s (2011) study analyzed image-text relations encountered in the typical online multimodal webpage reading tasks. 32 sixth-grade readers with high, medium, and low performance on the Australian state reading comprehension tests participated. Researchers figured that finding matching information in words and images was the easiest for all participants since the redundancy in meaning where the content corresponds across modes facilitated accomplished meaning-making. When the modes were complementary, the score got lowered in this order: (1) distribution (complementary meanings are distributed across image and text), (2) augmentation (image provides additional ideational elements to text or vice versa), and (3) divergence (text content of image/text is opposed or at variance). Some readers only focused on one type of mode, missing more relevant information spread across modes. When the text was lengthier and the written words were more complex, only 31% of the readers could answer the questions. As these difficulties exist, it is imperative to teach students how to evaluate the relatedness of modal information during OMR.

2.2.4. Strategies for Making Modal Choices

Readers make strategic modal choices during OMR. It refers to choosing modes in the text according to the reader's (1) reading purpose, (2) modal preference, or (3) reading ability. This strategy may depend on individual differences or prior OMR experiences. Several studies from this review delineated readers' strategic mode choices from OMR.

Firstly, readers' choice of modes was influenced by their reading purposes or task goals. Readers choose modes that might bring them to the most efficient information to accomplish their reading purposes. In Smith's (2019) study, tenth-grade American students strategically selected mode types to understand poems. Participants used nonlinguistic modes to catch the abstract themes that the poems imply. One student reported, "I thought putting images first would help me to understand the poem better with seeing it visually than just reading it" (p. 210). Other students conceptualized themes by aural modes (listening to music) and audiovisual modes (watching videos). Nonlinguistic modes served as means to explore abstract literary themes, and these participants naturally chose modes that might help them to do so. Delivering abstract meanings through nonlinguistic forms can be more effective and straightforward. Likewise, readers from Karchmer-Klein and Shinas (2019) and Hovious et al.'s (2020) research also picked visual modes (e.g., animation, color) to understand the digital narrative. These studies both examined how eighth-grade readers comprehend an online multimodal narrative story. The data suggested that readers brought their prior experience of OMR to this task to choose modes for different purposes. For example, they relied on written words to learn story elements and read nonlinguistic modes to understand the tone and details of the story. The participants utilized flexible approaches to navigate the story by selecting different modes. This pattern was also shown by adult readers from Park et al. (2020). While undergraduate readers found information online, they gathered clear and specific information from written words and purposefully accessed images to enhance and elaborate their understandings. When they were getting the information, they viewed images along with written words or searched for images, used Google maps, listened to the audio, and watched videos according to their reading tasks. For example, one participant chose video mode rather than written descriptions to understand a recipe, saying, “I was confused when I read the texts about the recipe, but it was clearer and easier to see the cooking process on video” (Park et al., 2020, p. 491).

Next, readers choose what modes to read by their preferences to accomplish tasks. While most reviewed literature showed different levels of readers’ strategic mode choices presumably driven by their preferences, one study specifically mentioned this preference-based multimodal reading from their description (Rasmusson & Eklund, 2013). Here, a dyad of 10 and 15-year-old Swedish students were supposed to explain the difference between hip-hop and hard rock by reading multimodal articles on the Internet. The students preferred the mode of a music video to complete the task compared to reading written words, although they could make meanings using other modes such as pictures and written words. As a result, they got more information from this video since it had better affordances to understand the topic.

Finally, readers choose modes according to their apparent reading abilities. The reading ability includes the actual reading performance levels or the assumed diagnoses of reading proficiency by readers themselves implied by readers' reports. From Hamdan et al. (2017), undergraduate readers intentionally chose to read specific modes that suit their reading proficiency to understand the teaching models they were learning. One junior student said, "when I do not understand the passage, I will watch the video provided. It improves my comprehension" (Hamdan et al., 2017, p. 121). These authors pointed out that readers must be able to choose modes that would be beneficial for them to learn whether a reader selects modes by their preferences or abilities. Participants from this study also chose modes by their reading preferences. Likewise, modal choices can be derived from more than one reason, but the authors emphasized that readers be "smart in choosing the materials that would help them comprehend" (Hamdan et al., 2017, p. 121). It demands strategic modal choice, understanding of multimodality, and metacognitive thinking that can monitor readers themselves as OMR occurs.

2.2.5. Strategies for Multimodal Navigation

The literature revealed that readers set reading paths for multimodal reading during OMR. It means that accomplished readers purposefully set the reading order of modes as soon as they saw the new multimodal text. It is an important organizational strategy essential for reading on the Internet filled with hyperlinks. I found two different strategy types of multimodal navigation that readers used during OMR: (1) setting reading paths for multimodal reading and (2) selecting hyperlinks for multimodal navigation.

Firstly, readers set reading paths from the beginning of the multimodal reading. From Hamdan et al. (2017), a participant said, "…when I look at the diagram first, I might have better understanding when I read the text." This quote shows that reading paths influence the quality of understanding and readers use this strategy to plan their reading for better reading performance. For example, a reader could skim a multimodal text and quickly plan to read menus and graphic organizers first, read important paragraphs, and then watch related videos. A reader from Cho and Afflerbach (2015)'s study also reported that she makes continuous decisions about where to navigate to find information and thinks about how to sequence her reading between and across multiple texts. This strategy differs from the multimodal evaluation (see 2.2.3) because the purpose of imposing various criteria of text quality and usefulness here is not primarily for judging credibility or usefulness, but for setting efficient reading paths. As navigation and making paths through hyperlinks are essential in online reading, navigating through modes and deciding what modes to read become important.

Most navigation patterns from the literature were viewing visuals (e.g., graphic organizers, images, charts, graphs) first and then applying them to relevant written words. For example, an interview showed that when learning a complex concept, a reader looks at pictures first, visualizes and thinks about them, and interprets written aspects of the concept (Smith, 2019). Similarly, a typical pattern -- Karchmer-Klein and Shinas (2019) named it "modal connections" (p. 478) -- of digital storybook reading revealed that readers "look at the images and listen to the sounds, infer what was taking place and then connect or confirm their inference to the written language" (Karchmer-Klein & Shinas, 2019, p. 478).

The opposite approach was also common in multimodal navigation. It was to read written words first and then move to nonlinguistic modes to extend or elaborate meaning (Karchmer-Klein & Shinas, 2019). For example, a reader glances at words first and then looks at the picture. Since it is hard to anticipate what would come up on the new webpage, OMR demands readers' flexibility more than reading traditional printed books with static written words (Karchmer-Klein & Shinas, 2019). These two reports from Hamdan et al. (2017) indicate readers' flexible yet contrasting multimodal navigation strategies: "So when I do not understand the passage, I will watch the video provided." "I think when I look at the diagram first, I might have better understanding when I read the text" (Hamdan et al., 2017, p. 121).

Next, readers selected hyperlinks strategically to navigate different modes or multimodal texts. Hyperlinks are one of the unique modes that the Web offers; generally in written words mode, but it is clickable and links to another webpage, usually indicated by blue (before click) and purple (after click) colors. In OMR, there are various forms of hyperlinks (e.g., icons, pictures, GIFs, videos) in addition to typical written modes. Readers should be aware of where their clicks might bring them to and remember their reading goals to manage their online reading threads. Sixth-grade Spanish students from Salmerón and García's (2011) study performed cohesive hyperlinking strategies while reading a multimodal text about daily lives in ancient Rome. The cohesive hyperlinking strategy refers to selecting links to maximize the semantic relationship between the part just read and the next one. The authors found this strategy positively correlated with higher comprehension scores. These students used hyperlinks regardless of having a reading goal. However, it was clear that good OMR readers navigated through cohesive hyperlinks, which led them to comprehend the text better.

2.2.6. Strategies for Multimodal Prior Knowledge Use

Research describes readers using multimodal strategies related to prior knowledge. Similar to traditional reading, readers' prior knowledge is activated in each reading cycle. van den Broek's Landscape model helps describe this activation as readers access and use prior knowledge from (1) the text or mode currently being processed, (2) the preceding OMR cycle, (3) reactivated concepts from the earlier reading cycles, and (4) the reader's own background knowledge (van den Broek et al., 1999). This prior knowledge activation occurs in each reading cycle, including reading new sentences, modes, or texts in OMR. This process can be both intentional (strategic) and unintentional (automatic). Research indicates there are two kinds of prior knowledge used under this strategy: (1) prior knowledge of multimodal reading and (2) the reader's own prior knowledge about the topic or the modes.

Firstly, readers recalled and used prior knowledge about multimodal reading or their prior OMR experience (Hovious et al., 2020; Karchmer-Klein & Shinas, 2019). From the study of eighth-grade readers' digital multimodal narrative reading, readers used their knowledge of multimodality to comprehend the story using images, moving images, sounds, and written words (Karchmer-Klein & Shinas, 2019). Participants acted based on their understanding of reading modes in combination to understand the text (Hovious et al., 2020). They were aware of the mode integration and the purposes of each mode type; written language is for communicating the meaning of story elements, and nonlinguistic modes (e.g., music, images, animated images) as a way to set the atmosphere and add details (Hovious et al., 2020).

Readers also used the second type of prior knowledge during OMR—that of the topic or reading content. Readers used their prior knowledge about the topic or the modes they were reading. Prior knowledge is often activated automatically, and when it is automatic, it is no longer considered strategic (Afflerbach et al., 2008). Therefore, I counted the reading process in if I could see the reader's intention or attempts to connect their activated prior knowledge to multimodal reading. Only Hamden et al. (2017) clearly described this strategy by stating that "students were able to construct new knowledge by relating it (picture, table, diagram, video, audio) with previous knowledge, either from the existing texts or other previous ones" (p. 121). However, as situation model construction is fundamental to OMR, I assume that this strategy underlies any process of OMR. For example, both Park et al.'s (2020) undergraduate readers and Hovious et al.'s (2020) middle school readers applied their prior knowledge to connect the text and themselves or between texts. They recalled their experience to understand the information presented from the modes. One reader read a multimodal text about snowboard champion Chloe Kim and connected her knowledge of the Korean language and her prior experience of hearing about the ski place to understand it (Park et al., 2020). Watching a video and viewing images helped her comprehend the contents. The author referred to it as connecting texts and world knowledge (Park et al., 2020). The reader reported, "I like winter and love to go skiing. Chloe Kim sounds like a Korean name, and she is a snowboard champion. (playing a video) Oh, yeah. They are Korean. This is an interesting place that I have never heard about before" (Park et al., 2020, p. 493). Middle school students from Hovious et al. (2020) also performed this strategy while they were reading an online multimodal story. One reader recalled his memory of the snow scene and said, "I thought back to my own experiences because my parents have been out and me and my brother would be home alone during a snowstorm. Or just if it was dark outside and you get really worried, trying to decide what to do, whether or not they're going to come home"

(Hovious et al., 2020, p. 224). The author described that these modes supported readers' text comprehension and asserted that using multimodal texts for literacy classrooms should be a critical consideration.

2.2.7. How OMR Strategies Influence Meaning-making

Additionally, I examined the literature to answer the second research question, "How do the online multimodal reading strategies contribute to the readers' meaning-making?" I figured how the six taxonomized OMR strategies—strategies for (1) multimodal meaning-making, (2) multimodal searching, (3) multimodal evaluation, (4) making modal choices, (5) multimodal navigation, (6) multimodal prior knowledge use—positively or negatively influence individuals' meaning-making. Also, I tried to mark any noteworthy attributes around OMR.

How OMR Strategies Support Online Readers' Meaning-making

Successful OMR comprehension results in a coherent mental representation and a situation model building by reading two or more modes together (Kalantzis et al., 2016; Kintsch, 1998; Pressley & Afflerbach, 1995). From the reviewed literature, thirteen out of thirty studies indicated readers' increased text comprehension by using OMR strategies in their result or discussion sections (Casey, 2012; Cho, 2014; Cho & Afflerbach, 2015; Delgado, Lund, Salmerón, & Bråten, 2020; Fitzgerald & Palincsar, 2017; Goldman et al., 2012; Hamdan et al., 2017; Karchmer-Klein & Shinas, 2019; Klois, Segers, & Verhoeven, 2013; Salmerón, & García, 2011; Salmerón, Sampietro, & Delgado, 2020; Smith, 2019; Sullivan & Puntambekar, 2019). From these study results, using OMR strategies enhances text comprehension. In contrast, four studies (Cho & Afflerbach, 2015; Karchmer-Klein & Shinas, 2019; Kiili, Bråten, Kullberg, &

Leppänen, 2020; Klois et al., 2013) depicted adverse effects of OMR strategies on text comprehension. Among them, three overlapping studies (Cho & Afflerbach, 2015; Karchmer-Klein & Shinas, 2019; Klois et al., 2013) described both benefits and drawbacks of OMR strategies for reading comprehension. I searched if those studies mentioned any positive or negative results of OMR strategies use in any part of the articles and analyzed them to categorize the effects (see Table 2). The reviewed research demonstrated overall positive effects of OMR strategies on text comprehension or task accomplishment if they stated the effects at all. Five emerging aspects indicate the positive influence of OMR strategies on text comprehension.

Table 2

Effects of OMR Strategies Use for Readers' Text Comprehension

Effects	Description (How each study described the effects of OMR strategies)	Reviewed Research
Positive Effects	Through the multimodal reading project, students accumulated a basic understanding of their group's body system.	Casey (2012)
	Participants were engaged in constructing critical questions by incorporating what they had gained from the Internet multimodal texts reading with their own prior knowledge.	Cho (2014)
	A participant learned from the diverse multimodal sources that she has realized and constructed on the Internet. As a result, she was able to pinpoint a critical issue related to childhood obesity.	Cho & Afflerbach (2015)
	Participants used embedded hyperlinks in multiple documents to make source-content integration. Reading conflicting arguments through hyperlinks helped readers to figure conflicts and to connect text sources.	Delgado et al. (2020)
	Participants learned concepts regardless of prior knowledge. They made frequent use of the learning support features, including the multiple representations and multimodal text.	Fitzgerald & Palincsar, 2017
	Better learners used more monitoring and evaluation strategies during OMR to determine what they understood from the information provided and whether it was scientifically credible or task relevant.	Goldman et al., 2012

	Hyperlinks and glossary provided on the websites helped facilitate a better understanding of the reading materials. The hyperlinked and multimodal word support helped readers with learning keywords.	Hamdan et al., 2017
	Skilled readers utilized nonlinguistic modes to understand the tone and details when reading digital narratives. They connected different modal information and flexibly understood what was happening from the story.	Karchmer-Klein & Shinas, 2019
	Readers produced more complex and detailed mind maps when they read the multimodal hypertext with an overview. Also, this type of text shortened their navigation patterns by reducing linearity and increasing the flexibility of reading paths. It helped readers focus more on the content of the texts.	Klois et al., 2013
	Reading skills showed positive influence on comprehension and on the use of the cohesive hyperlinking strategy. The overview processing strategy helped comprehension.	Salmerón, & García, 2011
	Participants remembered the doctor's occupation more often if they watched the video than if they read written words. Readers captured the spoken words and visual information together to remember the contents. Students may trust sources depending on the modality by critically using multimodal sources to evaluate information.	Salmerón et al., 2020
	Multiple modes influenced students' comprehension of literature in a variety of impactful ways. Seeing, hearing, and discussing literary meaning facilitated their interpretation of specific vocabulary and literary devices before writing.	Smith, 2019
	Learning outcomes showed that students learned knowledge of the physics concepts presented in the online texts regardless of the prior knowledge.	Sullivan & Puntambekar, 2019
Negative Effects	• Not all the strategies Amalie (the participant) used were effective. • However, her strategies contributed to her identifying and learning important ideas from Web sources, evaluating the sources, and monitoring her own thinking processes during OMR.	Cho & Afflerbach, 2015
	• Skilled readers were challenged at times when navigating the narrative OMR due to the distractions (e.g., written words faded away, moving words). • Frustrations and confusion occurred with the puzzles without instructions. • Participants recognized the variety of modes but were not always able to make sense of how they were supposed to use them to navigate. • None of the students caught some nonlinguistic modes and just focused on written words, assuming they are tangential rather than central to meaning-making.	Karchmer-Klein & Shinas, 2019

	• Most students were able to take an explicit stance on the issue in question, but corroboration and sourcing are very sophisticated strategies for them. • Nearly 1/3 of participants based their written product on only one information resource or no resource at all. • Some effort to integrate ideas within and across the online resources were observed, but students mainly copied and paraphrased textual information to construct their emails. • Showing strategies and comprehension through written products was difficult for elementary students.	Kiili et al., 2020
	• Participants learned more in the written text with overview condition as opposed to the hypertext condition. • They learned just as much in the hypertext and hypertext with overview conditions as in the regular linear text. • The result of comprehension was not relevant to text types or provision of the graphical overview. Providing OMR texts was not effective.	Klois et al., 2013

Firstly, one of the most prominent aspects was that OMR strategies help readers' concept or content understanding from text reading (Casey, 2012; Fitzgerald & Palincsar, 2017; Klois et al., 2013; Salmerón et al., 2020; Smith, 2019; Sullivan & Puntambekar, 2019). According to the pedagogy of multiliteracies, "conceptualizing involves the development of abstract, generalizing concepts, and theoretical synthesis of these concepts" (Cope & Kalantzis, 2015, p. 19). When readers conceptualize things, they can use terms that reduce the ambiguities and assemble mental models so that the world comes to have deeper meanings (Cope & Kalantzis, 2015). Participants from the thirteen studies read modes together using multimodal meaning-making strategies (see 2.2.1) to build conceptual knowledge or understand basic text contents.

For example, Smith's (2019) study was representative of the successful use of multimodal meaning-making strategies and provided rich accounts of participants' thought processes. The researcher examined tenth-grade student groups on how literary interpretation is transformed when mediated through various modes. Smith determined that multiple modes, including videos, maps, infographics, or photos, served as valuable tools for readers to build situation models. Readers could expand and confirm their comprehension with various modes using *Integrating modes to make coherent meaning* strategy. The *Context understanding with modes* strategy provided the means to understand the context of the literature. One student reported, "We are learning things I did not know!" (p. 212), indicating that a new knowledge comprehension occurred. Another student said that visuals (e.g., photos, cartoons, videos) helped her to "see literature," which led her to a better understanding (p. 214). Notably, students also used *the Making intertextual connections* strategy to make multimodal connections linked to speeches, literature, plays, artwork, songs, and TV shows that were external to (i.e., they did not appear with) the provided texts. They activated their prior knowledge and made intertextual connections with current reading to build situation models. Smith reported, "Multiple modes mediated students' comprehension of literature in a variety of impactful ways. Seeing, hearing, and discussing literary meaning facilitated their interpretation of specific vocabulary and literary devices before writing" (Smith, 2019, p. 215). Incorporating quantitative analysis of the influence of OMR on comprehension, Fitzgerald and Palinscar (2017) studied sixth-grade science class's OMR reading to understand the relationship between nitrogen and temperature. Using *Multimodal Meaning-Making* strategies, students synthesized a brief text and a video to construct a coherent meaning that temperature played an important role in the size of the balloon filled with nitrogen. They frequently used learning support features, including multiple representations and multimodal text. The researchers assessed this conceptual understanding before and after the reading. The result showed that regardless of their prior knowledge, participants made significant growth in the assessment of conceptual understanding by OMR. As a result, student pairs could clearly explain their ideas to their partners and provide evidence from multimodal texts and other observations to support their claims (Fitzgerald & Palinscar, 2017).

Secondly, readers engaged in critical reading comprehension using OMR strategies (Cho, 2014; Cho & Afflerbach, 2015; Delgado et al., 2020; Salmerón et al., 2020). For example, two related studies (Cho, 2014; Cho & Afflerbach, 2015) involved a critical online reading task; making critical questions about a social issue. These authors focused on general multiple texts reading strategies for reading on the Internet. However, the texts the participants faced were multimodal, where OMR strategies were naturally facilitated, such as meaning-making, searching, evaluating, and monitoring for this task. Cho (2014) described that readers were engaged in making meanings across modes as a result of using *multimodal meaning-making* strategies, and this strategic reading "helped them identify supportive or conflicting ideas and perspectives among the texts" (Cho, 2014, p. 273). Readers understood semantic sentences, but more importantly, they integrated their prior knowledge, experience, and what they learned from the current mode reading to construct situation models. Cho and Afflerbach (2015) focused on one participant's reading from Cho (2014). They accounted that these online reading strategies, involving *making modal choices,* and *multimodal navigation* strategy, helped the reader to navigate the Internet to determine the relevance to her goals and to select hyperlinks that contributed to meaning-making. "Her strategic choices contributed to the construction of meaning, deciding what to read and what to ignore, and how to sequence her reading between and across multiple texts" and "her strategic examination and selection of hyperlinks on the

Internet is a critical part of the process of assembling and reconstructing information from different sources into a coherent understanding," accounted by the authors (Cho & Afflerbach, 2015, pp. 510-511). As a result, she understood the diverse sources that she had realized and constructed on the Internet and response to the issue of childhood obesity (Cho & Afflerbach, 2015).

Thirdly, three studies reported enhanced task performance using OMR strategies (Cho, 2014; Goldman et al., 2012; Klois et al., 2013). Goldman et al. (2012) reported, higher achieving learners used more monitoring and evaluation strategies – *multimodal evaluation* strategies during OMR – to clarify what they understood from the information provided, and determine the credibility of content and relevancy to the task at hand. An undergraduate student from this study used one of the most typical OMR strategies, *Integrating Modes to Make Coherent Meanings*, when reading diagrams and maps to connect with the written words. An essay writing about what causes volcano eruption and the pre and post-science inquiry test about conceptual knowledge of volcanoes took place. As a result, he showed increased knowledge of the volcanic system (Goldman et al., 2012). Accomplished online readers approach their reading tasks strategically using their knowledge about OMR (Hamdan et al., 2017). An undergraduate student reported that she would watch videos if she does not understand written words because she believes the additional information source may help to improve comprehension. Another student agreed and said, "I think when I look at the diagram first, I might have better understanding when I read the text" (Hamdan et al., 2017, p. 121). OMR strategies, *Multimodal Prior Knowledge Use*, in particular, helped the participants obtain a better comprehension of reading models of TESL, which was the given task because readers could construct knowledge by relating modes with prior knowledge either from the existing texts or other previous ones. In another study, readers produced more complex and detailed mind maps when reading the hypertext with a graphic overview (Klois et al., 2013). These readers used *integrating modes to make coherent meanings* strategy to accomplish their tasks and accordingly showed an enhanced task quality.

Fourthly, OMR strategies helped readers comprehend narrative genre texts (Hovious & Shinas, 2020; Karchmer-Klein & Shinas, 2019; Smith, 2019), indicating that their benefits are not confined to informative text reading. Skilled readers utilized nonlinguistic modes to sense the ambiance, atmosphere, tone, or details of the digital literature genre (Karchmer-Klein & Shinas, 2019). Both Hovious and Shinas (2020) and Karchmer-Klein and Shinas (2019) interviewed and examined eighth-grade US students' online multimodal story reading called *Inanimate Alice*. This story was intentionally designed to present a cohesive multimodal digital narrative (Karchmer-Klein & Shinas, 2019). The participants used various OMR strategies, including Integrating modes to construct coherent meanings, Understanding context or atmosphere by linking and adding up modes, Choosing modes according to reading purposes and goals, Setting reading paths for multimodal reading, Using prior knowledge of multimodal reading, and Using reader's own prior knowledge about the topic or the modes. Readers used modes to understand the story and drew on semiotic meaning construction. The strategies showed the benefits of studying transmedia narratives and provided the potential to use them in reading instructions. Participants from both studies used visuals and music as salient modal information to explain their successful sensemaking experiences. Also, Smith (2019) described a variety of OMR strategies and multiple modes used for digital narrative reading. Readers performed multimodal brainstorming about literary themes using nonlinguistic modes (e.g., visuals, music, videos). They used *multimodal searching* strategy to find online images to understand abstract poetic themes such as biculturalism, equality, and identity and viewed and assessed the search results. Bilingual Latina students in the US searched “dying dreams,” which stood out from the poem they had to comprehend. They found a picture of a dandelion with half its spores blowing away. Using *multimodal prior knowledge activation* strategy, they connected this picture to their prior knowledge about African Americans being forced to defer their dreams because of racial discrimination. One reported that searching and viewing images helped her understand the poem better than just reading written words. Students also described how visuals allowed them to “see literature” (Smith, 2019, p. 214). From the interview, one participant reported, “When you’re looking at pictures, you can visualize it and you can think of it. It really helps to understand” (Smith, 2019, p. 214).

Lastly, readers used multimodal word support to better understand written words, using *vocabulary or concept understanding from modes* strategy (Hamdan et al., 2017; Smith, 2019). Hyperlinks and glossary provided on the websites helped readers better understand the reading materials. The hyperlinked and multimodal word support helped readers learn keywords from the text (Hamdan et al., 2017). Bilingual students suggest various multimodal word support options, including conducting image searches, using Google Translate, listening to words or phrases online, or pop-up vocabulary functions (Fitzgerald & Palinscar, 2017; Smith, 2019). Presumably, this strategy can also be helpful for English learners and lower-level readers. One of the benefits of using the Internet is that readers can search words at any time of the reading process and get the result in multimodal forms. Reduced time and energy for searching unfamiliar words support readers to quickly search for terms, learn them, and resume reading.

For example, readers conducted an image search (using *searching for visuals to understand* strategy) for ‘imperialism’ since they lost the way to deliver it to other readers. They scanned their search results and found an image of a flag encircling and choking the earth. The readers reported that the image depicted “exactly” what they “were trying to say” (Smith, 2019, p. 214).

Summary of Benefits of OMR Strategies

Based on the research review, OMR strategies can benefit meaning-making because they focus on different information sources that supplement one another. It means that two or more modes may possess different information or ways of delivering that information while sharing the same idea. From the study about fifth graders learning the vaporization process, Wolsey et al. (2015) determined that students have deeply understood the complex scientific concept and related terms through OMR. Students read written words about vaporization and searched for pictures of boiling water where vaporization occurred not only on the surface but also throughout the liquid. Accordingly, students looked at terms such as ‘boil’ and ‘boiling point’ precisely and strengthened their understanding using multimodal searching and multimodal meaning-making strategies. It could not have happened with this much precision if they only read written words explaining the boiling process. In this research, locating a visual image for the term made them understand challenging concepts, as one participant reported, “Sometimes you need pictures to explain something difficult” (Wolsey et al., 2015, p. 456). Another participant described this multimodal learning project as “was like bubble gum… the more you chew it, the more you get from it" (p. 456). I believe that OMR can afford readers with many modes to select and chew as much as they want until they reach a certain level of understanding. While written descriptions and pictures both explained the same phenomenon, the world narrated can be different from the world depicted and displayed (Kress, 2003). Kress and van Leeuwen (2021) argued that even when people express what seem to have the same meanings in either image, writing, or speech, they will be realized differently. Expressing information verbally or visually makes a difference, and that affects meaning (Kress & van Leeuwen, 2021). Therefore, different modes provide information with various affordances with different meaning potentials that may help readers reach deeper comprehension.

Another reason OMR can benefit meaning-making is because it provides readers with various modes that provoke their prior knowledge to form situation models. These different sensory modes enable readers to link new information with what they already know or have experienced. From Cho (2014), participants did OMR with multiple texts on the Internet, including articles, numerical information, charts, tables, and written reports. Students incorporated their prior knowledge and the new multimodal information while reading them to create a deeper understanding of social issues, such as hidden reasons for obesity, the cost of the death penalty, alternative energy, and so forth. People cannot avoid the task of interpreting or making sense of texts filtered through their prior knowledge (Kalantzis et al., 2016). At the same time, listeners, viewers, and readers are moved and changed by the meaning prompts they encounter (Kalantzis et al., 2016), which involves the information that various modes carry.

Difficulties of OMR for Meaning-making

Reading comprehension depends on interrelated factors, such as “the reader, the text, and the activity or purpose for reading” (Snow, 2002, p. xiii). OMR also occurs from these factors within a larger sociocultural context in and out of the Internet space. Thus, OMR strategies cannot always be effective for comprehension. Four studies (see Table 2) showed that OMR is not always beneficial or effective for meaning-making (Cho & Afflerbach, 2015; Karchmer-Klein & Shinas, 2019; Kiili et al., 2020; Klois et al., 2013). Even skilled readers were distracted, frustrated, or confused due to the distractions or lacking instructions during OMR (Karchmer-Klein & Shinas, 2019). Also, readers sometimes did not know how to make sense of modes and depended on reading words, assuming words would have central meanings, and nonlinguistic ones deliver tangential meanings (Karchmer-Klein & Shinas, 2019; Kiili et al., 2020). Besides, one study reported that a visual overview in a hypertext does not affect children's comprehension because their learning did not differ with or without it. These students adopted highly linear reading patterns either with or without an accompanying visual overview (Klois et al., 2013). OMR study results may largely depend on text types used for OMR. Still, these reports leave critical remarks for discussing what could be obstacles between successful OMR strategy use and reading comprehension.

Chan and Unsworth (2011) categorized difficulties that sixth-grade readers met from OMR regarding meaning overlap between visual and linguistic modes. They figured that if modes have redundancy in meaning (e.g., written words having matching illustrations), readers easily answered the comprehension question based on the contents corresponding across modes. However, meaning-making became harder when modes showed complementary information (e.g., distribution, augmentation, divergence). For example, where meanings were distributed across images and written words (distribution relationship) so that they had to identify, understand, and then synthesize, readers felt it harder to comprehend the text. Once the image had additional meanings to text or vice versa, the correct answers decreased to 50%, down to only 30% when the modes had divergent meanings. Underachieving students were in the most vulnerable position from this situation, notwithstanding that they reported they prefer online reading. The authors asserted that educators must ensure that these students are well supported in the skills required for online reading because they tend to lack familiarity or experience with OMR. Otherwise, it may cause frustration or confusion for these readers.

Moreover, researchers argued that textual obstacles often inherent in OMR present challenges for students to read online effectively. For example, a few participants from Hamdan et al. (2017) found certain tables or diagrams confusing because they were too small, not editable, or without words. Besides, OMR can be either beneficial or disturbing for comprehension depending on the reader's levels, preference, or familiarity with online reading. It is in accordance with Macedo-Rouet et al. (2003), which compared the effects of print versus multiple online texts reading on the same topic. They found more perceived cognitive load and lower comprehension from the online multimodal text regarding the accessibility of tables and graphics, content and size of the written words, and readability of the data in the animated diagram. Also, participants found it challenging to understand if the information was hidden in the menus, so they had to click to see the information, which is a typical presentation style of OMR (Macedo-Rouet et al., 2003). There are other difficulties of OMR with regards to auditory distractions (e.g., deviant tones, background music) that often deteriorate reading performance (Patrick et al., 2020), disturbing advertisements, easier access to social media, loss of concentration from lengthy texts, and scrolling up and down to find information (Hamdan et al., 2017).

OMR demands readers' flexible adaptation of reading strategies and prior knowledge of multimodal reading (Karchmer-Klein & Shinas, 2019). Skilled Internet readers may adjust their background knowledge of multimodality and text structure, but "we cannot assume they will always do so or that their schema is adequate for the texts they confront" (Karchmer-Klein & Shinas, 2019, p. 480). This frustration was identified because readers prioritized written words over nonlinguistic modes, which does not always apply to the representation and communication in OMR. Accordingly, the readers ignored the important story portion presented through nonlinguistic modes for meaning-making, assuming it was not central to the episode (Karchmer-Klein & Shinas, 2019).

In sum, OMR—like other forms of reading—can present challenges for readers. In addition, not all OMR strategies can be beneficial for readers' meaning-making. Readers are sometimes unaware of various roles and information that modes deliver and lack multimodal literacy due to the traditional reading instruction often primarily based on printed, written words. Besides, multimodal texts on the Internet can be distracting, hard to navigate, and confusing to understand. Thus, readers must learn OMR strategies and how to use them purposefully to become competent readers in the digital space.

2.3 Summary of the Literature Review

So far, I derived six major OMR strategies from the existing research literature: (1) multimodal meaning-making, (2) multimodal searching, (3) multimodal evaluation, (4) making modal choice, (5) multimodal navigation, and (6) multimodal prior knowledge activation. These strategies generally showed positive influences on readers' meaning-making by supporting them to build situation models and perform multimodal synthesis between modes. Of note is that using strategies does not always lead to successful comprehension depending on various reasons, such as readers' developmental levels, prior knowledge, text difficulties, and so forth. Although some articles described difficulties of OMR due to the complex relationship between modes and distracting features of online reading that impede comprehension, OMR and using OMR strategies showed beneficial influence for readers to make meanings from multiple, multimodal texts on the Internet. The categorized OMR strategies will suggest the coding rules for strategies to be found in the data I will gather and transcribe. Also, I will use a theoretical framework from the next chapter to guide the data collection and analysis plans as well as various strategies explored from prior online reading strategies studies.

Chapter 3: Theoretical Framework

The purpose of this study is to explore competent readers' strategy use while reading online multimodal texts and to examine how these online multimodal reading (OMR) strategies influence multiple text comprehension. Since this study focuses on how readers use technology to navigate and learn from online spaces, it is fundamental to start with the account of what technology means in these readers' OMR. Technology is defined as "the practical application of knowledge, especially in a particular area, or a capability given by the practical application of knowledge" (Merriam-Webster, n.d.). According to Schatzberg (2018), the meaning of technology has evolved from 'the science or knowledge of the industrial arts and crafts' to the current pervasive concept of 'application of science or the produce of such application.' While acknowledging this transformation of the concept, I confine the definition of technology I use here as the application of knowledge about using online platforms, digital devices, and/or any relative knowledge about digital tools purposively to achieve goals. So to speak, using technology in this study means using knowledge or tools about digital devices or online platforms to accomplish tasks.

A central purpose of reading is to construct meaning from text (Afflerbach, 2017), and reading comprehension is "achieved when the reader constructs a mental representation of the situation described in the text" (Rouet, 2006, p. 28). Consequently, successful meaning-making results in a coherent mental representation (Pressley & Afflerbach, 1995), be it from traditional text or online multimodal reading (OMR). My efforts to construct the relevant theoretical framework for my research drew from four literatures: OMR as (1) cognitive meaning-making from online multimodal text, (2) situation model building, and (3) strategic meaning-making. The first section focuses on how OMR is related to cognitive meaning-making in relation to cognitive theory of multimedia learning. The next section describes how OMR can be helpful for a reader to build a mental model during reading, especially situation model building. The last section focuses on strategic aspects of OMR based upon constructively responsive reading theory. Combined, these perspectives allowed me to examine OMR strategies by providing accounts for cognitive and social aspects of multimodal meaning-making and strategic reading.

Figure 4

Theoretical Framework

3.1 Online Multimodal Reading as Cognitive Meaning-Making

Today's digital environment expands the concept of text from printed, written words to multimodal webpages on the Internet that combine written words, images, videos, and other modes of representation and communication. Meaning-making during OMR involves combining these different modes from multimodal texts to comprehend (Rasmusson & Eklund, 2013). Newly constructed knowledge from OMR matches or fixes the reader's prior knowledge, reconstructing the mental representation or the meaning just made (Rouet, 2006). Successful reading comprehension results in a coherent mental representation. Presumably, various OMR strategies and traditional reading strategies coexist while contributing to meaning-making in complex online reading (Leu et al., 2013). Everyday literacy practices "all require the reading and use of multipage documents including text, pictures, and various types of symbolic information" (Rouet, 2006, p. xvi), as evidenced by numerous multimodal texts on the Internet (Støle et al., 2020). Readers cognitively interact with various modes (e.g., written words, images, videos, diagrams, audios, layouts) to comprehend each mode and synthesize modes to make comprehension as a whole. With this regard, I am concerned with individual reader's multimodal meaning-making while reading multiple texts on the Internet for academic learning purposes. During this OMR process, readers activate reading strategies from their long-term memory or devise new strategies to make meanings and accomplish reading tasks (van Meter & Campbell, 2020).

Much of the work on reading strategy has foundations in *Cognitive Constructivism*. This theory posits that individuals transform external representations into an internal mental structure, applying prior knowledge and experience during this complex process (Alexander, 2005;

Anderson, Reder, Simon, Ericsson, & Glaser, 1998). For example, Cho, Han, and Kucan's (2018) study of online history reading found that seventh-grade students read images and videos on the Internet to understand the historical term ‘dust bowl.’ To illustrate, participants targeted a specific mode to find information while recognizing different types and features it brings. For example, one participant said, “I want to see some pictures, and I want to see what the Dust Bowl looked like. So I search for images…, and I choose this photo, saying *The Dust Bowl.* Oh, it was like a little dust storm, so I think … in that one area.” (Cho et al., 2018, p. 1535) Readers transformed external multimodal representations of the Dust Bowl (e.g., pictures, interview videos, maps, written words) into the internal mental structure of a severe dust storms happened during the 1930s. This multimodal reading also influenced their prior knowledge, just as the reader above connected the new multimodal information with a familiar storm scene that he already knows. Therefore, OMR can explain how readers make meanings through reading modes that they see on the Internet under the theory of Cognitive Constructivism.

Individual readers’ competencies in building symbolic structures (e.g., mental propositions, schema, patterns, images) and using strategies for text-based learning (Alexander, 2003; Anderson et al., 1998; Pressley & Afflerbach, 1995) can be examined in relation to an understanding of mental representation. The most common types of mental representation are in the forms of propositional networks and schemas that can be derived from discourse or text reading (Anderson, 1990). Propositions consist of particular units of meaning and can represent the meaning of sentences, images, and numbers. Schemas represent what those specific things have in common or cohere together, referring to the “knowledge about how features tend to go together to define objects or how events tend to go together to define episodes” (Anderson, 1990,

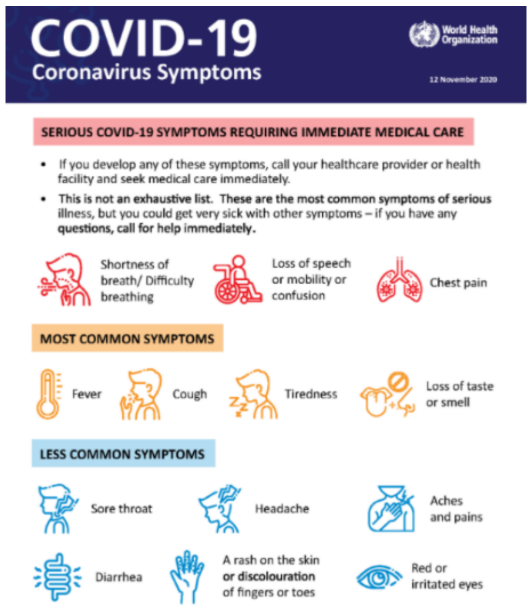
p. 144). These mental representations do not necessarily keep the exact same structures in long-term memory. However, schemas encode the relations among propositions, images, linear orderings (Anderson, 1990).

Multimodal reading also requires strategies to identify and understand information in different modes to construct meaning. For example, to build a schema of Coronavirus symptoms from the World Health Organization website brochure (see Figure 5), a reader may read written words (e.g., COVID-19, symptoms, serious, immediate medical care, fever, sore throat), images that visualize different symptoms (e.g., thermometer to indicate fever, lungs to indicate chest pain, an eye to describe red or irritated eyes), colors to show the seriousness of the symptoms (e.g., red to show severe symptoms requiring immediate medical care, yellow to show common symptoms, and blue to show less common symptoms), and arrangements of these groups to imply severity (e.g., top as the most severe symptoms, middle as average, low as not so serious). From this OMR, online readers may form schema for COVID-19 symptoms to apply to their current medical conditions and fix their prior knowledge of virus symptoms.

Many researchers remind us that "language and literacy practices have always been multimodal" (Mills & Unsworth, 2017, p. 2) since people have been communicating through gestures, sounds, drawings, across millennia. The 2021 PIRLS reading assessment framework for reading literacy defines reading as "the ability to understand and use those written language forms required by society and/or valued by the individual. Readers can construct meaning from texts in a variety of forms" (Mullis & Martin, 2019, p. 6). This definition encompasses multimodal forms of reading in addition to written language and puts emphasis on students' role as active meaning makers. Based on the overarching conceptualization of OMR as the reader's cognitive meaning-making from multimodal texts on the Internet, now I delineate what modes and multimodality mean in OMR.

Figure 5

A multimodal online brochure for COVID-19 symptoms (World Health Organization, 2020)



3.1.1. Modes and Multimodality in Online Multimodal Reading

Modes refer to "resources that a culture makes available as the means for making representations and meaning-- speech, writing, image, gesture, music, and others" (Jewitt & Kress, 2003, p. 4). Accordingly, the multimodal text refers to texts that utilize two or more modes to communicate or represent concepts and information (Serafini, 2014). During OMR, understanding different modes and their functions are fundamental to meaning-making (Kress, 2003; Smith, 2019) because meaning is created through interactions between modes. The combination of modes communicates meanings that a single mode cannot express alone (Gee, 2003). For example, *Whichever* bathroom signs at a restaurant consist of a pictogram of a half male half female silhouette and a word ‘Whichever’ written below. If the pictogram is presented alone, it may confuse some people who are not used to the all-gender toilet and assume that the man is wearing half-pointy pants. Suppose the ‘whichever’ is the only mode written on the bathroom door. It may confuse the users by making them try to connect possible words to whichever, such as whichever purpose, customer, or employment status. Therefore, it is essential to understand modes in ensemble (Serafini, 2014) or how modes are utilized and understood in conjunction with one another (Jewitt, 2008; Rowsell & Burke, 2009) to fully understand the text.

Multimodality on the Internet typically involves different modes compared to reading printed texts or having a face-to-face conversation. Among the five types of modes-- linguistic, audio, spatial, gestural, and visual-- classified by New London Group (NLG; 1996), online multimodal texts today depend significantly on linguistic, visual, and audio modes, reflecting the shift from page to screen, which resembles a paper but may provide additional visual and sound information (Bearne, 2009). According to NLG, the spatial information of offline communication is substituted for layouts of webpages, and gestural elements such as bodily gestures or proxemics are eliminated or reduced due to the untact nature of online communication. Therefore, I focused on those three modes (linguistic, audio, visual) that are typically seen on the Internet because this study deals with online informational texts reading for academic learning in hopes of applying taxonomized OMR strategies to K-12 reading instruction. Given that, I conjecture that the OMR strategies that I gather will be mainly in linguistic, audio, and visual modes. These three types of modes and how readers process them are theoretically explicated by Mayer's (2009; 2020) cognitive theory of multimedia learning, which is also based on cognitive constructivism.

3.1.2. Multimodality and Social Semiotics

With multimodal comprehension, each mode included in OMR has the meaning potential to contribute to readers' understanding. The combined modes and the meaning it derive are essential in multimodal reading. The underlying assumptions are: (1) meaning is distributed across whatever modes are employed in communication, not necessarily evenly, (2) different aspects of meaning are carried in different ways by each mode, and (3) each mode is partial to the whole meaning (no exceptions to speech and writing) (Jewitt & Kress, 2003). Each mode has its unique characteristics, meaning potentials, and affordances that make it more suited for certain tasks than others (Hull, 2003; Jewitt & Kress, 2003). The affordance refers to the action possibilities inherent in modes or a relationship between them that allow or constrain how the mode could be used for meaning-making (Bearne, 2003; Lee, Lee, & Hwang, 2014; Norman, 2013). Namely, modes convey information about how readers could interact with them in addition to the textual information. For example, drivers receive communication through traffic signs on the road with the affordance of visual images, such as red or green colors, illuminance, and configurations of various shapes. If the signs used written words only, the goal of quick and effective communication while driving might be difficult to achieve. Likewise, modes have various kinds of semiotic meaning potentials (Kress, 2009). In OMR with rich elaboration, images show lengthy, complex written contents in a glance, colors highlight focal points that are wished to be seen, written words explain what is hard to visually show, people's voice and its intonation deliver what is not revealed in a written sentence or visual modes, music implies the atmosphere or the tension that written language cannot depict, and GIFs show movement that static pictures cannot show. These affordances keep changing and developing through social interaction and technology development.

Semiotics is the science of sign-making, which regards all modes have meaning potentials in both representation and communication forms (Bezemer & Kress, 2016). A sign is a fusion of form and meaning, which is the core element of semiotics (Kress, 2009). Sign-making refers to the construction of non-materialized conceptual meaning through reading various modes and their affordances. For example, we use signs as connections between a signifier (e.g., a word, 'car') and the things it signifies (e.g., the actual car it refers to) (Kalantzis, Cope, Chan, & Dalley-Trim, 2016). Although this research focuses on individual reader's text-based meaning-making, of note is that signs are socially constructed (Kress, 2009; Jewitt & Kress, 2003). The distinction between semiotics and social semiotics takes part here. The former regards sign as ready-made by convention, not necessarily taking people's agency into account, whereas the latter values the "agency of socially situated humans as central to sign-making" (Jewitt & Kress, 2003, p. 10). Social Semiotics (Halliday, 1978; Hodge & Kress, 1988) brings society's role into semiotic meaning-making, arguing that meaning arises in a social environment and social interactions (Kress, 2009). In this view, people use certain modes because they consider them the most suitable or apt way to deliver meanings. These semiotic resources have a degree of stability and predictability for meaning-making in each culture (Bezemer & Kress, 2016; Kress, 2003). Suppose a person used a fist emoji with the word 'Hey' in a text message. It can be read as a cheerful fist bump to say hello with a high probability if the communicators' culture allows fist bump as common intimate action. If not so, that message may indicate a fight signal and end up with the receiver's misunderstanding. Therefore, although it is up to individual readers' decision to understand modes and their configuration, it is necessary to be aware that multimodal texts have different cultural meanings.

Multimodal Social Semiotics is at the intersection of multimodality and social semiotics. In this theory, it is crucial to know the different characteristics of modes, individuals' different preferences of modes, and understand appropriate forms of communication (Kress, 2009). Stein (2008) suggested general assumptions underlying the multimodal social semiotic approach to learning. Firstly, all acts of communication are multimodal, and there is no monomodal communication. In face-to-face communication, gestures, facial expressions, spatial proxemics, voice, and verbal languages are used simultaneously. In virtual digital communication mediated by digital screens, we still use visual images and layouts, written words, verbal languages, sounds, and voices to deliver meanings in a multimodal way. Therefore, today's students should learn the multimodality of human communication and understand how modes are read together to make meanings. Second, modes are the effect of the work of culture in shaping materials into resources of meaning-making. Jewitt and Kress (2003) argued that modes' regularities come from cultural work and frequent use in social interaction. For example, using hashtags (#) on social media and webpage postings has become ordinary nowadays. Students who want to comprehend those texts should also learn what these written, hyperlinked forms of abbreviated words mean, cultural messages and trends they carry, (e.g., #BLM meaning Black Lives Matter movement, #WFPB meaning Whole Food, Plant-Based diet, #OOTD meaning Outfit of the Day) and how they function to amass related postings using same hashtags. Third, people shape and transform available materials for representation as agents of meaning-making. Mills and Unsworth (2017) referred it to *transmediation*, which is "shifting or transferring semiotic content" (p. 3) that involves continually adapting users' intentions for representing knowledge. For example, an online multimodal article may show a picture of a man standing in front of a burning forest, a bolded written title 'how much of the Amazon is burning,' a picture of crying monkeys, and a map of South America with red dots showing the region with identified fire. Students should be able to combine these modes to understand the main idea of this multimodal text as well as the author's intention for using certain modes. Fourth, different modes have different affordances and potentials that make them better for certain tasks than others. For example, layouts are more useful than other types of modes to indicate what part of the text is more important than others. Students should infer different meanings of layouts of information on the webpage with the knowledge of what it means to place a particular mode in the middle of the text (central or focal idea, especially in a visual mode) or at the top (main or leading idea) or the bottom (less important or the concluding idea) to fully understand the text. Finally, each mode is partial in relation to the whole of the meaning. Referring back to the burning Amazon forest again, seeing only images from the article would not be sufficient to understand the detailed causes and history of the rainforest destruction, reading written words only would not be enough to see how Amazon looks like and the overall spread of the fire on the map, and the picture of monkeys would help evoke sympathy but not enough to understand the detailed information of this tragedy.

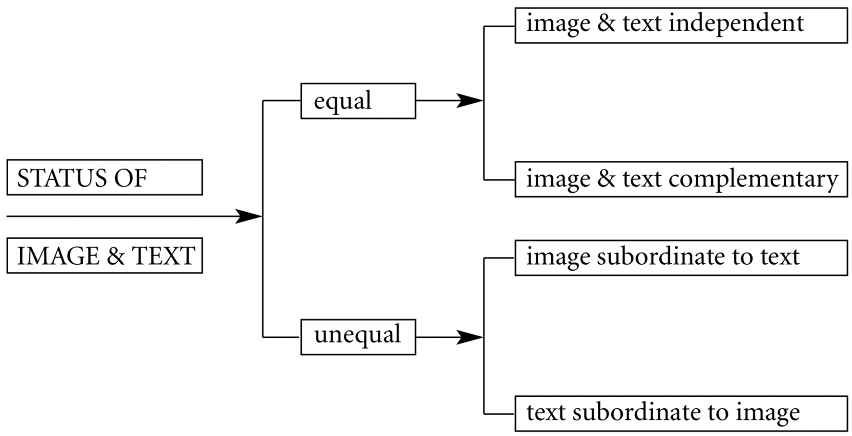
These five assumptions: (1) all acts of communication are multimodal, (2) modes are the effect of the culture, (3) people shape and transform representation, (4) each mode has different affordances and potentials, (5) each mode is partial to the whole meaning, have been considered throughout the analysis to apply the multimodal social semiotics framework to taxonomize OMR strategies. I believe this theory has important application when examining the multimodal nature of the Internet space, where various types of modes make an ensemble to convey information to readers. Although written word mode may still dominate online information searching and learning, digital design tools have given online authors the agency to represent meanings through various modes more conveniently. So far, K-12 reading education has been dependent primarily on printed texts and the mode of written words. However, the rapid transition from traditional to digital reading calls for educators to teach and assess multimodal reading. Due to the digital turn, which refers to “the increased attention to new literacy practices in digital environments across a variety of social contexts” (Mills, 2010, p. 246), research on OMR is urgent.

3.1.3. Visuals and Words Relations in Online Multimodal Texts

Martinec and Salway (2005) taxonomized image-text (written words) relation into equal status (image and text is wholly related to each other) and unequal status (one of them modifies the other). Equal status is divided into independent (image and written words deliver equivalent information in parallel), and complementary (image and written words deliver intertwined information). Image-text relation is subordinate when it only relates to a part of the other. Unequal status is divided into image subordination (image relating to a part of the written words), and text subordination (image has implicit meanings to be decoded such as artworks) (see Figure 6).

Figure 6

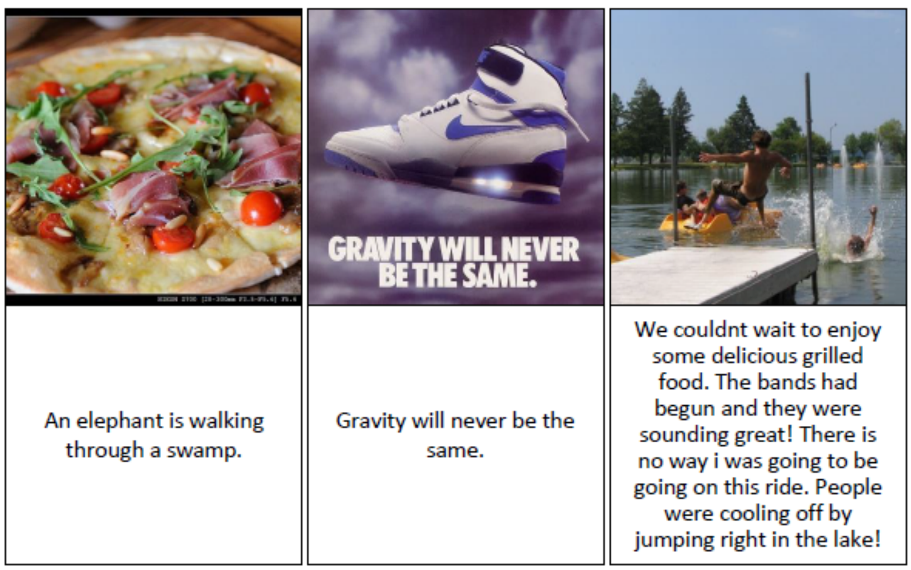
Image-Text Status Relations (Martinec & Salway, 2005)



Based on this taxonomy, Otto et al. (2019) suggested expanded semantic image-text relations which can be used for multimedia information retrieval on the web from the computer science perspective. They modified and added new image-words relations that suit OMR and described eight types of them: uncorrelated (no shared concepts), interdependent (no shared concepts but joint message on a higher semantic level), complementary (modalities complement each other), illustration (written words is supplemented with image), anchorage (image is supplemented with a caption describing visual concepts), contrasting (modalities complement each other, but contain contradicting details), bad illustrations (visual example is ill composed, unusual or ambiguous), and bad anchorage (caption describes details is wrong) (Otto et al., 2019). Their taxonomy includes wrong relation or unmatching meanings between visual and written words that online multiple text readers frequently go through. For example, Figure 7 shows the illustrative examples of how they define image-text relationship.

Figure 7

Examples for the uncorrelated (left), interdependent (middle), and complementary (right) text (Otto et al., 2019, p. 171)



Chan and Unsworth (2011), and Daly and Unsworth (2011) investigated Australian students' reading comprehension that entails negotiations between visual and written words. Unsworth and Chan (2009) indicated that different types of image-language relations in both print and online texts differ in the degree of difficulty they pose for reading comprehension, and that negotiating these relations are challenging for readers. Daly and Unsworth (2011) identified different types of image-language relations: concurrence and complementarity. Concurrence refers to when one mode elaborates the meaning of the other by specifying or describing it while no new meaning is introduced. It takes four forms: exemplification (e.g., image is an example of what is in the paragraph), exposition (e.g., re-expression of the meanings of the image in the words), equivalence (there is complete or partial redundancy of content like a caption heading under the image), and homospatiality (e.g., letter and image combined in one space like a word-letter). Complementarity refers to the relationship when a new meaning is introduced by either the written words or visuals. It has three types of relation: augmentation (new attribute is introduced through an image), distribution (juxtaposed image and written words jointly construct meaning), and divergence (image and written words convey different meanings).

These relations were given to 32 6th grade students and tested that equivalence was the easiest relation due to its redundancy and correspondence across modes, complementary relations showed more and more difficulty as it goes from distribution, augmentation, to divergence. For example, readers found it difficult to locate information separated across modes and matching them to make meanings. The most difficult relation was to recognize links between modes (words, diagram, moving images) and relate it to complex sentences in a long paragraph. I anticipate that these adult competent readers should be able to navigate and comprehend texts more easily than those young readers. However, as difficulties exist in visual and written words integration, I will figure how these modes are related and represented in the three texts that I will provide to subject. The descriptions of general relations between the modes will be applied to data analysis in terms of OMR strategy use on certain parts of the texts.

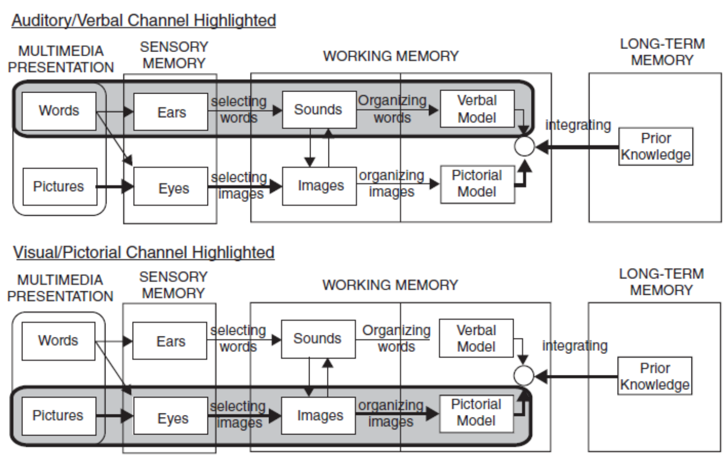
3.1.4. Cognitive Theory of Multimedia Learning

Mayer argued that "people learn better from words and pictures than from words alone" and described the benefits of computer-based multimedia instruction (Mayer, 2017, p. 404). He referred to multimedia learning as "learning from words and pictures" (Mayer, 2020, p. 3). He described verbal, auditory, and visual modes — similar to the most frequently used modes during OMR, using words to encompass both printed and spoken text. Multimodal theory, in general, distinguishes written and spoken language because the former is represented by alphabetic words that we see through the eyes, and the latter is by aural speech that we speak and hear. Nevertheless, he successfully combined them through the processes of cognitive meaning-making, with sequential stages: (1) multimedia presentation from the learning material (e.g., PowerPoint slides with pictures and words), (2) sensory memory that accepts them (e.g., written words and pictures through the eyes, verbal narrations through the ears), (3) working memory for screen-based textual meaning-making where selected words and images are processed, interacted, organized, and integrated with prior knowledge (see figure 8).

This model includes three features central to my study: (1) dual channel, (2) limited capacity, and (3) active learning processing (Mayer, 2009)—each has implications for OMR. Firstly, dual channel assumption means that there are two different channels for visual (pictorial) and auditory (verbal) representations (see how words go to eyes in sensory memory in Figure 8). Written words on the screen are initially processed in the visual channel, but then inhabit the auditory channel in working memory where verbal language is processed. Pictures enter the eyes and are processed as images and pictorial models in the working memory (see lower highlighted box in figure 8). Aural narrations are processed as sounds and then as the verbal model in the working memory (see the upper highlighted box in Figure 8). During this dual channel meaning-making, readers can create related images in their minds which correspond to selected verbal sounds or the opposite way of coming up with the sounds about the image (the left box under working memory). After organizing words or images (moving from the left to the right box in the working memory), verbal or pictorial mental models are built, and this early comprehension is integrated with the reader's prior knowledge from the long-term memory, which is an essential step for general text comprehension based on the cognitive constructivism theory.

Figure 8

The auditory/verbal channel (top frame) and the visual/pictorial channel (bottom frame), and how the processes are depicted by cognitive theory of multimedia learning (Mayer, 2009, p. 64).



This dual-channel assumption fits OMR because online readers should successfully build coherent meanings from multimodal texts containing both aural and visual information. Also, readers activate and apply their prior knowledge to the incoming information to best understand online texts and accomplish related reading tasks.

Secondly, the limited capacity assumption indicates “humans are limited in the amount of information that can be processed in each channel at one time” (Mayer, 2009, p. 66). It is based on the cognitive capacity theory in information processing, which posits that learners can hold only a few images or five to seven chunks of the written text, or information, in their working memory. Because of this limited capacity, readers use metacognitive strategies consciously or subconsciously to self-regulate by (1) deciding which pieces of information to pay attention to, (2) making connections among the selected information, and (3) building connections between selected information and prior knowledge (Mayer, 2009). Nevertheless, he suggested that cognitive overload can be resolved by “modality offloading – presenting words as narration rather than as on-screen text (p. 201).” It means that the dispersion of input on different sensory channels, such as showing illustration with spoken narration instead of showing illustration with written text, may assist readers’ more complex cognitive operations, including comprehension. Although he applied this principle only between visual and verbal modes, it can be applied to OMR strategies. For example, a reader may strategically choose to watch Internet News with a video and charts that give the narrated account, instead of reading a dense multimodal article filled with written words, diagrams, and photos about the same topic. He could intentionally decide that reading the News is cognitively overloading for his level of reading. In short, limited capacity may influence reader’s mode choices in OMR.

Lastly, the active processing assumption describes that learners actively engage in cognitive processing to construct a coherent mental representation, which is the essence of cognitive constructivism. It includes paying attention, organizing information, integrating the information with other text or prior knowledge, and so on. This notion is also the key to OMR and its strategies because OMR assumes that readers actively try to make sense of what they read on the Internet by synthesizing information represented in different modes. This active meaning-making helps readers build mental models that Kintsch's (1998) Construction-Integration (CI) theory of text comprehension accounted for, which I will address in the next section.

3.2 Online Multimodal Reading as Situation Model Building

"We comprehend a text, understand something, by building a mental model. To do so, we must form connections between things that were previously disparate: the ideas expressed in the text and relevant prior knowledge (Kintsch, 1998, p. 93)." Understanding a text is to build mental models, and online multimodal reading (OMR) is not discrete from this notion. Kintsch's (1998) theory of text comprehension is based on single text meaning-making using written words only, whereas OMR accounts for modes' combination to make meanings from multiple texts. However, I view that they share essential concepts as both describe text comprehension regarding how readers build mental models and what affects this process. Based on constructivism and Information Processing, Kintsch (1998) proposed Construction-Integration (CI) model. In this theory, a context-insensitive meaning construction process is accompanied by an integration process that may yield an orderly mental structure out of that initial unstructured reading. To be specific, "mental representations are formed by weak production rules that yield disorderly, redundant, and even contradictory output. (Kintsch, 1998, p. 94)" However, they go through the process of integration where irrelevant meanings to the context are suppressed, and correct, contextually appropriate meanings survive, which yields a well-structured mental representation. That is, after the reader's textual meaning-making goes through a messy, indiscriminate construction, it gets refined, suited to the context as well as his prior knowledge that eventually produces appropriate mental models. I postulate that this course of reading applies to OMR comprehension as well, although there are differences of the textual environment (printed to online), modes that appear on the text (written words to multimodal), number of texts (single to multiple and ever-expanding) and reading paths (rather linear to unpredictable and diverse reading paths due to hyperlinks). Thus, I applied Kintsch's (1998) CI theory to OMR to examine text comprehension in OMR situations. Meanwhile, I also applied van den Broek's Landscape model (van den Broek et al., 1999) to describe readers' process of mental representation building and their prior knowledge involvement while doing OMR. Based on Kintsch's theory, the Landscape model also describes how readers construct memory representations from reading texts. This model visualizes an individual's fluctuating comprehension through a three-dimensional landscape image by capturing ongoing reading cycles, mental representation, or prior knowledge activation.

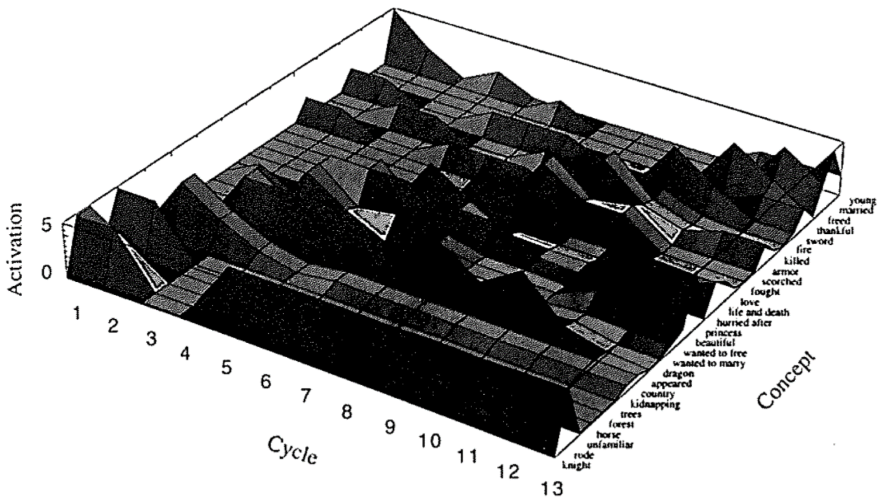
3.2.1. Textbase and Situation Model Building during Text Reading

The CI model depicts comprehension as a loosely structured, bottom-up, highly context-sensitive, and flexible process (Kintsch, 1998). According to Kintsch (1998), text representations are built up sequentially as a reader reads sentences. Each sentence is processed and immediately connected to the rest of the text in working memory. During this active processing, necessary information from the long-term memory gets activated according to the sentence being processed. The working memory spotlights here and there to construct and integrate a mental representation. In OMR, the integration may be performed whenever a new mode or a part of the mode in the text is read (viewed or heard) and added to the meaning network. This comprehension process results in a mental representation of a text.

van den Broek's Landscape model (van den Broek et al., 1999) describes how concepts are activated during text reading. Since readers' resources are typically very limited, readers activate concepts selectively from these four sources: (1) the text currently being processed, (2) immediately preceding reading cycle, (3) reactivated concepts that were processed in the earlier reading cycles, and (4) the reader's background knowledge (van den Broek et al., 1999). This activation occurs in each reading cycle including reading new sentences, propositions, text units, or, presumably, modes in OMR. In each reading cycle, new concepts are activated, some are retained, and others are removed from the attention or working memory, which forms a fluctuating landscape of activations (see figure 9; van den Broek, et al., 1999). Overall, both CI and Landscape model of textual meaning-making processes are akin to Mayer's (2020) Cognitive Theory of Multimedia Learning (see 4.1.2). In his description of multimodal meaning-making, the reader-chosen words and images from the multimodal text are processed, interacted, organized, and integrated with prior knowledge from the reader's long-term memory. In sum, I posit that the CI model is compatible, with modification, for explanations of OMR, as Mayer has partly proven.

Figure 9.

An example of a landscape of activations for a story reading (van den Broek et al., 1999, p. 75)



Kintsch described a reader's mental representation with two interrelated models: the textbase model and the situation model (Kintsch, 1998; van Dijk & Kintsch, 1983). Whereas a textbase reflects the text as it is, a situation model shows the reader's elaborations with her prior knowledge or experience (Kintsch, 1998). These two models are informative for strategic online reading (Cho, 2014) including OMR. Understanding the text itself as well as its relation to the prior knowledge can be essential in understanding texts as a whole and it requires strategies to reach thorough understanding. Of note is that the reason Kintsch distinguished the two models was not because they are different mental objects, but because it was useful to separate them to describe the representation and its origin. He emphasized that there is a single, unitary mental representation of a text.

The *textbase model* refers to the semantic mental representation of the text that a reader constructs in the process of reading comprehension. It consists of “elements and relations that are directly derived from the text itself” (Kintsch, 1998, p. 103). The textbase does not add anything that is not explicitly specified in the text. Typically, this procedure makes a deficient and even incoherent network. In case of a middle school science class where students are learning a basic phenomenon of water cycle from the Internet, a student may search “water cycle” on Google, choose several website links and read a few of them. From these initial OMR inputs, this student can form a textbase which is a propositional (or in other forms of mental representation) network that is yet to be integrated or refined, in so far as theoretically. In a written word reading, it is relatively clearer to determine if the textbase has been constructed compared to multimodal reading because readers only need to decode the language mode. It is even possible to build a textbase without understanding what the text means. For example, readers can recite a written paragraph about the water cycle not necessarily understanding what it means if it makes sense syntactically. In this study, I did not count textbase model construction as a case of a successful meaning-making although I admit that it is the start of the basic OMR comprehension.

In multimodal texts reading, it is hard to draw the line between when this syntactic, textbase understanding ends and semantic, symbolic meaning-making begins because there are various modes with different syntax and affordances. Readers tend to choose and read modes together in OMR by connecting meanings from multiple reading cycles or their prior knowledge related to the modes they read. However, in a real-life reading, prior knowledge influences reader’s textbase throughout the reading cycle to the point that the textbase immediately turns into a situation model. van den Broek’s Landscape model (1999) described how prior knowledge gets intertwined in the meaning-making as one of the major factors in determining activation of concepts of current and prior reading. The preliminary notion is that the more prior knowledge a reader has and the more interconnected it is with her current reading, the more easily and extensively it can be accessed so that it affects mental representation building (van den Broek, 1999). van den Broek (1999) noted that individuals differ in the extent to which they access prior knowledge during reading according to their reading goals. Namely, "a reader may sometimes aim to stay close to the text and at other times engage in extensive activation of background knowledge" (van den Broek, 1999, p. 90). In OMR, this rule may depend on the type of the reading task (e.g., critical reading, making questions, submissively understanding the topic, rote memorization of contents), reader's prior knowledge regarding the topic and the text type (e.g., familiarity of the topic, prior experience on reading visuals and layouts with words), or the modes and their attributes (e.g., photos and videos may provoke more prior knowledge and experience, graphs require mathematical reading skills) that readers have to deal with.

Readers' prior knowledge is involved when building the textbase. It is known that readers activate different types of prior knowledge—including declarative, procedural, conditional, disciplinary, and epistemic (Afflerbach, Hurt, & Cho, 2020)-- to reach a desired level of comprehension. This research is related to the first four because they are the type of prior knowledge that readers commonly activate in online reading, while it may vary according to reading purposes. Declarative knowledge refers to knowing things, such as historical facts or character names from a novel. It is what a reader already knows, which he can activate to use in the ongoing reading cycle. Readers' declarative knowledge about the text content is a strong indicator of how well they will learn from the text (Marzano, 2004). In the water cycle example, a reader may activate declarative knowledge about what the climate cycle is, various forms of water, basic conceptual knowledge about heat, air, and molecule. He can access and apply them in the current OMR to understand the information in various modes to construct a coherent meaning about this phenomenon.

Next, procedural knowledge is knowing how to do things, such as reading strategies or prior knowledge and experiences about reading processes. It is knowing how a strategy works and how to take procedures to use that strategy (Paris, Lipson, & Wixson, 1983). Readers with a high procedural knowledge can use various strategies to support their meaning-making of the text (Schraw, 1998). This study primarily focuses on OMR strategies that readers bring to their reading tasks in the forms of procedural knowledge. More importantly, learning and accumulating declarative knowledge is enabled by readers' procedural knowledge during OMR. Advanced online multimodal text readers may activate their OMR strategies, such as reading an image and written description below it subsequently to understand an online text as a whole or evaluating task relevance of a webpage by viewing videos and diagrams first and then moving to read written words. They also should retrieve knowledge about each mode's affordance and attributes to initially decide how to choose and use different modes for meaning-making, such as using layouts to find the placement of the desired information or flipping slide shows by clicking on an arrow instead of vertical, linear reading. Readers may also determine what genre the OMR text is (e.g., expository, literary, personal blog) and access their procedural knowledge about how to read a particular genre and set reading paths for multimodal texts, or what to expect from each reading cycle. Activating this procedural knowledge when reading multimodal texts will be one of the primary competencies of readers who have acquired multimodal literacy.

Conditional knowledge refers to knowing when, why, and how to use the aforementioned prior knowledge. It reflects a reader's metacognitive understanding of when and why using a specific strategy may be effective in a reading cycle (Paris et al., 1983). This knowledge is essential in online reading because Internet readers face more complex reading situations than reading traditional, printed texts (Leu et al., 2013). For example, OMR necessitates readers to monitor their hyperlink/mode choices, reading goals, strategies, or navigation paths while self-regulating amid increased distractions and limited working memory and attention span. Conditional prior knowledge helps readers have a situational understanding of their reading to learn new content and new strategies while independently managing their reading (Afflerbach, Hurt, & Cho, 2020).

Disciplinary knowledge refers to the knowledge of how reading and text structures operate in a particular discipline (e.g., science or history). It is often described as 'reading like scientists or historians' in a classroom. Reading in the disciplines demands disciplinary knowledge in addition to the other prior knowledge types. It is required for readers when they move beyond reading for simple factual recall, and instead reading to interpret, analyze, apply, and interact with texts. In OMR, readers may face reading situations that require disciplinary knowledge. For example, if a reader wants to see the Coronavirus infection rate, he should be able to use his disciplinary knowledge to examine various modes to evaluate if the online text is based on the truthful data, analyze graphs used from the text, or apply what he figured from charts and images provided to the written words to fully understand the situation. Online readers should possess disciplinary knowledge since online reading offers unexpected chances to read texts that needs it.

In sum, OMR requires readers to be alert to the cues about when and which types of prior knowledge will facilitate the construction of meaning. The activation of prior knowledge occurs both intentionally and unintentionally. A reader may try to remember related declarative, procedural, conceptual, or disciplinary knowledge from the beginning of the reading task. Prior knowledge can also be activated when a concept in a text provokes interconnected cohort concepts or schema, which again exert a strong influence on the processing of subsequent text (van den Broek et al., 1999).

3.2.2. Situation Model Building Through Online Multimodal Reading

Comprehension involves not only the textbase but also “the activation, updating, and other uses of a situation model” (Van Dijk & Kintsch, 1983, p. 10). It is rare to form a pure textbase once a reader understands a text since readers typically supplement their reading with various forms of prior knowledge described above. The situation model refers to “the complete structure that is composed of both text-derived propositions (the textbase) and propositions (this includes imagery and action, which we also represent as propositions) contributed from long-term memory” (Kintsch, 1998, p. 49). In other words, situation models may incorporate the reader’s previous experiences, prior knowledge about corresponding reading, and even previously created textbases from the ongoing task. Our reading comprehension is in accord with this process, whether it is a printed reading or OMR using various digital devices. Building a situation model from reading is the quintessential purpose of reading in general as well as OMR. Thus, I equated OMR reading comprehension to the coherent situation model building from reading two or more modes, based on Kintsch’s construction and integration theory and Mayer’s cognitive theory of multimedia learning. Revisiting the water cycle example in the case of situation model building, a reader may activate prior knowledge to construct situation models by reading modes in conjunction: written words that define and describe the water cycle, viewing diagrams that depict the process of evaporation, condensation, precipitation with arrows and changing images of water, a video that shows a colorful animation about waterdrops' travel dubbed with voice narration. Situation models keep being formed and updated like a flexible schema (van Dijk & Kintsch, 1983) as new modes of information are read and added to the evolving, previous mental model. Besides, a student may recall her personal experience, for example, of seeing a wet fog from a family trip at the lakeside and integrate it to form a situation model. These processes may support the reader to accomplish the reading goal, which is to construct coherent mental representations of the water cycle through OMR.

We can surmise that there are two general benefits of OMR on mental model construction, especially on situation model building. On the one hand, OMR can be more effective for readers to form and update situation models compared to printed, traditional reading, which typically utilizes written words only. For example, during reading a multimodal text with an image and written words, modes-shifting between these two helps a reader to learn through visualizing the meaning in an image as well as making corresponding propositions in words (Kalantzis et al., 2016). Supporting Mayer's multimedia learning theory, Mason, Pluchino, Tornatora, and Ariasi (2013) conducted an eye-tracking study with 59 11th grade Italian students about learning from a scientific multimodal text on the screen (inclined plane and the exerted force) with written words and illustrations. Participants scored higher when they were presented with words and illustrations than in the words-only setting. The researchers inferred that when readers viewed a picture of a skier on the slope, it may have retrieved sustaining memory about skiing, which was an effective cue for the retrieval of associated information about an inclined plane from the long-term memory. They indicated that better learning performance was associated with less time spent on the written words "but more fixation time on the illustration, and more attempts to integrate the graphical and verbal information” (Mason et al., 2013, p. 376).

Similarly, Meneses, Escobar, and Véliz (2018) proved that multimodal text significantly improved reading comprehension for low-skilled readers. Although they used printed texts for this comparison, multimodal text reading significantly boosted readers to make meanings about a complex scientific concept of energy transfer. According to Leu et al., multimodality in online texts supports readers’ meaning-making because these texts “contain multimedia, a traditionally supportive context for struggling readers” and “each webpage is really a graphic image and struggling readers are often quite skilled readers of information presented graphically” (Leu et al., 2013, p. 1168). Multimodal texts give intuitive, sensory stimulus that may activate readers’ prior knowledge and experience. Sanacore and Piro (2014) indicated that multimodal comprehension is neurocognitively beneficial because cortical networks that process different modes of information (e.g., visual, auditory, motor) overlap in the brain, especially visual and linguistic parts. They argued that multimodal activities scaffold learning because multiple sign systems work as a stimulus that generates a complementary network in the brain.

In addition, multimodal texts may encourage readers to form situation models by providing different modes. For example, Januarty and Nima (2018) interviewed ten middle school students about multimodal reading in class. From this qualitative study, students reported that they feel more interested in reading a text with words and pictures combined because it is more interesting and encouraging to finish the whole text and to find main ideas easily. 80 percent of participants contended that visuals help them understand the text because they provide background knowledge for guessing the topic. A study on adolescents' multimodal navigation in the digital narrative by Karchmer-Klein and Shinas (2019) also emphasized that multimodality can scaffold understanding of written words like tools that readers can use as needed. The fundamental strategy of multimodal literacy is to understand modes in conjunction, treating all modes with equal potential to elicit meanings. The Internet's design functions led to the production of multimodal texts, which induce people to read different modes altogether by juxtaposing them in a text. Intended or not, online authors operate these multimodal functions in their texts, assuming each mode is apt for conveying information to their imaginary readers. When the modes are provided effectively, they prompt readers to engage in the cognitive processes for learning (Butcher & Kintsch, 2004).

Van Dijk and Kintsch, (1983) whose model addressed single text reading, argued that situation models are necessary for comprehension and learning. I regard single text reading as associated with OMR, which includes multiple texts reading and strategic text processing that I will describe in the following parts of the theoretical framework. Here I address five reasons that situation model construction can be a theoretical lens for OMR strategies and comprehension. By keeping these characteristics in mind, I tried to find strategies from the data that helped readers construct situation models during OMR.

Firstly, situation models include semantic information, context information from the text, and the author's intention of writing the text just as multimodal texts do. Van Dijk and Kintsch

(1983) described it as crossmodality integration. They stated that “information from textual and nontextual sources must be integrated. The situation model … forms a much needed link between modalities” (p. 340). Thus, it is crucial to analyze readers’ multimodal integration to make meanings during OMR.

Second, the situation model may deal with a larger scope of meaning integration from various texts, whereas the textbase is only concerned with the local coherence. The former is more suitable for OMR because it requires readers to collect scattered multimodal information into a coherent mental representation, typically through multiple webpages. It is hard to strictly determine any local textual coherence among different modes because they possess different syntax and affordances to convey meanings. Besides, situation models are constructed as soon as readers naturally apply prior knowledge in the course of OMR. Therefore, I will focus on meaning-making from modes overall (e.g., what modes are combined, what meanings are drawn) rather than meticulous links of coherence.

Third, readers can understand the contextual information by building situation models from OMR. For example, when a student reads a blog page about a peasant revolution in the 1800s Joseon Dynasty in Korea, it helps her to build contextual knowledge as she combines various modes, which may include a painting that depicted this era, a work song these peasants used to sing, a poem they wrote to mock the noblemen or a map that indicates the route they took during the incident. Contextual meaning-making may occur by reading a single linguistic mode. However, it becomes more fruitful and effective to build situation models when readers have more exposure to OMR's multisensory inputs. Kalantzis et al. (2016) referred to this phenomenon as synaesthesia, which they defined as “a process of shifting backwards and forwards between different modes of meaning" (p. 233). In multimodal reading, this synaesthesia, or mode-shifting, occurs in different modes of meanings such as audio, oral, written, visual, spatial, tactile, gestural. They argued that it could be a powerful way to support and deepen learning by providing pedagogical support for reading and writing through the juxtaposition and transposition of parallel or complementary modes of meaning (Kalantzis et al., 2016). They stated, "Knowing how to represent and communicate things in multiple modes is a way to get a multifaceted and, in this sense, a deeper understanding of these things" (p. 234).

Fourth, readers tend to build situation models rather than textbase if the text is complex or uncertain, making it hard to create a detailed textbase. Reading on the Internet is often complex (Cho & Afflerbach, 2015), and so is OMR since it can be more complexified by modal discrepancies. People tend to delete unimportant information and remember the gist or overarching ideas as text complexity increases, which results in a situation model (Van Dijk & Kintsch, 1983). It is an economic decision that the mind makes when it is too daunting to memorize all the details that the textbase constructs. When various modes are combined, building textbase by remembering what each mode delivers separately is not as meaningful as building a situation model through integrating modes. Readers often read multiple multimodal webpages and make intertextual connections across texts and modes in them. By building situation models, readers get the intuition of whether the same facts are described in certain texts or not (Bråten, Braasch, & Salmerón, 2016). It is an important meaning-making strategy since it helps readers navigate the information on the Internet by understanding main ideas, neglecting irrelevant information, and integrating related texts to solve problems. Therefore, I focused on

OMR strategies that build situation models from reading modes together, rather than focusing on each mode and the textbase it constructs.

Lastly, the situation model reflects readers' individual differences, such as prior knowledge, goals, personal experience, or interest. This aspect is also not negligible in OMR. Whereas textbases are formed similarly among readers, situation models are formed all differently because every person brings different prior knowledge, experience, purpose, or interest to the reading cycles (van den Broek et al., 1999). More importantly, in OMR, readers construct different reading paths by making varied decisions on hyperlinks or modes choices (Kress, 2003; Rowsell & Burke, 2009). There are no static rules or linear ways to guide this path, so as readers follow the flow of multimodal information, they end up having diverse situation models. This individual difference may be inevitable in OMR, and this complexity increases due to one of the major characteristics of OMR, that is, it inevitably entails multiple texts reading.

3.2.3. Multiple Texts Reading on the Internet

I refer to *multiple texts reading on the Internet* as reading two or more webpages to construct a situation model through the integration of information. Although the CI model (Kintsch, 1998) was based on single text and written words reading, I posit that the concept of construction and integration processes and situation model building are germane to multiple texts in OMR. For the analysis of OMR strategies and situation model construction, theories regarding multiple texts reading are necessary because online readers frequently engage with multiple texts on the Internet (Bråten, Braasch, & Salmerón, 2016) while searching and examining information to accomplish reading tasks. Online texts basically take the hypertext format connected by myriad hyperlinks (Salmerón, Kintsch, & Cañas, 2006). Multiple texts reading typically entails constructing meanings from different texts that may have different perspectives on the same situation, issue, or phenomenon (Bråten, Braasch, & Salmerón, 2016).

Intertextuality is one of the major characteristics of multiple texts reading. New London Group (NLG; 1996) described it as the ways in which meanings are constructed through relationships to other texts, discourses, genres, and modes of meaning. As NLG stated, modes can contribute to intertextual meaning-making when readers perform multimodal synthesis. For example, during OMR, a reader can understand global warming by reading a news article describing this situation, viewing pictures of sinking islands, moving diagrams of heat energy circulation, and watching a documentary on this topic. During multiple texts reading, readers may gather multimodal resources to integrate meaning and reconstruct or deconstruct links to develop their inner text (Hartman, 1995). In this interaction between the reader and texts or within texts, reading is always open to further interpretations so that their situation model keeps being updated.

There are two notable models of multiple text reading that may describe readers' OMR strategy use during online reading tasks. Firstly, Perfetti, Rouet, and Britt (1999) came up with the Documents Model (DM) framework based on the CI model, which introduces levels of representation for multiple texts reading comprehension. They argued that during multiple texts reading, a reader constructs a documents model (DM), which includes semantic contents and the source information and the relationship among texts. It is like a globally represented situation model of multiple texts (Cho, 2014). These researchers found difficulties separating textbase and situation model from text due to the vagueness of mundane reading, which often results in nonpropositional mental models. They figured that this difficulty disappears by abandoning the textbase and representing text at a syntactic level, and limiting semantic representations to situations. A possible advantage from this syntactic-semantic representation was focusing on a richer, inference-rich model of relationships from multiple texts. Accordingly, they defined multiple texts comprehension as “the transformation of syntactic strings . . . having only limited semantic interpretations . . . into meaning-rich situation models” (Perfetti et al., 1999, p. 100). This model is relevant to OMR since it inherently is multiple texts reading, and there should be a dissonance to resort to propositional representations from multimodal reading. Therefore, I took DM concepts because it is a more flexible framework to explain situation model building in OMR.

DM accounts for connections between texts in various ways that are common for online reading, such as updating a situation model by connecting current information to previously read information and making contradictory situation models from oppositional texts. These ways of updating situation models can be resourceful for finding OMR strategies because the Internet is filled with messy information that requires readers to integrate, update, and classify. DM is a combination of the Intertext Model (relationship among documents) and the Situations Model (situations constructed broadly from texts) (Perfetti et al., 1999). Constructing DM is influenced by readers’ individual differences, such as reading goals, task requirements, and motivation to connect text and situations. Well-written texts have intertextual predicates or cues for readers to form the Intertext Model conveniently, but it is hard to expect this level of text quality on the Internet. Therefore, readers must perform a strategic reading to build a coherent documents model during OMR.

The next prominent model is the Multiple-Document Task-based Relevance Assessment and Content Extraction (MD-TRACE) model by Rouet and Britt (2011). Whereas DM specifically describes how readers mentally represent multiple texts, MD-TRACE is more concerned with task procedures and the relevant strategies for multiple texts reading. It is broader in scope by offering a general sequence of reading cycles to complete reading tasks (Bråten, Braasch, Salmerón, 2020). This model goes hand in hand with online reading since the Internet is fundamentally an intertextual space where reading strategies for a single printed text reading are insufficient (Cho, 2014). In MD-TRACE, each reader cycles through five steps during multiple texts reading: (1) construction of a task model, (2) assessment of one's information needs, (3) selection, processing, and integration of document information, (4) construction of a task product, and (5) assessment of product quality. Although this model does not address multimodal texts, this procedure can be applied to OMR in any degree, assuming this model deals with multiple texts on the Internet that are generally multimodal.

While every step relates to OMR strategies, I presume that they will be primarily necessary for the third step, which is about "the complex and interactive process of accessing, processing, and integrating information within and across documents" (Rouet & Britt, 2011, p. 10). This stage is consisted of three iterative steps that I applied upon OMR: (3a) assess item relevance, (3b) process text contents, (3c) create and update a documents model. For the first step (3a), a reader could use strategies such as multimodal information searching, evaluating modes by task relevance, skimming through the webpage layout to find information, or making reading paths to find appropriate information. In the next step (3b), once the reader decided what text to read, they can perform multimodal synthesis strategies to construct a situation model from the modes, such as combining written paragraphs with adjacent images, following colored or bolded fonts, and connecting them to a video. Readers may bring their prior knowledge or whatever they just read to form and update situation models. In the last step (3c), the reader can finally build a documents model, an integrated situation model from OMR. Just as readers build documents model from multiple written texts reading, they can make sense of what modes add to, support, oppose, or contradict each other from multiple multimodal texts or modes.

So far, I have described OMR as mental model building processes and related it to Kintsch's Construction-Integration model and the underlying concept of textbase and situation model for textual meaning-making. While CI model is applicable to OMR as a broader perspective, I focused on situation model because it provides the possibility of building more flexible and general mental representation during OMR. Accordingly, I brought two theoretical models that accounted for multiple texts reading: Documents Model (DM) and MD-TRACE. Both frameworks have taken further steps from CI model and are informative for OMR since DM accounted for how intertextual and situational comprehension is formed from multiple texts reading, and MD-TRACE furnished the lens for OMR strategies by describing typical stages of multiple texts reading. Thus far, I have accounted for how readers cognitively make meanings and what these mental models look like during OMR.

3.3 Online Multimodal Reading as Strategic Meaning-Making

3.3.1. Online Reading Strategies

According to New Literacies theory (Leu et al., 2004, 2013), the meaning of literacy has become deictic, which requires people to acquire new literacies to keep up with the rapidly evolving digital technology. Therefore, Leu and colleagues proposed a dual level of new literacies. The lower case new literacies indicate specific literacy areas which keep evolving as technology develops, such as multimodal literacy, online research and comprehension, semiotics, and multiliteracies. The upper case New Literacies is a combination of shared patterns of lowercase literacies. To name a few, it says: (1) the Internet is this generation's defining technology for literacy and learning, requiring additional literacies to fully access their potential, (2) new literacies are multiple, multimodal, and multifaceted, and (3) new forms of strategic knowledge are required (Leu et al., 2013). Integrating these aspects of New Literacies, it is necessary to figure OMR strategies that readers use and have today's students learn them to develop competencies. Structures and detailed descriptions of these strategies will contribute to the discussion of new literacies research (Cho, 2014).

To restate, I refer to online multimodal reading strategy as "a reader's goal directed, cognitive attempts to construct meanings from multimodal text on the Internet." A strategy is a form of procedural knowledge (van Dijk & Kintsch, 1983) in long-term memory like a tool in a toolbox. It is better for readers to have as many tools as possible (Alexander, 2005) because they flexibly and adaptively apply strategies to achieve their goals (Afflerbach et al., 2008; van Meter & Campbell, 2020). The construct of strategic reading changes over time, and today's technological development drive the need for strategic processing more than ever (van Meter & Campbell, 2020). Reflectively, Leu and colleagues (2013) suggested five types of strategies that online reading requires: (1) defining important questions or problems, (2) searching for and locating information, (3) critically evaluating information, (4) synthesizing information from multiple sources in a variety of text formats (video, audio, etc.), and (5) reading and writing to communicate findings (Leu et al., 2017). Given that the fourth strategy is the closest to what readers might use during OMR, I plan to discover cognitive and metacognitive strategies. According to van Meter and Campbell's (2018) taxonomy of strategies in general, cognitive and metacognitive strategies have dispositions described in table 3.

Table 3

Categories of cognitive and metacognitive strategies (van Meter & Campbell, 2018, p. 89). (Other types of strategies deleted)

Strategy Types	Description	Examples
Cognitive	• Influences how internal mental operations are applied toward learning material	• Memory strategies (e.g., 1st letter mnemonic) • Problem solving strategies (e.g., draw a diagram) • Self-explanation • Outlining
	• May include covert, observable behavior, but the causal mechanism lies in the internal cognitive processes	
	• Intended to support performance on academic tasks such as problem solving, reading comprehension, and knowledge acquisition	
Metacognitive	• Guides and directs cognitive processes	• Choosing a strategy that will work best • Rereading when did not understand • Self-assessment
	• Intended to support planning, monitoring, evaluation	
	• Includes knowing how, when, and where to apply strategies	

I used these descriptions as a reference to determine whether a specific process performed during reading is a cognitive multimodal reading strategy or not. Especially, I focused on the descriptions related to online reading, such as strategies to support performance on academic tasks and planning, monitoring, and evaluation. Also, it cleared up how metacognitive

OMR strategies should look like, which includes knowing how, when, and where to apply strategies.

3.3.2. Constructively Responsive Online Multimodal Reading

Pressley and Afflerbach (1995) developed a *Constructively Responsive Reading* (CRR) model and classified related reading strategies. *Constructively responsive* refers to the advanced readers' behaviors of active meaning-making and responding to information according to their reading purposes. They examined readers' think aloud protocols and found three major reading strategies that they used: identifying and learning text content, evaluating, and monitoring. Although these competent readers' behaviors are mostly confined to single, printed text reading, these findings denote a relation between traditional reading strategies and what today's digital reading requires (Cho, 2014; Coiro & Dobler, 2007). These traditional reading strategies are still fundamental to OMR because online readers also should make coherent meanings, evaluate source information, decide the relevance of the text, and monitor their navigation and thoughts while constructing and revising their reading paths.

Afflerbach and Cho (2009) updated CRR to incorporate online hypertexts reading. The new taxonomy embraced the intertextual nature of multiple texts reading and revised the strategies into four categories to suit the Internet hypertexts reading situation: text location, meaning-making, self-monitoring, and evaluation. For text location strategies, the researchers discovered expert online readers' pattern of *realizing and constructing potential texts to read* as they negotiate the multiple texts, spaces, and reading choices (Cho & Afflerbach, 2015). This strategy reflected the nature of the online reading that text contents are unknown until the reader searches and clicks the specific hyperlink. It emphasized the importance of identifying what to read and setting reading paths while making intertextual linkages. Influenced by this taxonomy, I sought OMR strategies from the literature that might fall into these four strategy types, emphasizing meaning-making by reading various modes together.

Afflerbach and Cho (2009) stated that the CRR framework is always open to modification and revision as people's understanding of literacies and contexts evolve. They foresaw that this categorization would accommodate the novel or hybrid strategies that new reading situations may create. OMR strategies can be one of the extensions that modify the CRR framework by incorporating multimodal, multiple texts reading into the predominantly language-based reading strategies. This explication of reading strategies contributes to replenishing the knowledge of the construct of reading and gives implications of how to foster reading instruction (Afflerbach & Cho, 2009). Accordingly, I argue that research of OMR strategies can supplement current literacy education by reflecting the pervasive multimodality in people's daily digital reading. By finding and categorizing OMR strategies, I hope "we become better able to consider how curriculum and instruction can support students as they learn to effectively read on the Internet" (Cho & Afflerbach, 2015, p. 505).

Chapter 4: Method

The purpose of this study is to explore competent readers' strategy use while reading online multimodal texts and to examine how these online multimodal reading (OMR) strategies influence multiple text comprehension. Specifically, this study investigates how doctoral students read multimodal texts for academic learning purposes by qualitatively analyzing individual readers' OMR strategy use. To meet these purposes, I present two primary research questions: (1) What type of online multimodal reading (OMR) strategies do competent readers use to comprehend multiple multimodal texts on the Internet? (2) What is a preliminary taxonomy of readers' online multimodal text reading strategies? This chapter will describe the research methods that I will use for the investigation.

Research on how readers use online reading strategies is a developing field, and research focused on the intersection of online and multimodal reading is of special interest here, given the growth and prevalence of this genre of reading. The theoretical domain of multimodality is still evolving, and multimodality is a field in which different methodologies have been tested (Kress et al., 2001; Kress & van Leeuwen, 2001; Jewitt & Kress, 2008). I believe that descriptive, qualitative methods in service of discovery and description are best suited to my proposed work. In the following sections, I will provide details of the study design and plan concerning (1) participants, (2) OMR task, (3) data collection, and (4) data analysis.

4.1 Participants

4.1.1. Participant Selection

I recruited participants using purposeful sampling which enables the researcher to answer research questions and provide information that is particularly relevant to research goals (Maxwell, 2012). Based on previous exploratory research on reading strategies (e.g., Pressley & Afflerbach, 1995; Afflerbach & Cho, 2008), I believe that in-depth analyses of participants' reading strategies is suited to the examination and cataloging of OMR strategies. The study should contribute to the knowledge base of OMR, a prevalent but relatively under-examined phenomenon, and creating an inventory of OMR strategies and a preliminary examination of patterns of strategy use across readers (Coiro & Dobler, 2007). Accordingly, I purposefully selected individuals using self-nomination as accomplished readers who regularly perform OMR through digital devices. Based on previous studies that utilized verbal reports and protocol analysis, I believe approximately ten readers is a sufficient number to identify and describe OMR strategy use, and to examine patterns of OMR strategy use across participants including commonalities and differences (Coiro & Dobler, 2007).

I recruited doctoral-level students who describe themselves as frequent online text readers and who regularly read online texts to achieve academic or professional goals (e.g., reading online articles, searching for information online, reading posted online class modules or materials). Compared to other majors where extensive reading is not expected, these doctoral students are majoring in various departments in the college of education where descriptive journal articles or books are regularly used for course materials. I regard their doctoral studies in educational intervention and policy as expertise in reading and writing because of their high educational level and professional experience in education as teachers, researchers, journal writers, teaching and research assistants, or teacher-educators. All these students are equally required to read extensive journal articles and books from the first-year coursework so that they are trained to be experts in education research. These readers usually read online journals, read multimodal texts through course materials, or read each other's writings and presentations to learn. Most readers use digital devices (e.g., laptops, tablet PCs, smartphones) to take courses and often use collaborative digital platforms to read and share research content.

Ten readers met individually with the researcher. I used observations, interviews, and verbal protocols as data sources to inform a grounded theory, open coding method (Glaser & Strauss, 2006). I note that I used a modified grounded theory to identify, describe and categorize OMR strategies from these readers. There are studies that examined how students read multiple texts and characterized the emerging patterns with a data-driven, bottom-up approach (Coiro & Dobler, 2007; Cho, 2014; Cho & Afflerbach, 2015; List & Alexander, 2017). This discovery-based approach is also suited for this study because this topic is rather new regarding its specificity of OMR strategies. Reading strategies used with print are still essential in online texts reading because online reading demands traditional reading skills, such as vocabulary recognition, inferencing, and finding main ideas (Afflerbach & Cho, 2009; Cho, 2014). In this study, I expect that participating students possess a level of printed reading proficiency that is demanded for doctoral level studies. Assuming their amount of reading for their coursework and academic research they pursue, their competence in reading would suffice to understand the Internet texts used in the study. There should be individual differences regarding their reading levels and the actual hours or experiences they have spent doing OMR. I used these differences to inform the relative data on the interpretation of each reader's OMR strategies. The relative OMR history of each reader was collected from the survey prior to the experiment. The detailed information of the individual difference of each reader was applied to the data analysis to see if there is any relation that might influence behavioral, cognitive, or metacognitive strategic choices.

Internet reading is complex (Afflerbach & Cho, 2009; Cho & Afflerbach, 2015), and readers need higher order thinking as they read complex texts or perform complex reading tasks. Therefore, OMR also requires higher order thinking which entails goal-directedness, responsive multi-sensory processes of different modes of information, or self-regulation (Afflerbach et al., 2015). My literature review (see Chapter 2) indicated a small but growing research literature on OMR which specifically analyzes strategies in the intersection of Internet reading, strategic (behavioral or cognitive) processes, and multimodal comprehension.

4.1.2. Participant Characteristics

Doctoral students from a mid-Atlantic university were invited to this study, and I used their graduate student membership as one proxy for accomplished reading. These competent readers are assumed to have high verbal abilities and reading process expertise, although this expertise is not expected in the content area used in the study (Johnston & Afflerbach, 1984). Given doctoral level students' accumulated training in reading and learning from various texts, these readers were good fit to provide fruitful data on OMR strategies. Online learning is assumed for the students to accomplish their academic requirements. Also, the COVID-19 pandemic has forced these students to spend more time online (Breakstone et al., 2021) because all courses were provided online for the whole academic year between Fall 2020 and Spring 2021. I recruited doctoral students with a consecutive enrollment since 2020, with the experience of taking online courses and course readings. The participants must have prior experience learning from Internet texts and understanding multimodal forms of information on the Internet. In addition, I use doctoral program writing experience as a proxy for writing competence. The subjects should be able to answer three simple (i.e., literal) questions related to how much they knew and learned about the topic of OMR study texts (i.e., coral bleaching). Writing comprises a substantial part of the doctoral student experience (Waight, 2022), so I assume they are readily able to write short phrases or sentences about the topic.

Table 4

Participant Demographics

Number	Pseudonym	Race/ethnicity	Age group	Gender identity
1	Amy	Hispanic or Latino or Spanish Origin of any race, White, non-Hispanic White	25-34	Woman
2	Blair	Hispanic or Latino or Spanish Origin of any race, White, non-Hispanic White	25-34	Woman
3	Chloe	White, non-Hispanic White	25-34	Woman
4	Dylan	Asian or Pacific Islander Asian	25-34	Man
5	Emily	White, non-Hispanic White	45-54	Woman
6	Felix	White, non-Hispanic White	25-34	Man
7	George	White, non-Hispanic White	25-34	Man
8	Hannah	White, non-Hispanic White	25-34	Woman
9	Isa	Black, non-Hispanic Black or African American, White, non-Hispanic White	25-34	Woman
10	Jamie	Asian or Pacific Islander Asian	25-34	Woman

Prior research suggests that participant selection of accomplished readers raises two important issues: (1) readers' automatization of strategies, and (2) individual differences that these readers possess. Accomplished readers may lose the ability to report their strategies if the attention is not given on the process—and this is sometimes the case as advanced readers exhibit automaticity as they use reading skills. The intermediate processes can be lost which leads to the lack of report on the mediated nature of reading strategies (Afflerbach & Johnston, 1984; Ericsson & Simon, 1980). To address this, de-automatization is needed to make the processes more reportable. Afflerbach and Johnston (1984) suggested that unfamiliar or difficult texts can deautomatize reading processes and make these processes available for verbal reporting, even as the readers maintain their processing expertise. Therefore, I planned to use a scientific topic that is not related to the participants' majors, a topic for which participants are assumed to have limited knowledge. This may make the task challenging but still comprehensible and increase the probability of de-automatizing strategies use for verbal reporting (Afflerbach & Johnston, 1984). On the other hand, too much new information across modalities may freeze or interfere with readers' comprehension due to the increased cognitive load (Murphy et al., 2016). Fortunately, the piloted participants reported that the texts were not too complex to understand, although they were unfamiliar with the topic or the think-aloud procedures. They took 15 to 20 minutes to read through all three texts and reported that the topic, coral bleaching, was new, but they could easily understand what it was by reading provided texts.

Next, all participants possessed individual differences that I expect will be reflected on the data analysis (e.g., average reading time, habits, familiarity with OMR, personal preferences of mode types, purposes of OMR, prior knowledge about multimodal text navigation). I collected this information through the survey and the short interview prior to the experiment and use it to support the analysis to describe how the individual difference influences OMR reading comprehension. For example, someone unfamiliar with multimodal information might focus more on words than images or audio. Her reading path may look more linear, top to bottom, rather than dispersed or lateral. Since I use a grounded theory-based discovery approach, using the data as valuable first encounter, those differences will inform how different readers approach OMR. I use a simple prior knowledge assessment that could provide valuable information as I interpret each reader's data (see 4.3.1). I limited the readers' major to social science since the topic of the text provided will be scientific. Also, the participants were fluent English speakers to guarantee high fluency with their verbal protocol processes.

4.1.3. Researcher Positionality

I am a Korean and East Asian female researcher studying in the same academic department as the participants. Participants are my colleagues; I have known some from coursework. My positionality as having similar academic background would have affected the participants. From the onset, some participants quite quickly opened up about their academic status and projects, and most were familiar with how qualitative study goes and tried to be supportive and fluent as possible. They knew I was an international student who understood the difficulties of code-switching between English and my original language, and four international student participants shared some dual language strategies as they performed OMR. These are hypotheses, but the participants occasionally used phrases like "As you know" or "I don't know this word in English." Therefore, my racial, academic, and linguistic positionality, as well as my current status and cultural background, might have affected the extent to which the participants shared their thoughts.

4.1.4. Recruitment of Participants

I recruited participants via email sent out to the doctoral student community. These subjects may voluntarily decide to participate in this study and recommend other participants. As the participants responded, they received an email containing letters of participation and consent forms. I initially recruited 12 participants in case of unexpected absence and data elimination and ended up with 10. Each participant was compensated with a $30 gift card after the one-time, two hours of participation. If they decide to participate, I contacted each individually through email to establish the time, place, and other matters.

Online Reading Survey

I asked subjects to answer the 'Questionnaire about Reading on the Internet' using Qualtrics survey webpage (www.qualtrics.com). This survey is taking place at the end of all experiment tasks to avoid interference with the data. This survey was created according to Coiro and Dobler (2007) and Cho (2014). These studies analyzed online reading strategies through students' hypermedia text reading like the current study. I modified their entry surveys and combined them to create a survey to acknowledge each participant's Internet reading behavior, preconceptions about four types of modes (written words, visual, audio, audiovisual), and OMR experiences and relative learning experiences (See Appendix A).

From the Internet reading habit studies, college students' average amount of Internet use was reported to be 1 to 2.47 hours a day (Ahmed, 2016; Mokhtari et al., 2009) and 9.5 to 12.3

hours a week (Van Deursen et al., 2011). Therefore, I screened out someone who says her average Internet reading time is less than 7 hours a week, which is below average for this demographic group, which did not happen in this recruitment. Although the number of hours spent online reading and online reading strategies are not proved to be related (Van Deursen et al., 2011), the least amount of weekly Internet reading (at least the average hours) will give participants medium familiarity to use the Internet. Survey responses were used as complementary data that inform how each participant uses certain modes for comprehension or strategic patterns connected to her prior Internet and multimodal reading habits. If not screened out, I assume that the participants are well-versed in online reading, including navigating to find information on the Internet which is essential for this OMR experiment.

4.2 Online Multimodal Reading Task

The OMR task is constructed to gather process data on the strategies used by competent readers. Therefore, this task is designed to elicit each participant's OMR strategies as they read. The experimental task requires participants to use OMR strategies found and shared from the literature (see Chapter 2) such as to locate, comprehend, synthesize, or evaluate information from expository multimodal texts within researcher-created multimodal hypertexts and search engines (Coiro & Dobler, 2007). Still, I did not confine the analysis only to these strategies because the modified grounded theory methodology I use is opened to any possibilities of new strategies that may emerge. It is an open-ended task where a variety of meanings resulted from the OMR are valuable. The topic, multimodal text set, and task demands and study procedures will be described subsequently.

4.2.1. Topic for Online Multimodal Reading

All participants worked with identical texts and tasks. The expository text genre is used because it is typically used in academic learning and online information searching. The topic of the text/task set is 'Coral bleaching: what causes it, why is it dangerous, and how do we stop it.' It is purposefully selected for readers not majoring in science or environmental studies in hopes that it could feel unfamiliar to them while it was assumed to be of interest as the world is facing environmental issues. Most readers may not have readily available prior knowledge about coral bleaching events because they are not domain experts, so they can focus on understanding unfamiliar concepts (Ozuru et al., 2009). This topic is also challenging enough for them to be engaged for a maximum of 25 minutes of reading/think aloud, depending on the readability analysis (see 4.2.2). Still, I assumed that the readers would not know enough about this topic because it has not been a widespread issue until recently. In contrast, the coral bleaching issue is familiar to the researcher from conducting the pilot study, which should benefit the interviews and analysis procedures. The researcher has plenty of knowledge about coral bleaching issues based on the interest in global climate change through documentaries and articles that helped accumulate knowledge that helps analyze subjects' reports during the experiment. Every participant's prior knowledge level would differ. I collected the information about how much they know about the topic through pre-reading written knowledge report where they can write as much as they know about coral bleaching. The data collection and data analysis parts address the details of collecting and using different levels of prior knowledge.

4.2.2. Multimodal Texts Set Provided to the Subject

Multimodal Texts Set Creation

I searched and found three multimodal texts on the Internet. The decision rules for the OMR texts are: (1) each text should be multimodal, using two or more different types of modes, (2) modes should provide a definition or description of coral bleaching, (3) modes are in a complementary relationship with regards to information delivery (e.g., information distributed in different modes, contents augmented by another mode, divergent relationship where modes say different information), (4) texts may have hyperlinks or menus extended to the external resources, but all are initially presented in each single, initial webpage. There are tradeoffs in the provision of naturalistic online text with hyperlinks. It enhances ecological validity, whereas it might lessen the control of the data by taking the reader all over the web. Still, I focused on how readers come up with strategies in the natural Internet space by allowing them to navigate freely. I anticipate there will be overlaps in readers' strategic choices while reading them. Also, allowing hyperlink clicks may lead to more diverse strategy use because hyperlink navigation is part of the OMR strategies that differ in its choice by levels of prior knowledge (Salmerón et al., 2006). Three webpages on the reader's preferred web platform will be provided in an order on lateral tabs, with the fourth tab containing only a Google search bar. This setting is like a typical online information reading scene that may increase ecological validity (Schmuckler, 2001).

Three texts were chosen to allocate mode dominance differently for the three modes I focused on: linguistic, visual, and audiovisual. I used Mayer's (2009, 2020) multimedia learning as part of the theoretical framework for this study which refers to learning from words and pictures. Among the modes that multiliteracies studies (Kalantzis et al., 2016) categorized –

written, visual, spatial, tactile, gestural, audio, oral – the theory of multimedia learning focused on words (spoken or written) and pictures (static or dynamic) (Mayer, 2017). 'Words' and 'pictures' here overlap with the modes I used for the multimodal text set: words, visuals, and audiovisuals. "Some common uses of multimedia in e-learning include an animation, video, or static graphics with accompanying narration; an animation, video, or static graphic with accompanying onscreen text; or a computer-based interactive game, simulation, or activity that includes spoken or printed text" (Mayer, 2017, pp. 403-404). Also, relative multimedia learning studies that examined Web-based learning facilitated by computers, mobile phones, tablet PCs often utilize "narrated stop-motion animation; generic modeling language; digital video; augmented reality; design based research; gamification; learning manager; simulation; computer based teaching; library webinars, (Sousa et al., 2017, p. 5189)" "language, motion, images, (Firmansyah et al., 2020, p. 9536)" "pictures, sound, or video" which provides interaction between learner and page (hyperlinks to other resources, interactive models and games), or high simulation fidelity" (Cook, 2005, p. 267). As a result, I used three types of modes –words, visuals, and audiovisuals – for the multimodal text set, considering the prevalence of their use in multimedia learning. In addition to the multimodal assemblage, I also intended to see how readers form meanings when each of these modes is dominant in a text. For example, I imagine a reader could use a unique, visual-centered OMR strategy for a text dominant with visuals or apply different emphasis on these texts since their modal dominance is differently allocated. The reader might use word-dominated text to comprehend the overall situation of coral bleaching and integrate that information into what coral bleaching visually looks like from the visual-oriented text.

The result is three multimodal texts in a task assemblage on coral bleaching. I analyzed the redundancy and complementary nature of information in each of the three texts. According to Chan and Unsworth's (2011) multimodal text comprehension study, there were different types of content relationships across modes: corresponding (modes describing the same thing redundantly) and complementary (e.g., contents distributed in different modes, contents augmented by another mode, divergent where modes say opposed or different things). Given the inevitable overlaps of information in a text for the coherence matter, I focused on the complementary nature of the dispersed information in various modes to see how readers integrate information from them.

All texts contain at least three modes in it: linguistic (e.g., words, hyperlinks), visual (e.g., images, graphs, illustrations, cartoons), aural (e.g., audio, oral sounds), or audiovisual (e.g., video with visuals and sound). I assigned each as the dominant mode in each text (see Table 5). In this paper, I define a dominant mode as (1) a mode that delivers the most crucial idea of the text, which also (2) occupies the largest area of the page. For example, in Text A, if written words are spread to half of the page and deliver the definition of coral bleaching while images, videos, and audio deliver marginal or backup information, I designated the dominant mode of this text as linguistic (words) mode. Table 5 shows the three texts I provided as an OMR text set. The total reading time was 25 minutes maximum, based on the pilot studies I conducted with two doctoral students who reported that 15 minutes was enough to understand coral bleaching and answer prior knowledge questions. I allotted 30 minutes in case they needed more time, but they are allowed to finish reading earlier if they think they have learned enough.

Table 5

Online Multimodal Texts Provided to the Participants

Texts	Main idea of the text	Dominant mode	Other modes
Text A (Tab 1)	Basic definition and information about coral bleaching (https://www.barrierreef.org/the-reef/threats/coral-bleaching)	Linguistic	Visual Audiovisual
Text B (Tab 2)	Why coral bleaching is problematic (https://time.com/coral/)	Visual	Linguistic Audiovisual
Text C (Tab 3)	How people prevent coral bleaching (tinyurl.com/ywmuja8x)	Audiovisual (Video)	Linguistic Visual
Tab 4	Google search bar (the reader may use it or not)	Up to readers' search results	Up to readers' search results

Text A contains basic definitions and information about coral bleaching, *Text B* shows why it is problematic, and *Text C* describes how to prevent it. All texts are limited to one or two printed page lengths which do not demand lengthy scroll-downs to avoid distraction. The order of the first text with a certain modal dominance may work as an anchor upon which subsequent modal or strategic choices are made so that readers might allocate progressively less time to the texts accessed later (Perreault, 1975; Reader & Payne, 2007). Contents from the videos might preempt other parts of texts by giving general information on coral bleaching while each addresses its subtopic. They can be helpful for the reader by offering complementary information, but they might cause a short circuit by overlapping information with the other. Still, I used videos because it is a natural characteristic of multiple online text reading where readers often see overlapping information in various texts and find coherence. For the comprehensiveness of think aloud data, I encouraged verbal reports to find patterns of how readers deal with common information from different texts or modes by yielding instructions such as “How does the information add up?” when they see complementary information from these texts.

Readability Test for Text difficulty

I performed a readability (text difficulty) test for the three texts using the Flesch-Kincaid readability test (Flesch, 1948; https://goodcalculators.com/flesch-kincaid-calculator/) which applies to the 5th grade to the professional adult level. Although it could only be applied to linguistic modes in three texts, it is valuable to examine if the texts are suitable for the participants who are graduate-level adults which score 0 to 50 (college, college graduate, and professional level). I copied all the words presented in each text and performed readability tests for written words. As a result, words in the three texts were spread from the 10th to 12th-grade level (fairly difficult to read) to college-level (difficult to read) (Text A scored 58.3, Text B scored 54.0, and Text C scored 34.6). For videos, spoken/narrated text, subscripts in the videos from each text were transcribed and evaluated for readability using the same test. As a result, three texts were spread from the 8th and 9th grade, 10th to 12th grade, and college-level (Text A scored 50.8, Text B scored 50.0, and Text C scored 62.1). In sum, Text A and B were leveled from high school to college, and Text C scored college-level words with more straightforward video content. I view that these levels of readability are suited for the text, although the subjects are competent readers. It is not only because the texts are at a fairly difficult level but also because the texts can be pretty challenging depending on the novelty of the topic and content, multimodal text organization, and, more crucially, reader’s individual differences (e.g., prior knowledge, experience, motivation) (Fisher & Frey, 2012). Plus, the texts are all in multimodal forms with the necessity of making meanings from visuals, maps, audiovisuals, and layouts of modes which may demand complex meaning-making. The text organization and visual aspects of text analysis are neglected in the readability test, although these multimodality features sometimes add challenges (Hamdan et al., 2017; Macedo-Rouet et al., 2003).

Unlike language-based readability metrics, there are no standard metrics for analyzing multimodal readability. Quantifying the complexity of multimodal texts is still nascent. Serafini et al. (2018) noted the necessity to theorize multimodal grammar and content analyses that investigate modes' integrated operation. Hovious and O'Connor (2022) suggested one way of analyzing multimodal readability by combining transinformation analysis and entropy of information. Transinformation means the semantic portion of information the reader receives (Weltner, 1973), and entropy refers to the uncertainty of the message delivered from the multimodal text (Shannon, 1948). They argue that reading words and nonlinguistic symbols use the same neural structure, and the relationship between entropy and cognition can be used to examine multimodal readability. They described a way to gauge the readability by combining objective (difficulty from the multimodal text itself) and subjective (difficulty felt by how each reader read modes) entropy. Although this transinformation analysis proved a viable method for analyzing multimodal readability, it was unfitting for this study because they conceptualized readability differently by the reader's attention and working memory capacity.

Multimodal Text Analysis

Understanding the meaning potential of different modes and how they interact are essential considerations in designing instructional materials and understanding the OMR processes (Chan & Unsworth, 2011). However, it is hard to analyze what visuals deliver through multimodal texts because not so much effort has been spent on identifying units of analysis in images than in text (Martinec & Salway, 2005). Also, readers' interpretation of visual meanings differs upon their prior knowledge, reading purpose, or experience of OMR. Since this study used visual and verbal modes for the reading task, I will analyze these two mode types into various relations based on the research that examined semantic image-text relations (Chan & Unsworth, 2011; Daly & Unsworth, 2011; Martinec & Salway, 2005; Otto et al., 2019).

In this study, I adopted Chan and Unsworth's (2011) and Daly and Unsworth's (2011) image-words relations -- concurrence and complementarity -- to analyze visuals and written words because the three texts are already coherent in explaining coral bleaching. Concurrence refers to when one mode elaborates the meaning of the other by specifying or describing it while no new meaning is introduced. It takes four forms: exemplification (e.g., image is an example of what is in the paragraph), exposition (e.g., re-expression of the meanings of the image in words), equivalence (e.g., complete or partial redundancy of content, like a caption under the image), and homospatiality (e.g., letter and image combined in one space like a word-letter). Complementarity refers to the relationship when a new meaning is introduced by either the written words or visuals. It has three types of relation: augmentation (a new attribute is introduced through an image), distribution (juxtaposed image and words jointly construct meaning), and divergence (image and words convey different meanings).

Table 6

Visual-Written Words Relation of Three Multimodal Texts

Texts	Main Idea	Modes and Information Presented	Visual-Words Relation
Text A (Tab 1)	What is coral bleaching?	• A paragraph about what coral bleaching is • Two videos about coral bleaching	augmentation
		• 4 written blocks explaining facts about coral bleaching • Small pictograms about each sentence	exposition
		• Coral bleaching FAQ's and the list of questions in drop down boxes • Two coral pictures under with short captions	distribution exemplification
Text B (Tab 2)	Why it is problematic?	• Title 'THE MOST BEAUTIFUL DEATH' • Photo or corals under water	homospatiality
		• Paragraphs about underwater investigation of coral bleaching • A map of New Caledonia Barrier Reef	exemplification
		• 4 360-degree images of underwater • Written paragraphs in between that explains reasons of death • Four illustrations of how healthy, fluorescing, bleached, dead corals look like	exemplification distribution
		• A video of what coral bleaching is • Concerning aspect of coral loss is what it suggests about the future.	divergence distribution
Text C (Tab 3)	How do we stop it?	• A large photo of corals at the beginning • Title "New Hope for Coral Reefs" • Paragraphs about the coral restoration hub • A video on how they restore corals	exemplification exposition distribution
		• Two paragraphs about mapping healthy coral reefs titled "MAPPING THE WAY TO HEALTHIER CORAL REEFS" • A photo of a drone taking pictures of coastal habitat to make maps	exemplification

		• Three paragraphs about mapping healthy coral reefs titled "RESILIENT CORAL REEFS MEANS SAFER COMMUNITIES" • A video about how people save coral reefs throughout the Caribbean and beyond.	exposition augmentation

If the visual part was a video, I viewed it to find relations with words around it. It is not helpful nor possible to analyze all hyperlinked pages for the websites while subjects will constantly be opening and searching new pages. Thus, I examined the three researcher-provided texts readers see at the beginning of reading. I divided the text into two or three sections to analyze its relations because readers scroll to view modes on one screen-sized page. Although difficulties exist in visual and word integration, I analyzed how linguistic, visual, and audiovisual modes are related and represent meaning in conjunction in the three texts. The descriptions of general relations between the modes will be applied to data analysis regarding each subject's OMR strategy use as visual-word relations may change according to how the reader chooses and comprehends them.

4.2.3. Task Demands and Study Procedures

To determine the proper time frames for the study and to optimize the overall experiment procedure, I have conducted a pilot study with two doctoral students majoring in social science. It showed that the OMR text set reading took 15 minutes for them to feel that they understood the topic and were confident answering questions. I prompted participants to read all three multimodal texts but let them know they do not need to read linearly or all parts of the texts. I encouraged readers to read various modes (I used the term, *various forms of information*) to learn as much as possible about the topic. I noted that they can switch the tabs as often as they want, including the new search results. These navigation choices were analyzed as strategies to realize and construct potential modal information to read (Cho, 2014). They were also allowed to search for further information as needed, which is meaningful as long as they make meanings and verbalize thoughts.

This research setting is digital and Internet-dependent. I asked each reader to bring a laptop and a mouse (or trackpad is allowed) they use to guarantee familiarity with the device (e.g., toggle features), which may influence reading performance. In doing so, the subject might use fewer behavioral skills to operate the device and focus more on texts while not being interfered with by complicated manipulation.

For screen recording, I used Zoom meeting to record each student's screen reading and voice while the subject screen share. At the same time, I used the app on my iPad, Voice Recorder, as a backup to avoid losing verbal reports. Retrospective interviews were also recorded through Zoom while we watched the OMR screen recording video. A stable Internet connection is crucial in this study, so I ensured that the Wi-fi works well in the experiment room.

I estimated that the length of individual sessions with participants would be two hours divided into two sets of sessions: (1) before and during reading (65 minutes) and (2) after reading (55 minutes). The division of these two sessions prevents the participant from being exhausted and losing focus from the hours of concentration and increases the accuracy of the think aloud data. Here I will describe the three stages: before, during, and after reading (See Table 7). I gave a ten-minute break between during and after reading sessions. Before in-person meetings with participants, I forwarded general information about participation which include some ideas of what they are expected to do. They also were guided to submit an online reading survey through

Qualtrics webpage prior to the participation day. This survey collected information on the reader's online reading habits and attitudes that was applied to the OMR strategy analysis.

Table 7

Task Procedure and Purpose

Session	Phases	Time (min)	Research Task	Purpose
Recruitment		0	Recruitment email	▪ Preliminary introduction (notify that they would think aloud while reading) ▪ Determining participants ▪ Collecting survey through Qualtrics
1	Before Reading	5	Research introduction	▪ Rapport building, increase motivation ▪ To inform participants about the whole process of this study (providing the task prompt through Qualtrics) ▪ Research procedure introduction beyond what I have already shared with participants via recruitment email
		20	Prior knowledge report writing	▪ To check readers' prior knowledge about the topic ▪ Provide Qualtrics prompt and let the subject type under three questions ▪ Practice the operation of the laptop
		10	Verbal protocol training	▪ Learning how to think aloud ▪ Reminding rules: giving reminders if silent, pointing cursor where they are reading ▪ Short practice by the participant
	During Reading	25-30	Online multimodal reading	▪ To find OMR strategies and get screen recording data ▪ To get intimate data on how each reader uses OMR strategies to make meanings using verbal protocol
10 minute break				

2	After Reading	20	Short writing task	▪ To compare the knowledge units before and after OMR in comparison with the prior knowledge report ▪ Provide Qualtrics prompt and let the subject type under three questions ▪ To see if there are any influences of OMR strategies on comprehension
		20	Retrospective interview	▪ Watching a recorded screen video together ▪ To discover strategies that the reader used during OMR that the researcher might not have noticed (member check) ▪ To find evidence that comprehension occurred by using OMR strategies
	Wrap Up	5	Summary	▪ Share thoughts or questions about the experiment
	Total	120	Wrap-up	▪ Give compensation

Before Reading

First, I verbally introduced the participant the whole process of this study while providing this prompt on the Qualtrics page as well. This process is also targeted to build a rapport and make the experimental environment as comfortable as possible. I made sure not to guide the data but to make the description detailed and clear. The prompt is written below.

Table 8

The Prompt for Before Reading to Introduce the Research

The Study of Doctoral Students' Online Multimodal Reading

Thanks for participating in this study. I am interested in investigating how doctoral students explore the Internet to learn new topics and utilize various forms of information to comprehend online texts. In this study, you will be primarily asked to read some articles on the Internet about the assigned topic and answer the same questions before and after Internet reading, based on what you learned from the Internet. Your primary task is thinking aloud your thought processes as you read various forms of information from texts. It takes no more than 2 hours to complete the study, and you will receive a gift card after participation. A detailed information about each section of the study is listed below.

Experiment Procedure

1. **Prior Knowledge Writing:** You will be asked to answer three questions regarding a specific topic.
2. **Verbal Report Training:** You will practice how to read aloud (5 minutes)
3. **Online Text Reading & Think aloud:** You will be asked to read three webpages to learn about the topic (You can also search further information on Google and explore the internet freely to learn about the topic, if desired). While learning about this topic, please think aloud your thought processes throughout the whole session. Specifically, instead of speaking what you're reading out loud, try reading various forms of information, such as visuals, videos, sounds, hyperlinks, maps, layouts, and so on. You can take notes on the provided paper if you want. Your voice and the screen will be recorded through Zoom.
4. **Post Reading Writing:** After reading, you will be asked to respond to the same three questions based on what you have learned from the webpages and your search. You will NOT have access to the webpages when answering these questions, but you may review your own notes if needed. I am interested in what you have understood and your usual reading strategies for reading various forms of information on the Internet.
5. **Break** (10 minutes)

6. **Post Interview**: You will be interviewed watching the screen-recording video of your reading with me. I will ask you questions about how you understood texts and the forms of information you read. Again, there are no right or wrong answers to this. You can freely describe what you were thinking, what you were doing to understand the texts. It is okay if you need to stop at any point of this participation, or if you want to take a break. Feel free to tell me or ask me any questions.

Next, I asked the reader to type their prior knowledge about the topic with three prompting questions: *(1) What is coral bleaching? What causes it? (2) Why is coral bleaching dangerous? (3) How do we prevent or stop it?* I decided to give those three questions instead of asking detailed questions to possibly reduce the priming effect, which might affect readers' OMR strategies or the direction of reading. The purpose of this 20-minute pre-reading task is to see how much prior knowledge each reader has and get a sense of the starting point of their meaning-making before they learn from the OMR task. Being able to answer it with short words or sentences will suffice. For example, two subjects from the pilot study answered, *"*I do not know… maybe I've heard of it from somewhere (maybe GRE?). Perhaps global warming causes coral bleaching*."* and *"*I don't know anything about it*."* for the first question. Of course, the primary focus of this study is to find and taxonomize OMR strategies. Still, I applied this evidence of prior knowledge on data triangulation to compare with the after-reading knowledge report to see what OMR strategy helped to understand certain idea units. I consider this research component to be exploratory in that the result may suggest future areas in which I examine the influence of prior knowledge on OMR strategies, more deeply in the future research. Namely, I anticipate that the examination of prior knowledge will allow initial exploration of the relationship of prior knowledge with strategies (See 4.3.1 for details).

Lastly, I gave the participants a training session to become acquainted with the think aloud method. They learned the purpose of this method, how to verbalize thought processes, and the basic rules to keep in mind when thinking aloud. I notified participants through the recruitment email that they will read texts on the Internet and think aloud. Participants practiced thinking aloud on the experiment day with a sample, non-topic-related online multimodal text. The topic was irrelevant to coral bleaching, but it was still a scientific expository text on the environmental issue. This way, the reader was trained to provide detailed verbal data (See 4.3.2 for details).

During Reading

During reading, students read three online multimodal texts about the topic for 25 minutes while verbalizing thoughts. The whole reading process (e.g., cursor movement, highlighting, clicking, switching tabs, think aloud voice, sounds from the speaker) were screen-recorded, making a 25-minute video for each participant. Only the screen, computer sound, and the reader's think aloud were recorded. Participants got a ten-minute break after this session. The prompt is as follows.

Table 9

The Prompt for During Reading

Online Multimodal Reading

Now you will be reading three online texts on the topic, Coral bleaching. I would like you to think aloud to show the processes you take in trying to understand the topic while you read. Please say what goes on your mind when you see images, written words, or videos as detailed as you can. Explicit language and voice are encouraged since your voice will be recorded and transcribed. I am interested in how you use various forms of information (e.g., images, words, hyperlinks, tables, graphs, videos, tabs, sounds, or any type of information you see) to understand the topic. If you stay silent, I may remind you to keep thinking aloud. Also, you will hear the beep sound while reading, reminding you that you should think aloud if you have not been. Please remember to put the cursor on the part you are looking at even if you are silent (the cursor should follow where your eyes go).

Please be sure to include all you can verbalize because the more you tell, the better I can learn about how you comprehend the texts. I encourage you to read all three texts, but not necessarily all parts of them if you feel it is unnecessary for the flow of your reading. It does not have to be a linear, orderly reading. You may look for more information using the Google search page on the fourth tab if you need it. There is no right or wrong way in this process, so you can say anything at any point in your reading. You can finish the reading earlier than thirty minutes if you feel you have learned enough about the topic, but I encourage you to delve deeper into this topic. You will answer the same questions you have been asked before reading. I will not score how much you learned. I encourage you to freely learn as much as you need about coral bleaching wherever your interest leads. Please let me know if you have any questions. Try not to be distracted and do your best to focus on the topic. Now, please open provided links (You may use other search engines instead of Google.) Please screen-share on Zoom. Remember to use a clear voice as possible.

After Reading

The reader recorded what they have learned from the task to the same question they answered before reading, and I gave them this prompt:

> Now you will respond to the same questions about what you have learned from reading. Write as much as you know. You may include information that you have provided before reading, but I would like you to focus more on what you have learned newly from the reading you have just finished. You may see your notes if you have taken any. You have 20 minutes to write, but you may finish it earlier. (1) What is coral bleaching? What causes it? (2) Why is coral bleaching dangerous? (3) How do we prevent or stop coral bleaching?

The purpose of this short writing is to show a possible knowledge accumulation and to use this data to examine how OMR strategies influenced the reader's reading comprehension. I used this data to see if there is any comparison of written knowledge reports before and after reading or to triangulate the segment of new understanding that the participant might have gotten from specific modes with their strategic behavior from the verbal report and the retrospective video. For example, if a student did not know what bleaching with regards to coral reefs means before reading (and had not written down any) but has written 'coral reefs are dying, and its skin turns transparent. Bleaching occurs because their skeleton, which is white, is showing.' I view that this is knowledge learned from the reading and ask them what part (mode or integration of modes) of reading helped her learn that and how (strategy use) she learned that. A detailed description of this triangulation was described in the following data collection and analysis sections.

A twenty-minute retrospective interview followed, watching the recorded video together with the researcher. Each reader was asked about the strategy they used by asking semi-structured interview questions (See Appendix C) (e.g., What did you think when you were reading this part? How did you understand this picture?) I also asked what they have learned from the OMR (e.g., What did you understand here? What did you learn from this text as a whole?). This interview was also voice-recorded for the analysis. At the end of this whole experiment, 'Questionnaire about Reading on the Internet' was taken by each participant. This survey is used for acknowledging each participant's Internet reading behavior, preconceptions about four types of modes (written words, visual, audio, audiovisual), and OMR experiences and relative learning experiences (See Appendix A). It was the supplementary data to learn more about online reading habits for data analysis.

4.3 Data Collection

Multiple data were collected from which I will infer each participant's strategic actions to construct a taxonomy of OMR strategies. The primary data is each participant's verbal reports during the online multimodal text set reading. It was integrated with a screen-recorded video of reader-computer interaction to analyze strategies. This video is different from the verbal report data because it captures the reader's course of reading that the think aloud data might have missed (e.g., forgot to report, too immersed in reading and unable to think aloud, cursor placements or clicks on the texts while silenced, video narration and think aloud overlap, fast scrolls up and down). It provided a detailed context of strategic behavior by connecting verbal reports with corresponding visual data of reader-computer interaction. With verbal reports as primary data supported by screen-recording videos, other types of data – topic prior knowledge report, written comprehension report, and retrospective verbal report – will be used for triangulation. This part of the chapter describes the collection plans for the five types of data in the subsequent order (See Table 10).

Table 10

Data Collection: Description and Purposes of Data

Stage	Type of Data	Description of the Data	Purpose of the Data Collection
Before reading	Topic prior knowledge report	A written report about topic-related prior knowledge Participants type their understanding of the topic under given questions	To check readers' prior knowledge of the topic To use this information to enhance the examination of readers' strategic behavior
During reading	Verbal report	Think aloud protocols related to OMR that indicates strategic thought processes and describes reader-text interactions with given texts	To use as primary data to infer OMR strategies that the participant used to comprehend modes and their integrated meanings
	Screen recording video	Reader-computer interaction protocols recorded with visual and aural trajectory	To observe participants' strategic behavior (e.g., cursor moves, highlights, tab switching) that can enhance or challenge the understanding of verbal report data
After reading	Written comprehension report	A written report about what each participant learned during reading Participant types their accumulated knowledge about the topic	To help inform the effectiveness of OMR strategies that each reader used during specific reading procedures To perform unit analysis that might disclose what strategy helped the accumulation of specific knowledge units

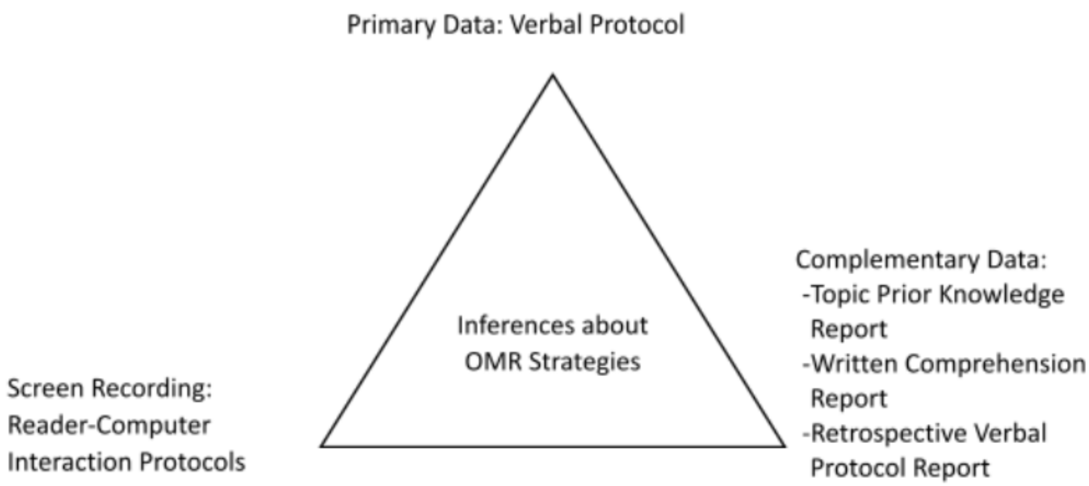
	Retrospective verbal report (interview)	Twenty-minute interview on how the reader performed OMR Watching the screen recording with the researcher Use semi-structured questions to elicit strategies from the reader's view	To investigate OMR strategies that might not have been clearly reported with think aloud protocols and screen recordings. To increase the accuracy of the inference that the researcher makes during the data analysis by listening to the participants' perspectives on their strategy use

Triangulation of the Data

Data triangulation refers to integrating multiple types of data into a coherent body of evidence (Cho, 2020). Verbal data analysis research notably manifests trends in data triangulation, often utilizing two or more sources of verbal data, such as think aloud reports, interviews, or eye movements (Cho, 2020). The triangulation reduces the risk of reflecting biases of a single method and allow different data to check each other to gain a more secure understanding of the investigation (Maxwell, 2012). I triangulated each reader's verbal protocol as the primary data, screen recording as the secondary, and support them with a written prior knowledge report, written comprehension report, and the retrospective verbal protocol to find more accurate evidence of OMR strategies (see Figure 10).

Figure 10

The Plan for Data Triangulation to Infer Each Participant's OMR Strategies



4.3.1. Topic Prior Knowledge Report (Pre-Reading Writing Task)

Assessing prior knowledge is important for the validity of reading research because it predicts the amount of information readers understand as learning outcomes (Shapiro, 2004). According to studies that examined the reader's prior knowledge and reading skills for text comprehension, prior knowledge is a significant predictor of text comprehension, often more so than reading skills (Ozuru, 2009). There are five types of prior knowledge that influence learning new knowledge and the use of reading strategy: declarative, procedural, domain, conditional, epistemic, and disciplinary knowledge (Afflerbach et al., 2020). In this study, I focused on declarative and procedural knowledge, which means topic and strategic knowledge accordingly. Topic prior knowledge is anticipated to have a significant difference because it demands the reader's reading and learning in specific areas of factual knowledge while disciplinary (domain) knowledge is assumed to be similar since the subjects come from the education major (Ozuru et al., 2009). Also, topic knowledge is a prerequisite for successful reading since learning declarative knowledge is enabled by the reader's procedural knowledge, namely, reading strategies (Afflerbach et al., 2020). Prior knowledge is also the individual difference factor that contributes to situation model construction and the support of strategic multiple text comprehension (Kintsch, 1998; List & Alexander, 2019; Rouet et al., 1997). Therefore, I take the possible differences in prior knowledge to the discovery of patterns about how it relates to online multimodal comprehension strategies for each reader.

Open-Ended Topic Prior Knowledge Writing

Topic prior knowledge refers to the specialized knowledge that is more specific to given texts (Shapiro, 2004). There are effective topic prior knowledge measures such as multiple choice, open-ended, completion, word association, recognition, or structured questions (Dochy et al., 1999; Holmes & Roser, 1987). Open-ended written reports were used for this study to probe structured questions developed from the topic, coral bleaching. This method is appropriate for this study because it helps elicit idea units of prior knowledge, both correct and incorrect, and yields specific knowledge under the time limit (Holmes & Roser, 1987). Multiple choice or overall evaluation of knowledge learning seemed more challenging to connect specific knowledge and the strategic process. Open-ended reports efficiently analyzed the strategy used to learn a unit by triangulating the think aloud, screen-recording, and retrospective interview that all pinpoint certain unit increases by comparing pre and after-reading knowledge report.

To ascertain readers' prior knowledge of the topic, I asked them how much they know about coral bleaching (See Appendix B). I asked the participant to type a short paragraph on Qualtrics under each question: (1) What is coral bleaching and what causes it? (2) Why is coral bleaching dangerous? (3) How do we prevent or stop coral bleaching? Readers may leave it blank if they knew nothing about it because how they learn new knowledge is the focus of this study. Some readers may have just read about coral bleaching elsewhere, and I identify this prior knowledge from their pre-reading written report. Some students might use schema for understanding coral bleaching (e.g., scientific knowledge they learned from high school, documentary scenes). I proceed with the whole experiment session with them equally but mark those readers' data as having prior knowledge, anticipating their different OMR strategies use. For example, I expect that readers who have prior knowledge about coral bleaching would not be reporting much on conceptualization strategies. They might use higher-order thinking, such as checking the accuracy of the information or challenging the author. To identify where they brought knowledge and to distinguish it from the newly accumulated ones, I follow up on their prior knowledge report by asking "Where did you get this information?" to document who already had the knowledge and how they got it. This way, the verbal protocol data will have more detail for interpretation.

Unit Analysis of the Prior Knowledge Report

I used a short measure of assessing written prior knowledge that has been devised in reading comprehension research (Cho, 2014; Leroy et al., 2022). Likewise, instead of developing a detailed scale of prior knowledge levels, I used each participant's descriptive answers as the explanatory variable which describes how initial knowledge influences strategic decisions during the reading task. For example, a reader who has limited knowledge (e.g., have not heard about it) may focus on written words that describe the definition of coral bleaching and use visuals to reinforce this understanding. In contrast, a reader who is knowledgeable of it might skim through the paragraphs describing what coral bleaching is and might jump right into the audiovisuals or numerical charts to see what is new or try more evaluative strategies to find useful texts.

The typed answer was parsed into the idea units (segments) to measure the amount and quality of each reader's topic prior knowledge (Chi, 1997). This method is called a 'quantitative-based qualitative approach' which uses the researcher's impression by coding the verbal evidence of representation of knowledge that the participant has and compares the frequencies of the codes quantitatively (Chi, 1997). It helps analyze verbal utterances, but I applied it to written paragraphs with the same segmentation method. It is important to decide the grain size of the segment that corresponds to what the researcher wants to see. I decided to use the smallest grain size, word, or proposition-sized units based on semantic features (e.g., ideas about coral bleaching) because finer grain size would provide more sensitive evidence of the possibly gained knowledge segments after OMR (Chi, 1997).

For example, suppose a participant wrote, 'I've heard that coral bleaching is dangerous for the underwater ecosystem because fish reside there and eat food from the corals to survive. I've watched a documentary about global warming and recall that it might have impacted the bleaching in Puerto Rico.' I coded words or phrases such as dangerous, underwater ecosystem, and fish survival (resident, fish food), due to global warming, which takes place in Puerto Rico. These are the idea units of how much a participant knows about the topic. I will tie the ideas into similar groups and quantify the idea units counted under the provided questions (see Table 11).

Table 11

Unit Analysis of Knowledge about the OMR Topic

Study Phase	(1) what coral bleaching is	(2) why it is dangerous	(3) how to prevent/solve it
Before reading	-underwater ecosystem -due to global warming	-dangerous -fish survival (resident, fish food) -takes place in Puerto Rico	N/A

The correctness of ideas is not critical, but the comparison of the idea units before and after OMR is important here because it will be triangulated with other data to infer what OMR strategies helped the subject learn certain knowledge that did not exist. I used the same unit analysis method for the written comprehension report after reading (see 4.3.4). In sum, this prior knowledge report was a valuable resource with regards to individual differences to examine how different levels of prior knowledge affect competent readers' strategic choices in online multimodal text reading.

4.3.2. Verbal Reports (Think Aloud Protocols)

"Verbal reports are spoken records of things that readers do and think related to their reading. Protocol analysis is the examination of verbal reports that allow us to describe reader behaviors, specifically their strategies, plans, and goals" (Afflerbach & Cho, 2009, p. 6). It is the primary data collection method for this study to find OMR strategies because of its suitability to describe reader-text interactions with multiple texts in the Internet environments (Afflerbach & Cho, 2009). I referenced reading strategy studies that used verbal protocol analysis for the overall process (Johnston & Afflerbach, 1985; Coiro & Dobler, 2007; Cho, 2011), as well as verbal protocol analysis methodology research (Afflerbach & Johnston, 1984; Pressley & Afflerbach, 1995) for detailed accounts of instructions.

Verbal Report Training

The verbal report task demands the subject to heed both processing and reporting simultaneously, which is unfamiliar for most participants (Afflerbach & Johnston, 1984). It is cognitively demanding and unnatural for most readers. At the same time, I hope to get explicit and reliable reports which can support accurate inferences during data analysis. These goals can be accomplished by self-imposed, nondirective practice procedures suited for advanced readers (Afflerbach & Johnston, 1984).

Participants were notified through the recruitment email that they will think aloud while they read online texts. On the experiment day, each subject practiced thinking aloud with a researcher-provided sample multimodal webpage for five minutes. This training avoids possible bias caused by the researcher's modeling (Johnston & Afflerbach, 1985). The sample webpage for training consists of the same type of modes used for the OMR task: words, visuals, and video. The topic of this text is 'the most pressing climate issues,' which is a general scientific topic related to the environmental issue but not overlapping with the current topic. I gave feedback on their think aloud if necessary. Also, the researcher sat near the subject, not too close, and reminded her to think aloud every 10 seconds when she is silent. I also demanded the readers to put a cursor wherever their eyes go. According to the pilot study, two doctoral students said that they were not bothered by this cursor moving because it was the behavior they usually do to focus. I have developed a detailed instruction prompt to familiarize subjects with this method, not to lose important verbal data. Participants received the following prompt, both written and verbal, before starting the reading task. The prompt was:

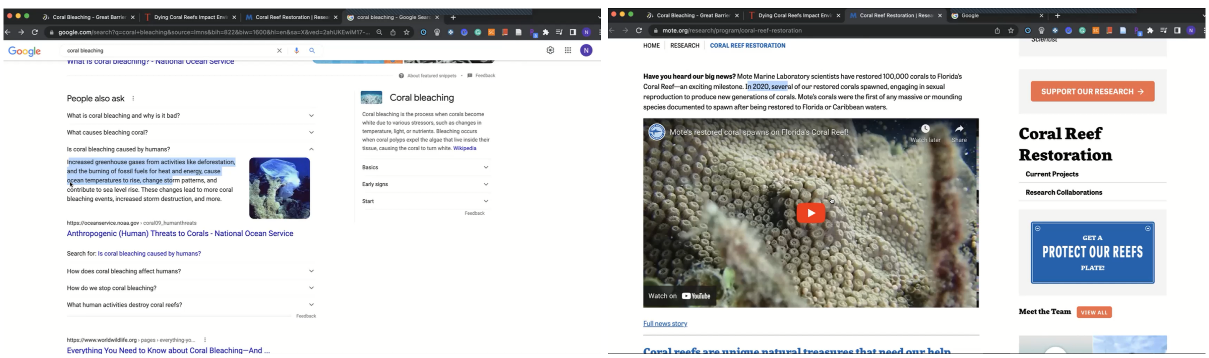
> Now you will practice online text reading as a warm-up practice. I will give you a text. When you read it, please say what goes on your mind like you might have seen from your class that the teacher thought aloud to teach how to calculate or read a textbook. Explicit language and voice are encouraged since your voice will be recorded and transcribed. I am interested in how you use various forms of information (e.g., images, words, hyperlinks, tables, graphs, videos, sounds) to understand the topic. I will tell you to think aloud to remind if you have not been for 10 seconds. Please try to put the cursor on the part you are looking at even if you are silent (the cursor should follow where your eyes go).

4.3.3. Screen-Recording Video (Reader-Computer Interaction Protocols)

Capturing online multimodal reading raises challenges for data collection due to its dynamic features regarding multiple multimodal texts and various navigation paths. One way to overcome them is to create stable offline data recorded through screen capture tools that can be repeatedly viewed (Jewitt et al., 2016). Thus, I recorded each participant's reading scene using the screen recording function on Zoom which records the screen with the think aloud (https://zoom.us). I decided to use this video to observe participants' strategic behavior, which can be lost when using verbal reports only. Screen recording enables researchers to explore the interactional synchrony between modes and provides a fine-grained sequential record (Jewitt et al., 2016). For example, since it is difficult to both tend to screen reading and think aloud, a reader may skip or forget to verbalize some parts of reading. To make up for those missing data, for example, I watched and analyzed the video to see what the subject saw at the point of missing utterance to infer thought processes through the cursor moves.

Figure 11

Screen-Recording of Reader-Computer Interaction Example (Captured from the Pilot Study)



4.3.4. Written Comprehension Report (Prompted Questions and Answers)

The purpose of asking same questions before and after the reading task was to see how much readers learned from the texts during reading and to make the readers focus on the topic learning to make this task similar to academic topic learning. There may exist priming effect of their learning since I notified that they will be asked the same questions so that they can focus on learning specific knowledge regarding the topic. Also, participants knowledge gains and OMR strategy use might be constrained due to this specified reading task. However, I decided to use this task because this knowledge comparison can help indicate what knowledge might have gained from certain parts of OMR, using what kind of OMR strategy, while there is still a possibility that the reader might brought it from her prior knowledge. Also, this task help readers remind the purpose of the task during OMR which is similar to searching and reading online texts for academic purposes.

Each participant wrote what they have learned from the OMR as the after-reading task. As I have described in the topic prior knowledge report analysis, I coded idea units (Chi, 1997) from the reader's written report under three questions: (1) what coral bleaching is, (2) why it is dangerous, and (3) how to prevent/solve it (see 4.3.1). The prompt was:

> Now you will respond to the same questions about what you have learned from reading. Write as much as you know. You may include information that you have provided before reading, but I would like you to focus more on what you have learned newly from the reading you have just finished. You may see your notes if you have taken any. You have 20 minutes to write, but you may finish it earlier.

This task is not focused on the memorization or accuracy of the information. The purpose is to find evidence of how readers comprehended or integrated modes from the dataset to draw inferences about OMR strategies. Mainly, this task complements the two data – verbal reports and the screen recording – in speculation of how particular strategy is applied to the reader's meaning-making. Connecting to the previous example of the prior knowledge report, the sample of the written comprehension report after OMR may look like this:

> The Great Barrier Reef is one of the richest and most complex natural ecosystems in the world. This area is in danger of dying coral reefs. When corals are under stress, they expel the microalgae that live in their tissues. Corals' tissues become transparent without these algae, exposing their white skeleton. This is called coral bleaching. Rising ocean

temperatures caused by climate change are the primary cause of coral bleaching. I've learned that fragile coral reefs become hypersensitive to climate change. While the world works toward reducing greenhouse gas emissions, people must make coral reefs more resilient and help them adapt to the warmer temperature.

Table 12

Unit Analysis of Knowledge about the OMR Topic

Study Phase	(1) what coral bleaching is	(2) why it is dangerous	(3) how to prevent/solve it
Before reading	-underwater ecosystem -due to global warming	-dangerous -fish survival (resident, fish food) -takes place in Puerto Rico	N/A
After reading	-corals under stress -expel algae -coral tissues become transparent exposing skeleton -caused by rising ocean temperature (climate change)	-corals become fragile -corals hypersensitive to climate change -The Great Barrier Reef (most complex natural ecosystem) in danger	-reduce greenhouse gas emissions -make coral reefs resilient -help them adapt

Compared to the prior knowledge (before reading) unit analysis, there are more (e.g., novel, specific, expanded) ideas from the written comprehension report (after reading) that can be inferred that the reader has learned from the OMR (during reading). I view these new idea units gained from the multimodal reading using OMR strategies and focus on the influence of strategic behaviors captured from the verbal reports and screen recording video on learning these ideas. The strategic choices are contextualized by triangulation of the dataset for a more accurate interpretation (Cho, 2020). For example, the reader from the example report did not report what causes the white color of corals. After reading, she wrote that bleaching occurs because coral tissues become transparent and expose the skeleton. The verbal protocol and screen recording data could have also captured this moment (e.g., reads "corals' tissues become transparent, exposing their white skeleton." and says, "Oh, that was why it looks white!" Circles the cursor over the white coral reef picture under the paragraph). More evidence can be collected about how this subject learned this fact from the retrospective interview if she says any of this part (e.g., "The huge coral skeleton caught my eyes, and I read the paragraph above it. It said it was the skeleton, which I never knew. I got intrigued and saw that video on the next tab, which said the same thing. The corals were also white, so I realized that they are all close to death."). These collected datasets are transcribed to the matrix and analyzed to find what kind of OMR strategies the reader used to understand certain knowledge she reported (see 4.4).

4.3.5. Retrospective Verbal Report (Post-Reading Interview)

I interviewed each participant for twenty minutes after they finish the post-writing session. I showed them their recorded video as a reference to recall their strategy use. The researcher and the participant worked through the footage together and pause whenever the subject wants to share something, or the researcher finds strategies that need further explanation. There are three categories for the interview questions: (1) overall questions to ask about strategies, (2) multimodal meaning-making strategies, and (3) overall reading and affective domain (see Appendix C). The interview questions were semi-structured and were provided as standardized as possible to minimize the difference between participants since the researcher-participant interaction might influence the data (e.g., What did you think when you clicked on this hyperlink? Why were you pausing? What were you thinking here? What did you understand from reading these modes?) This interview aims to get reader-centered accounts of OMR strategy use that can add to the researcher's observation. This data is expected to enhance the interpretive power of the verbal report analysis.

Since the readers will have just finished reading, I assume they can be the most potent informants to report what they did to understand texts, even more so than the researcher for certain parts. Still, two challenges exist for the retrospective verbal protocol. On the one hand, people have limited short-term memory, so the recency of cognition and response is critical. The greater the temporal distance between reading and the retrospective recall, the greater the possible decay of accurate information readers report (Ericsson & Simon, 1984; Pressley & Afflerbach, 1995). On the other hand, the retrieval process can be interrupted by similar prior memory mixing into the just-finished cognitive process. It is hard to separate specific cognitive processes that were heeded at a particular time from the thoughts formed before or after it (Ericsson & Simon, 1984). To counter these potential challenges, I interviewed the reader immediately after the post-writing task is completed, while much information about strategic reading is still in the short-term memory. Providing the screen-recording video was retrieval cues for readers to recall and report their thought processes (Ericsson & Simon, 1984). This post-interview was recorded through Zoom, and our voices were transcribed.

4.4 Data Analysis

The data was transcribed and analyzed to answer two initial research questions: (1) what type of online multimodal reading (OMR) strategies do competent readers use to comprehend multiple multimodal texts on the Internet? (2) What is a preliminary taxonomy of readers' online multimodal text reading strategies?

To answer the first question (what type of OMR strategies do readers use?), I took two steps of data analysis procedures: (1) data transcription and (2) qualitative coding to find OMR strategies. I transcribed each reader's verbal report recorded together with the screen-recording video as well as the retrospective verbal report. Pre- and post-reading knowledge reports were used as supporting data to contextualize strategy use, but they will not be transcribed (see 4.4.3). Instead, I left the researcher's notes on the matrix about any insight that I got from the whole five datasets, including those reports. Next, I qualitatively coded OMR strategies using the Excel spreadsheet I put a transcription matrix to this software and codify them to figure out categories of overlapping OMR strategies and determine the nature and salience of utterances. I performed coding separately with another expert in this field and check the interrater reliability (see 4.4.2) to confirm that the OMR strategies coded are valid. By coding ten participants' datasets, I anticipated getting saturated OMR strategies that can be used for the next research question.

For the second research question (What is a preliminary taxonomy of readers' online multimodal text reading strategies?), I found patterns emerging from codes to find commonalities and the hierarchy of strategies that can be extended from the Constructively Responsive Model (Afflerbach & Cho, 2009; Cho, 2014; Pressley & Afflerbach, 1995), which found major online reading strategies. Detailed analysis plans are presented in the following sections.

4.4.1. Data Transcription and Matrix Development

To begin with, I transcribed each reader's collected datasets into a matrix (see Table 13). There are no fully settled multimodal transcription conventions (Jewitt et al., 2016), so I referenced ideas from relevant multimodal studies and made a matrix that could best present the data. It involves verbal reports (think aloud protocols), a screen-recording video (reader-computer interaction protocols), and retrospective verbal reports (post-reading interview). Topic prior knowledge written report and written comprehension report analyzed by idea units were read through, and the insights were added up to the matrix. Due to the spoken data features that can be lost while changing into written formats, the range of transcription can be wide, including intonation, pauses, mumbling, and other variations (Afflerbach & Johnston, 1984).

A transcript is multimodal "when it contains more than one mode. Including image as well as writing as a means of transcription forces the transcriber to decide which meanings will reside where and how these modes relate" (Mavers, 2012, p. 4). For the multimodal transcription that aligns with verbal reports, I captured the screen recording (reader-computer interaction) into the matrix, based on the multimodal transcription method described in the relative multimodal analysis studies. Bezemer and Jewitt (2010) described the steps to analyzing video recordings of the classroom lesson focusing on multimodality. Although it is not identical to the reader-computer interaction log, this guidance was insightful regarding analyzing multimodal video. They suggested four steps for multimodal data analysis where I referenced some important caveats for this study: (1) collecting and logging data: include thumbnail depictions of particular excerpts of the scene and to add analytical notes, (2) viewing data: view video repeatedly with other encoder to get insights in different perspectives, (3) sampling data: modes to analyze should be guided by the research question because focusing on all modes is not feasible nor necessary, and (4) transcribing and analyzing data: transcription always tends to lose details and when it's multimodal it is more varied data that are lost (Bezemer & Jewitt, 2009). Especially, visual and video modes may get lost when moving from screen to print. Thus, how the reader utilized these modes will be viewed repeatedly and depicted as detailed as possible (Bezemer & Jewitt, 2009). I triangulated data to figure the essential parts that needs transcription.

Jewitt et al. (2016) emphasized that multimodal transcription should follow the theories of meaning-making of each research. My study aims to examine how multimodal information is perceived and comprehended by users (Jewitt et al., 2016). Considering that, Jewitt (2006)'s multimodal transcript table which transcribed data by observing modes used, using time as an anchor for mapping them into separate mode columns, suits my study. Jewitt's matrix included students' part and how they interacted as captured video images with their action and speech, but I eliminated this part because this study only accounts for reader-computer interactions. I focused on the plane of the screen (right half of Jewitt's matrix) and expand it to capture detailed modes interaction and transcribe verbal reports on the speech section.

Table 13

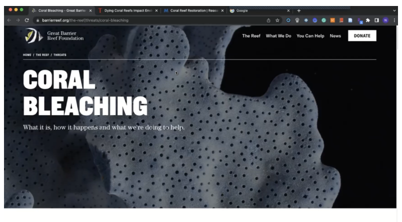
Jewitt (2006)'s Multimodal Transcript Sample of Two students Working with a CD-ROM (p. 39). (Contents edited by the researcher)

Time	**Plane of the classroom: students**			**Plane of the screen**		
	Video image	Action/gesture	Speech	Image	Action/gesture	Speech
0.36	Students image Students image	B&D Sitting back in chairs D: hand covering-holding mouse B: point screen D: clicks on bar. Brings up menu	T: in a minute you click onto the section you liked the most B: OK. Let's go. Let's go to…	Screen captured Screen captured		Voices reads diary Soundtrack… Dialogue 'guys like us…'

The contents of the column are determined by the researcher, so I utilized screenshots of the screen, modes that the participants read at that time or how they integrated two or more modes at the same time, and verbal protocols. The goal was to create proper blocks of time that typically include one or two screenshots of the websites. 10 to 30 seconds was a proper block of time that includes one or two significant screen reading scenes and relative strategies. However, scenes may last longer by how participants read texts and they can be captured into a block as meaningful strategies are discovered. Thus, I divided the screen recording video into each minute to transcribe the data like the example of matrix below (see Table 14).

Table 14

The Example of Data Transcription Including Verbal Reports, Reader-Computer Interaction, and Retrospective Verbal Reports.

Time (min)	Screen Captured (Reader-Computer Interaction)	Modes Read	Verbal Protocol Transcript	OMR Strategies	Retrospective Interview Transcript	Researcher Note (knowledge unit gained)
00:00		words (logo) visual (logo illustration) words (title)	Okay. Alright. Great barrier reef foundation. Cute logo. Coral bleaching, what it is, how it happens, and what we're doing to help.	Combining visuals and words to understand main topic	I thought it was a cute logo. I didn't know where great barrier was, but I learned it from this logo.	The Great Barrier Reef (most complex natural ecosystem) in danger
00:30-1:00		Words (title) Video (left)	(Scrolls down) What is coral bleaching…okay, good. (Plays the first video) Videos.	Sets the video speed 1.5 to view it faster	It was a video of what coral bleaching is and how it happens. I learned that it is caused by the ocean temperature rise.	Caused by ocean temperature rise
1:00-1:45		Video (left) Video (rewind) to words "expel the single-cell plants	(Stops the video at 1:50 and rewinds to 1:45) Umm.	Revisiting important parts of the video to understand it better	I set video to normal speed to view it again. I do that a lot when I watch YouTube.	coral tissues become transparent (skeleton)

4.4.2. Online Multimodal Reading Strategy Matrix Analysis

Prediction of Codes

I analyzed the transcript through Excel spreadsheet. I and another encoder analyzed the data qualitatively, focusing on the instances where there is evidence of the reader using OMR strategies (Cho et al., 2020; Woodward & Cho, 2020). Based on grounded theory (Strauss & Corbin, 1990), the two coders used a combination of a priori and emergent codes. Namely, OMR strategy categories can be induced from the transcribed data matrix or previous categories (Pressley & Afflerbach, 1995). The body of literature that examined online multimodal text reading comprehension and the relative strategies suggests that strategies predicted to be found are: (1) multimodal meaning-making, (2) multimodal searching, (3) multimodal evaluation, (4) making modal choices, (5) multimodal navigation, and (6) multimodal prior knowledge use (see Chapter 2). I also anticipated that the readers might use online hypertext reading strategies that are generally focused on written words comprehension, such as: (1) realizing and constructing potential texts to read, (2) identifying and learning important information, (3) monitoring, and (4) evaluating, according to the Constructively Responsive Reading Model by Afflerbach and Cho (2009).

However, I did not confine the type of strategies to this list. I also analyzed the matrix aiming for the discovery of novel strategies, strategic combinations, and sequences of strategies that have not been previously cataloged (Cho et al., 2020). Reading strategies can be applied to investigate novel or hybrid strategies that new reading situations create (Afflerbach & Cho, 2009), which is the major goal of this study. While traditional printed text reading strategies still being influential, I emphasized multimodal reading strategies to discover various online multimodal, multiple texts reading strategies that competent readers use. OMR strategies found from the analysis were categorized into similar strategies, leading to a taxonomy of online multimodal reading strategies.

Qualitative Coding

The goal of coding is not to count things depending on the preestablished set of strategies. It is to segment the data and rearrange them into categories to organize them into broader themes, which, in this study, are OMR strategies (Maxwell, 2012). I identified data segments to infer OMR strategy from and codify them to see if there are any emerging categories. Codes are based on the researcher's prior ideas of what is important and theoretical perspectives of conceptualizing OMR constructively responsive reading strategies (Pressley & Afflerbach, 1995). More importantly, inductive attempts to capture novel insights called "open coding" was applied to capture new insights for developing my coding categories (Corbin & Strauss, 2007, pp. 195-204; Maxwell, 2012). This open coding was more suited to solve the research questions to find OMR strategies and taxonomize them because it is an emerging area that demands more initial discoveries.

I added field notes and code strategies while watching the reader-computer interaction video with the verbal protocol again. Using spreadsheet, OMR strategies were analyzed into categories based on the grounded theory approach (Glaser & Strauss, 1967; 2006) I have modified. Encoders inductively coded meaningful segments to capture strategies each reader used while reading online multimodal texts, especially focusing on multimodal integration (e.g., reading a photograph and written paragraphs, viewing colors and fonts within written words). I anticipated that various coding rules will be developed and revised during this coding process. It can be induced from verbal propositions or paragraphs, cursor moves or clicks, modes the reader looks at, and so on. Encoded data for each subject were analyzed using the constant comparative method, which refers to "comparing one segment of data with another to determine similarities and differences" (Merriam & Tisdell, 2015, p. 32). The data was grouped to be named by their similar characteristics. It resulted in taxonomized OMR strategies that show patterns of online readers' comprehension of multimodal texts on the Internet. I finalized a taxonomy by referencing OMR strategies I found from the literature and the CRR model.

Interrater Reliability of Codes

Encoding is often evaluated by reliability tests between encoders independent of each other (Ericsson & Simon, 1993). To ensure consistency of the codes for all participants, I collaborated with an expert reading faculty (co-encoder) to enhance the reliability of coding and inference about strategy use. Firstly, we discussed the rubrics of OMR strategy coding to ensure that we understand the coding rules similarly. We agreed on the OMR strategies and relative inferences based on the model of Constructively Responsive Reading (Afflerbach & Cho, 2009). For example, researchers from Kohnen et al. (2022) used their codebook developed from priori and emergent codes to apply to the reader practices and confirmed interrater agreement to search for code patterns from verbal report data and screen recordings.

Next, encoders practiced on a sample subset of transcripts from a participant using the multimodal matrix that I transcribed. We will talk through any disagreements until we felt confident enough to encode data identically. From Cho (2014)'s online reading strategies study, two encoders collaborated in the processes of data coding and checking intercoder reliability. They discussed task demands and procedures, affordances and constraints, transcription, data segmentation, coding before they gauged interrater reliability. We also identified and discussed nonmatching codes and resolve them to reach close to a maximum agreement. The process of identifying, interpreting, and categorizing strategies occurs in a recursive and complicated way. The encoders revisited the process of data segmentation and repeat the data analysis process with an improved matching understanding when needed. Finally, I measured interrater reliability on coding with complete OMR Strategy Matrices.

Chi (1997) described caveats regarding interrater reliability. The first one is how to define categories between encoders carefully. She suggested coding with only a preliminary discussion of what is being sought (for this study, six OMR categories were driven from the literature review and online hypertext reading strategies from the CRR model). For my analysis, once preliminary coding is done, the two coders developed the more specified OMR strategies so that the second coding will be done based on them through discussions. If there are discrepancies between the encoders, we leave that as is for the first round to keep away from biases and revisit them in the second round to find a new coding system for that part. In this study, OMR strategies must be inferred from verbal and non-verbal data in a multimodal matrix. Explicit strategies (e.g., revisiting the same mode) were easily categorized. At the same time, some strategies demanded more profound inference (e.g., viewing different modes to understand specific concepts) with possible low interrater reliability (Afflerbach & Johnston, 1984). I tried to increase interrater reliability by training another encoder. Also, all types of data are reflected in the multimodal transcription matrix so that both encoders can consider them all to contextualize the implications of OMR strategy use (Afflerbach & Johnston, 1984).

Validity of Coding

“A central task in using verbally reported information is to make the encoding process as objective as possible” (Ericsson & Simon, 1993). Validity refers to “the correctness or credibility of a description, conclusion, explanation, interpretation, or other sorts of account” (Maxwell, 2012, p. 122). It is captured by the question, “how precisely do verbal reports capture readers’ thought processes?” (Cho, 2020). One of the big concerns of self-reports is whether they are believable. The method suggested by Pressley and Afflerbach (1995) is to relate the verbal protocol to the reader’s objective performance, such as understanding or other behavioral indicators (e.g., eye-tracking). In this study, I used pre- and post-OMR written reports on knowledge learned and screen recording video by each reader to increase validity.

Additionally, I ruled out validity threats according to Maxwell (2012)’s validity checklist, in which I find three ways to secure validity. Firstly, the rich data collected and analyzed in this study will reduce the validity threat through data triangulation. Detailed and varied types of data in this study (e.g., interviews, screen-recording video, verbal protocols, written reports) and their transcripts with researcher’s notes put additionally secured the validity of the OMR strategy use that I observed. Secondly, respondent validation, which is often referred to as member check, was used in the form of retrospective verbal report data. Maxwell (2012) defines it as systematically soliciting feedback about the subjects' data and conclusions (in this study, OMR strategies). It helps the researcher rule out the misinterpretation of what readers think aloud and do, which helps identify the researcher’s biases and misunderstandings. Interview responses are more valid than member checking. This method of retrospective reporting in a semi-structured interview benefited for enhancing validity. Lastly, triangulation helps to increase validity.

However, using triangulation does not guarantee validity. All the data used for triangulation should be clear of validity threats. Also, encoders were vigilant of the possible bias that might be caused and tend to the evidence drawn from the data to support OMR strategies during the coding process instead of just resorting to triangulation itself (Maxwell, 2012). Since nonverbal aspects of verbal reports can be lost during transcription, considering validity in these ways also helped the researcher assess whether there is a loss of nonverbal or multimodal information that might affect the validity of the codes.

I conducted a test for interrater reliability. 28 verbal protocol excerpts were randomly chosen from the entire pool of reported OMR strategies. These strategies were initially coded by the researcher, according to the definitions and descriptions of each strategy provided in this dissertation. For example, in the strategy category of Multimodal Evaluation, evaluating text credibility by reading modes, the following guidance was provided for the coding: determining the accuracy or trustworthiness of the mode to enhance their comprehension to reach to the reading goal. A second coder, familiar with the verbal reporting methodology and reading strategy research, then analyzed the 28 verbal protocol excerpts and coded each, again using the definitions and descriptions of strategies used in this dissertation. The initial codings of Reviewer 1 and Reviewer 2 resulted in an agreement in 26 of 28 excerpts, for a rate of 93%. The disagreements in coding of the 2 remaining excerpts were resolved in discussion.

4.4.3. Prior Knowledge and Written Comprehension Report Analysis

While it is not the focus of this study, I am interested in examining how readers' varying prior knowledge influences their OMR strategies use and whether the strategy helped them learn new topic knowledge from OMR. I compared readers' before and after and written reports on coral bleaching to find if there was any knowledge increase or modification. I used the same measure of idea unit I described in the data collection part for this analysis (Chi, 1997). Below is an example of what a subject already knew and what is newly learned from OMR. Suppose a new idea unit was not reported from the prior knowledge report and appears on the after-reading report (e.g., idea units put on the 'knowledge unit gained' on Table 15). I view them as knowledge increase which means that the OMR somehow helped the reader understand and learn ideas about coral bleaching. Of course, there could have been delayed activation of prior knowledge from the long-term memory that was not reflected in the prior knowledge report. It could have been re-activated during OMR to resemble new units. To prevent this bias and draw a valid inference, I triangulated indicators of learning from the transcribed data sources (e.g., verbal reports, screen recording, and retrospective verbal reports) that contributed to this knowledge accumulation. I will examine this topic further for my future research.

Table 15

Unit Analysis of Knowledge Gained from OMR (focused on the last row)

Study Phase	(1) what coral bleaching is	(2) why it is dangerous	(3) how to prevent/solve it
Before reading	-underwater ecosystem -due to global warming	-dangerous -fish survival (resident, fish food) -takes place in Puerto Rico	N/A
After reading	-corals under stress -expel algae -coral tissues become transparent -caused by rising ocean temperature (climate change)	-corals become fragile -corals hypersensitive to climate change -The Great Barrier Reef (most complex natural ecosystem) in danger	-reduce greenhouse gas emissions -make coral reefs resilient -help them adapt
Knowledge unit gained	Stress reaction of corals -expel algae -coral tissues become transparent (skeleton) Caused by ocean temperature rise	-corals become fragile -corals hypersensitive to climate change -The Great Barrier Reef (most complex natural ecosystem) in danger	-reduce greenhouse gas emissions -make coral reefs resilient -help them adapt

The connection between the modes that the participant read and constructed meaning from is contextualized and inferred through this procedure (see Table 16). First, a new idea unit, if there is any, was collected by comparing the pre- and post-reading written reports (e.g., Stress reaction of corals: expel algae → coral tissues become transparent). Next, the researcher matched the moment when and where this meaning was constructed by data triangulation. Think aloud protocols of the reader describing this idea (e.g., "Under stress they expel micro… Okay. So, corals are stressed and expel algae..."), screen recording video scenes where the reader views specific modes that contain this information (e.g., coral expelling algae, words describing that it is a stress reaction), and part of the retrospective reports that describes the pinpointed part (e.g., "I watched the video first and sort of clarified it with this text"). Lastly, the integration of the dataset was used to infer that the subject might have constructed new knowledge using certain OMR strategies used at that moment (e.g., revisiting important parts of the video to understand it better, goes back to the paragraph and applies what she learned from the video).

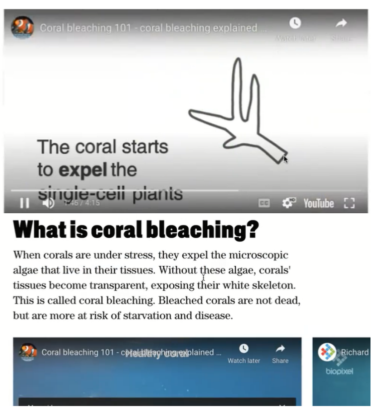
Table 16

Example of Data Triangulation for New Knowledge Units

"Under stress they expel micro… Okay. So, corals are *stressed* and expel *algae*...."

Think aloud protocols

↓



Screen-recordings of video and words read

→

Knowledge units:

Stress reaction of corals:

expel algae → coral tissues

Data triangulation

←

"I set video to normal speed to *view it again*. I do that a lot when I watch YouTube. I *watched the video* first and sort of *clarified it with this text*."

Retrospective interviews

↑

Revisiting important parts of the *video* to understand it better
Goes back to the *paragraph* and applies what she learned from the video

Strategic OMR behaviors

The inference can be supported by the theoretical framework which views OMR as cognitive meaning-making, mental model building, and strategic meaning-making (see Chapter 3). I posit that newly constructed knowledge from OMR matches or fixes the reader's prior knowledge, reconstructing the mental representation or the meaning just made (Rouet, 2006). Also, cognitive multimedia learning theory saying, "people learn better from words and pictures than from words alone" (Mayer, 2017, p. 404) accounts for the increase of knowledge concerning multimodal reading. Readers cognitively interact with various modes (e.g., written words, images, videos, diagrams, audios, layouts) to comprehend and synthesize texts. OMR strategies can be involved during this cognitive processing because online reading demands more sophisticated strategies due to its complexity (Cho & Afflerbach, 2015; Coiro, 2003; Coiro & Dobler, 2007).

I can only make inferences about this knowledge gain because verbal protocols or self-reports generally do not tell the "full story" (i.e., they are not a complete account of the cognitive strategies used by a reader). However, the triangulated dataset can inform the snippets of how the reader's thought processes work. Still, finding and taxonomizing OMR strategies are my two research questions for this study. I will apply the possible findings from this knowledge analysis to future OMR strategy research. Further analysis focusing on this matter will be studied more in-depth in my future research. I believe this additional description of OMR strategies will be a valuable resource for reading research that examines why and how readers use certain OMR strategies to understand multimodal information from the Internet.

4.4.4. Summary

This study examined and taxonomized ten competent readers' online multimodal reading (OMR) strategies through qualitative analysis, including verbal protocols, reader-computer interactions, interviews, and pre- and post-knowledge reports. Readers perform the online multimodal reading task to learn about the topic while thinking aloud their thoughts during reading on the Internet. Each reader's data was transcribed into a matrix and coded to discover OMR strategies, resulting in a taxonomy of OMR strategies. Additionally, knowledge units that each reader gained from the reading task were analyzed and triangulated to determine how OMR strategies influenced the reader's learning.

Chapter 5: Results

In this chapter, I describe the online multimodal reading strategies present in the dataset related to the research questions: (1) What type of online multimodal reading (OMR) strategies do competent readers use to comprehend multiple multimodal texts on the Internet? (2) What is a preliminary taxonomy of readers' online multimodal text reading strategies? Online multimodal reading (OMR) strategies were gleaned from each reader's verbal protocols and interviews and combined with pre-and post-knowledge reports. I describe an overview of participants' performances in the Internet reading task of the current study. I then report the results from the analysis of ten participants' OMR strategies use. Lastly, I provide detailed accounts of OMR strategies identified in the data analysis using representative examples.

OMR strategies were inferred from readers' verbal protocols, interviews, combined with screen recording videos, supported by written knowledge reports before and after reading with written notes. These sources also allowed for triangulating the study data. Some OMR strategies overlap with the preliminary OMR taxonomy developed in relation to the literature review (see Chapter 2) which framed the collected data. However, my analysis found novel strategies that are included in the revised taxonomy. All strategies I coded for the taxonomy are focused on modes reading during OMR.

My analysis indicated eight categories of OMR strategies: (1) multimodal metacognition, (2) multimodal evaluation, (3) mode selection, (4) multimodal searching, (5) understanding meanings of modes, (6) prior knowledge use to understand multimodal texts, (7) intertextual linking through multimodal texts, and (8) multimodal navigation. In the following sections, I describe each category and their subordinate strategies and the scenes in which they were used.

5.1 Multimodal Metacognition Strategies

The first group of identified strategies involves metacognition. Metacognition refers to higher order thinking which involves active control over the cognitive processes engaged in learning. Planning how to approach given learning tasks, evaluating progress toward the task completion, or monitoring comprehension are counted as metacognitive (Livingston, 2003). In essence, metacognition is the process of understanding of one's own thought processes. The metacognition strategies used by participants are presented below.

Table 17

Multimodal Metacognition Strategies

OMR Strategy Name	Definition of the Strategy
Creating a problem space to construct meaning	Deliberately creating a problem space in which reader works toward OMR goal(s)
Checking prior knowledge	Ongoing analysis of what is known related to OMR texts, how the prior knowledge augments, duplicates or contradicts information encountered in text
Finding knowledge gap	Determining what gaps in knowledge exist as prelude to reading to locate that knowledge
Examining usefulness of a component of OMR for reading purpose	Determining if information and mode of information is helpful or appropriate for learning certain knowledge to accomplish reading tasks
Mode change to enhance understanding	Using different modes of OMR to further knowledge construction as prompted by metacognitive knowledge that more information may be available in different modes, and different mode may clarify information in current mode
Checking text configuration on the imaginary map in mind	Drawing an imaginary map in mind that describes reader's subjective placement of the information in a part of a text, a whole text, or the group of texts while they read multimodal texts.

Self-monitoring	Demonstration of top-down strategies using executive functions to control rate of reading, giving of attention and effort

Multimodal metacognition strategies were used by participants to support their reading comprehension. Readers used metacognition to organize and control their strategies in relation to their reading tasks. This group of strategies demonstrates that metacognition figures largely in both traditional reading and online multimodal reading by illustrating how participants' metacognition influences reading comprehension. The prominent strategies included: (1) creating a problem space to construct meaning, (2) checking reader's prior knowledge level, (3) finding knowledge gap, (4) examining usefulness of a component of OMR for reading purpose, (5) mode change to enhance understanding, (6) checking text configuration on the imaginary map in mind, and (7) self-monitoring to achieve reading goals. In this section, I provide a definition of the strategy, followed by a representative verbal protocol or interview examples that highlight the strategy use, followed by descriptions and analysis of the strategy.

5.1.1. Creating a problem space to construct meaning

Definition

Readers generated questions as they read. Through this question making, they created a problem space of comprehension which means the space in their learning processes that works as a goal of reading, or a place to fill in with the knowledge gained from the texts. The problem spaces were also created by thinking about the necessary knowledge parts. For example, Felix thought aloud, "So what this doesn't tell me is why we should care about coral reef and not on why they exist" to make a problem space and started to find information to construct meaning.

Verbal report or interview example

Blair thought aloud, "I wonder how they know when the spawning time will happen. I wonder how many times a year that happens" as she tries to understand coral's spawning. She raised questions as she was setting this mini goal for the ongoing reading. Questions create a requirement of answers. Once the questions are set, they play a role in forming workspaces in mind – consisting smaller subgoals (e.g., understanding how corals spawn) – different than the bigger goal (e.g., learning coral bleaching). Creating this milieu of comprehension was one of the important metacognition strategies for these participants to get to the goal because readers find the space that they need to fill in from the text, raise questions to confirm this necessity by comparing it with what they know, and read texts to fill the space. Felix frequently asked questions to create problem spaces. Following, he raises a question when he thought he needed to learn more about why we should care about coral bleaching.

> So why do we care? [Skims the paragraph quickly, Highlights with cursor: "complex natural…around the world"…"but this alone is not enough…climate change"] So what this doesn't tell me is why we should care about coral reef and not on why they exist.

As he learned more about coral bleaching, he became more curious about the topic and raised the question about why people should care about coral bleaching. After setting this goal, he used this question as the marker of his reading task, and this helped him focus on certain modes to be able to answer the question.

Analysis and further description

Participants deliberately created a problem space in which they work toward the reading goal. These problem spaces functioned in relation to mini goals which were used to build elaborated comprehension of coral bleaching phenomenon. Readers used this strategy when they felt that they did not know certain content or anticipated that they needed to fill in the gaps for understanding, based on their metacognitive thinking of what they know and do not know. By raising questions, readers created this problem space that was addressed through reading relevant modes from the texts, and they immediately tried to learn from the texts to fill in this problem space. When these questions and related work were completed, they moved on to accomplish the general goal of understanding coral bleaching.

5.1.2. Checking prior knowledge

Definition

Participants frequently checked their prior knowledge during OMR. This metacognitive strategy involved ongoing analysis of what (and if) they knew about certain information, whether this prior knowledge was determined to be sufficient, what (and how) they should learn further, and what they should learn more from the ongoing multimodal reading.

Verbal report or interview example

Blair used this strategy three times as she thought aloud:

I don't know what solar irradiance is so I'm gonna look that up [checks google search + diagram → skipped]. I don’t understand the diagram. [Search: solar irradiance] [Linear reading top description] ‘Solar irradiance is a powerful is a power per unit area, surface power density, received from the sun in the form of electromagnet.’ I still don’t know what that means. So, I'm gonna look at a different source. [reads description below] ‘Is the output of light energy from the entire disc of the sun measured at the earth.’ Okay, so that's more understandable for me. So now I can put that in context here.

The above excerpt illustrates the potential value of switching modes, or sources, within an act of OMR. From the retrospective interview, Blair reported, “I didn't know what solar irradiance was, so I just looked at that definition. Found a definition, I didn't understand it because it felt like it was a specialized terminology. So, I moved to a more casual term for me to understand cause of my level of prior knowledge. I did not pay attention to that graphic (graph). It was too complex that I didn't have the time for it. I got what I needed. So, I think I moved on to the last one.” She was fluent in changing sources depending on her prior knowledge levels. Her metacognitive strategy of checking prior knowledge indicated that more information in different modes was needed for her to fully understand the concept of solar irradiance. She switched modes/sources from the diagram to written words and to the ‘People also ask’ function from the Google search result to construct an accurate understanding.

Analysis and further description

Participants checked prior knowledge regularly during OMR and when they felt they did not understand something. For example, Felix returned to the prior text parts, saying, “I still don’t know… I’ll just go back. I still don’t understand what the reef is. [goes back to 3:23 of the video].” George gave up using the mode reporting, “Difficult to understand (this video) [stops the video],” and moved on. Chloe was satisfied with her knowledge level, and she stopped learning, saying, “I felt like I had already learned enough that I was able to talk about it. And then I didn't need more information necessarily. So, I felt free enough to watch a video of Turtles.”

While the prior knowledge aspect of these verbal reports varied by participants, a commonality was that they used checking prior knowledge strategy throughout their reading to determine whether they should learn about certain knowledge portions to accomplish OMR goals. This toggling back and forth between what is known and what should be learned – knowing what they know – figured largely in metacognitive thinking used to guide readers toward task achievement.

5.1.3. Finding knowledge gap

Definition

Finding knowledge gaps is defined as determining what gaps in the reader's knowledge exist as a prelude to reading to locate that knowledge. Readers continually attempted to determine their knowledge gaps while comprehending OMR content. This strategy is similar to the prior strategy of checking prior knowledge. However, it is a more specific metacognition strategy to find the exact gap, informing the flow of learning. It can be prompted by checking prior knowledge. However, readers use this strategy not just to determine their knowledge but to find specific knowledge segments and fill it in by reading texts.

Verbal report or interview example

Hannah thought aloud, "Most of this for me seems like it'd be more useful if I knew the geography of the Great Barrier Reef." She realized her knowledge gap about the geography of this region among all the different knowledge units. Later she searched for the maps of the Great Barrier Reef and browsed them to fill this knowledge gap with visuals. Similarly, Blair kept questioning what she knew or not in order to discover her knowledge gaps as she quickly scanned the text. She regularly searched for the gaps in her knowledge. For example, she reported, "What is this? What is that? I know, I know. What causes, how can they recover? [Opens the dropdown menu and reads]" at a rapid pace. Scanning revealed new information, and when she found a specific knowledge gap, such as what causes coral bleaching and how they recover, she immediately opened one of the drop-down menus to continue learning.

Analysis and further description

Participants used their metacognition to find what they knew or not from the text and quickly tried to fill this gap to proceed with learning. This strategy was like painters covering little holes in the wall to make the wall look flat and neat. When the knowledge they confronted was new and determined to be relevant to reach a larger goal, they decided to learn more by searching and reading the details of that part to get knowledge and move on to the reading.

5.1.4. Examining usefulness of a component of OMR for reading purpose

Definition

Participants strategically examined the usefulness of multimodal texts to achieve their reading goals. This strategy is used when the reader considers whether certain modes of information are helpful or appropriate for getting information and learning. The strategy is similar to the multimodal evaluation strategy in the next section (see 5.2), but this one is operated under metacognition because readers focused on their task processes as they examined text components. It is also related to the finding knowledge gap in that the usefulness is determined, in part, by the connection of the two.

Verbal report example, complemented by interview data

Blair used two texts on two different tabs and judged the usefulness of the second text based on the knowledge she constructed from the first tab. She scanned the second text to determine if it offered any new information by verbalizing, “OK, I already know that.” On the other hand, Felix used this strategy to skip the video that seemed no longer useful. He chose a video and skipped it several times by clicking on the play bar to find the information he wanted, saying, “I'm gonna see if... there's anything else that I wanna see, really.” George also used this strategy to decide whether the website was useful for topic learning. He said, “So we're definitely not talking about the Nature Conservancy anymore or the coral reef bleaching anymore [Goes back to the prior page].” The information was not helping him solidify or enrich his knowledge. This is where his metacognition came in, and he determined that this website is no longer helpful.

Analysis and further description

Readers examined the usefulness of a part of or the whole multimodal text if it assists with their reading task, learning coral bleaching. The above data indicated that readers not only examine linguistic modes but also consider if a video, visual, or the whole text is helpful. They sometimes use mode affordances (e.g., skipping videos, fast-forwarding videos, using captions, quick scanning graphs, or diagrams) to examine text usefulness. This strategy is not directly metacognitive (e.g., determining what the reader knows or not). However, it is derived from metacognition as it emanates from readers' thinking about what they know or do not know first, and then they move on to examining the mode’s usefulness based on that decision. Making fast decisions about what modes to read or not is important in OMR because there are many modes in multimodal texts, and the reader should be able to focus on some of them to accomplish the task.

5.1.5. Mode change to enhance understanding

Definition

Mode change refers to changing modes (e.g., images, diagrams, videos, written words) of information that the reader uses among different modes in OMR to improve comprehension, prompted by metacognitive knowledge that (1) more information may be available in different modes, and (2) different mode may clarify information in current mode.

Verbal report example, complemented by interview data

Participants changed modes in the text they were reading to enhance understanding. For example, Blair read a diagram that she did not understand. She verbalized, “I still don't know what that means. So, I'm gonna look at a different source.” She immediately switched to paragraph reading to understand the concept better. This decision is based on her metacognitive thinking of knowing what she understands or not, whether this part of mode reading is working to achieve the reading goal.

Analysis and further description

Switching modes based on the reader's metacognition of task accomplishment helped readers construct a more elaborated understanding. This decision is based on their metacognitive thinking of knowing what the reader understands. The changing of modes was prompted by either a perceived need for more information or wanting to augment and add to a current level of knowledge. Namely, the reader’s need to change modes as they comprehend was based on their metacognitive decision that it would help their comprehension or task achievement.

5.1.6. Checking text configuration on the imaginary map in mind

Definition

Participants checked multimodal text configuration to construct a knowledge map in mind. Configuration refers to the layout or the location of modes used in the text. I refer to the imaginary map as the knowledge map in mind that describes the reader's subjective placement of the information in a part of a text, a whole text, or a group of texts while they read multimodal texts.

Verbal report example, complemented by interview data

Jamie invoked a knowledge map as she switched tabs to compare the information. After reading two separate texts, she recalled where and in what part of the text the video about coral bleaching colors was located, and she came back to the exact part of the video she wanted to view again and played it to clarify bleaching color stages.

> [Skips first part of paragraphs → goes directly to the paragraph with diagram and reads two paragraphs] (Cursor on the coral diagram) "Healthy, fl… belached, dead!" Oh! Brown is dead. Actually, it was brownie… [Goes back to Text 1-replays the first video from the front part (what coral is)] "Hmm" Video: Now, the plants are actually a sort of brownie green color. And so most healthy corals most of the time are a brownie green color.

As traditional written words readers may remember what information is located in certain parts of a paragraph or a book, online multimodal readers create maps in mind to help them find information. This map also can be created at the beginning of the OMR. Hannah opened all three tabs that the researcher provided in the order. She quickly scanned what each multimodal text is about by looking at what kind of modes there were, and what she might expect from reading them. Here is her verbal protocol.

> [Opens Tab 1] The first one seems to be similar to the polar bear example. It's a Conservancy. [Opens Tab2] I'm gonna go to the next, also a foundation. Great Barrier Reef is in Australia. [Opens Tab 3] And Time, ugh, the most beautiful death. [Scrolls down a little bit] Sad. So Time seems like an investigative piece or one that is trying to bring attention.

Hannah accounted from her interview,

> I think even just from looking at the tabs, I saw that one was the Times article, so I went and looked at the other ones briefly, and then started back at the first one. Perhaps in hindsight, I would've actually started at the middle one because it was more specific to coral bleaching. And the first one I started at, I don't even think it really mentioned coral bleaching specifically. Yeah, the first one (tab). I went to the, went to the conservation one, and took a look at that one and started and reread it.

She reported from the interview that she had this knowledge map where each text provides different types of information: informational, investigative, or less specific.

Analysis and further description

Remembering and creating a map in mind about the multimodal text's configuration was a valuable metacognition strategy for the readers to remember and locate information. Since the online space and the opened tabs can create a complex workspace, strategically retrieving various modes of information is necessary. Also, readers indicated that they remembered parts of the video after they viewed, stopped, and returned to certain parts they wanted to see again.

Therefore, this strategy was available for drawing a map based on OMR's components, including written words, whole text, charts, pictures, and videos.

5.1.7. Self-monitoring

Definition

Participants used a self-monitoring strategy based on their executive functions as they proceeded with OMR. Executive functions invoke metacognition as all participants manage their behaviors to achieve goals and control their learning. Executive functions refer to the ability to "make possible mentally playing with ideas; taking the time to think before acting; meeting novel, unanticipated challenges; resisting temptations; and staying focused" (Diamond, 2012, p. 1). It is an effortful mental process that people use when concentrating and paying attention (Diamond, 2012).

Verbal report example, complemented by interview data

For example, Dylan thought aloud, "I just think it's bit too long. I don't, I don't know how much time I have or how detailed I should go on things." This report shows his metacognitive thinking, gauging and remembering what he should know, as well as his time management to complete the task. Participants tried to control their focus and manage working memory, as well as the time left for the task and text complexity. Hannah decided not to watch the video: "I kind of got an understanding of what this is like from other videos." She has already got the concept, so she used this self-monitoring strategy to save time and focus on new knowledge. Also, most readers used quick scrolling toward the end of the text to check how long the text was. Jamie's screen recording showed "[Scrolls down to check the end → scrolls back to the video → plays it]. The purpose was to check what information was left and if there was more to read.

Analysis and further description

"Self-monitoring strategies work under the reader's executive function that controls the complex processes entailed in both text location and meaning-making" (Cho, 2014, p. 275). According to the traditional and online hypertext reading strategies, self-monitoring strategies are related to executive functioning. For example, Coiro and Dobler (2007) analyzed sixth-grade students' verbal report data and found that successful internet readers used self-regulated reading strategies to plan and monitor their reading. Cho (2014) also found that monitoring the reader's current understanding was critical metacognitive thinking contributing to reading progress.

Summary

Data showed participants' active control over the cognitive processes during learning from online multimodal texts based on their metacognitive thinking, as well as self-monitoring strategies. The above multimodal metacognition strategies are essential in the reader's checking on knowledge statuses, choosing resources within OMR, controlling reading, and giving attention and effort.

Creating problem space to construct a meaning strategy was useful in question-making that works as a place to fill in with the knowledge learned from OMR. Checking the reader's prior knowledge level strategy informed readers as to what remained to be learned from the ongoing reading. Finding knowledge gap strategy guided readers to search for new information and elaborate their understanding. Examining the usefulness of a component of OMR helped readers determine whether or not information in multimodal texts helped achieve their goals. Mode change to enhance understanding strategy helped readers advance their comprehension by finding a more suited mode of information. It is also a signature OMR strategy, as the presence of different modes affords such changes. Checking text configuration on the imaginary map in mind strategy helped readers build a representation that includes placement of the information to find necessary information. Finally, self-monitoring to achieve reading goal helped readers to control and monitor themselves to be focused and motivated to get knowledge from texts and approach their reading goals.

These multimodal metacognition strategies were shown from the traditional and hypertext reading strategies related to metacognition because the readers constantly examine what they know during reading texts while activating self-monitoring. However, these coded OMR strategies were focused on multimodal text reading and were not confined to written words. Those strategies showed that readers use their metacognition during multimodal reading on the Internet, and they keep checking knowledge, consider changing modes, or build knowledge maps depending on the multimodal configurations of the texts they read on the Internet to complete the reading task.

5.2 Multimodal Evaluation Strategies

Participants used various text evaluation OMR strategies. The strategies were categorized into four groups: (1) evaluating text credibility by reading modes, (2) evaluating goal relevancy of modes or multimodal texts, and (3) evaluating information by cross-checking modes. Evaluation usually refers to the act of examining and determining if certain information or texts are accurate, trustworthy, or reliable. Here, I also included the examination of the information relevancy to the ongoing task, which involves metacognitive thinking. Readers use this strategy to determine the contribution of modes and connect different modes to relate different aspects of a topic. I counted these aspects of the OMR strategy as evaluation in addition to fact-checking. Participants tried to evaluate modes or multimodal texts to understand as much as possible to answer the question: What is coral bleaching, why is it problematic, and how to prevent it.

Table 18

Multimodal Evaluation Strategies

OMR Strategy Name	Definition of the Strategy
Evaluating text credibility by reading modes	Determining the accuracy or trustworthiness of the mode to enhance their comprehension to reach the reading goal
Evaluating goal relevancy of modes or multimodal texts	Examining the mode's relevancy to the reading goal. This evaluation strategy is not about credibility but about examining the relevancy of the information to the goal or a task (going to information that is more relevant to the goal).
Evaluating information by cross-checking modes	Checking or comparing the information from two or more modes in relation to one another to determine coordination, elaboration, or contradiction in information. Evaluating the trustworthiness of two different modes or sources of information

5.2.1. Evaluating text credibility by reading modes

Definition

Evaluating text credibility by reading modes refers to determining the trustworthiness of the mode or the whole multimodal texts to enhance their comprehension to reach the reading goal. Verbal reports demonstrated participants' evaluation strategy use during OMR. I coded six strategies under this category: (1) checking dates to evaluate credibility, (2) checking source names to evaluate website credibility, (3) checking logos, words, fonts to evaluate credibility, (4) video evaluation strategies for trustworthiness, (5) checking the author's intention or purpose.

Verbal report example, complemented by interview data

Checking dates to evaluate credibility

Some participants checked dates when the text was published to evaluate credibility and determine whether the website's contents were trustworthy. For example, Amy thought aloud, “Okay, so nature conservative, conservancy. I don’t see date on this one either. No date (pdf). No date. [close the pdf].” When asked the reason, she answered,

> I really like to find dates. Dates because this one, it didn't have a date when the article was written, but I gathered that it was 2016. Cause it said something about 2014 and then it said we're on track in 2016 for something. So, I figured out that it's probably 2016. But yeah, so that was one thing I thought was interesting to see how up to date is some of this stuff. I was scrolling, looking for a date.

Emily also tried to find the date of the video to determine the relevance of the information to the topic. Her protocol shows, “I wonder what the date is on this video…I'm gonna open it. I want to know what the date is (hovers at the bottom to find it but fails) …(ellipsis)… I wonder what the date is on this, but I'm pretty sure it's still relevant. Of course. (End the video).” The recency of the source was important for the readers because those years were relatively recent but still at least five years behind. Up-to-date sources seemed to increase their trustworthiness for these readers.

Checking source name/title/descriptor to evaluate website credibility

Readers checked source names as they accessed the websites and checked their domains (e.g., org, gov, com). Blair checked the name of the website (National Ocean Service) before she started reading it to make sure it was a reputable source. She reported, “So it's from the National

Ocean Service. I'm not familiar with it but it does look like it is legit." She also looked at the various modes in the text to determine its trustworthiness, although she initiated it with the name of the organization. Dylan had prior knowledge about OMR, and he explained, "I go to the website looking at thenatural.org. Seems like the natural conservation thing. So, it seems like '.org' is somewhat credible but not sure." He took a seminar where he learned strategies for fact-checking websites. His strategic reading indicated that OMR can be instructed, and from doing so, the reader can establish a certain level of knowledge that he can use to become a successful text evaluator during OMR. Felix reported, "[Clicks on the "Local threats to coral reefs" website] Coral dot org. Seems reliable. [Search: "coral.org Wikipedia"] (The first result shows "Coral reef alliance"—clicks on the Wikipedia link and opens) Looks reliable to me. Cool," as he evaluated the webpage he searched on Google. From the interview about this scene, he reported:

> So, I was goal-oriented in reading. I normally don't love using these except when I know it's for instance, a statistical issue than it's more factual. But here I felt that there's some interpretation to what we can do as humans. So, I would've been careful too, for instance, look for the general strategies that we can do to preserve the coral because that part probably would be political or something. [Unclear] So that's why I trusted this website, but I did fact-check or checked whether it was really an organization or just any kind of .org.

George also used this *checking source name to evaluate website credibility* strategy while he was reading one of the researcher-provided texts. He determined that this site was trustworthy from reading the contents. "This Nature Conservancy looks like another non-profit or an organization dedicated to preservation probably of coral reefs. Given that they're... well maybe not." He was more content-focused, so he clicked on the 'What they do' menu to see what this organization is doing and found photos related to animal protection, enough for him to say it is credible. He reported,

> Because it detailed a lot about what this organization was actually doing. It struck me as a bit more hopeful, more proactive. I was interested to know. They were connected to a larger organization as well, and they were doing so much, and I think they did a good job explaining, the connection between the health of the coral reef and the Caribbean to the people who depend on it.

George trusted this website based on its detailed information, authority, and matching information based on what he had read so far from the given coral bleaching texts. In summary, these readers used source names and domain addresses to determine how credible the website is, but also combined different information about it to make sure they trust it.

Checking logos, words, fonts to evaluate credibility

Readers used logos as initial indicators of the text's credibility. For example, Blair examined the logo from the researcher-given text and thought it was reputable. When I asked why she said, "So I was just gonna say it seems very elementary, but just the color of it, the simplicity of a logo. If it's very simple then I think that that helps (ellipsis). This source too is just TIME. So, I feel like everyone kind of accepts TIME." Her answer shows how a website evaluation strategy can be combined by checking the source name, its reputation, and its logo. She reported:

> [goes up to check source] Great Barrier Reef Foundation. They have a fish (logo) I guess

> which makes them reputable. I'm just gonna look at the ‘about us’ just cause I'm curious. [reads] Solving those complex trauma problems. I don’t know, that just seems kind of counterintuitive that they would say that it's not a problem, but they have a whole organization dedicated to it. Um. Okay.

She saw their logo and did the multimodal reading of the image of the logo and the written name of the foundation. They matched in similarity of the meanings, and she supported their credibility by looking at the introduction of the foundation. From the interview, she said:

> So, I go back up, I look at the emblem, the emblem, I'm like, okay, it's looks kind of the cheap unintended, but it's just not very intricate. You know what I mean? But the fact that this says great barrier foundation is kind of makes me feel more inclined to trust it. You know what I mean? So it's the name this, but if it was something like a really shitty name, I would be like, okay, this is probably not a reputable source. Just cuz that emblem just isn't very trustworthy. And then I clicked on just 'about us' just to see one of the most complex problems. At that point I was like, okay, I guess I'll just trust it.

She vetted the legitimacy of the text through the emblem or the logo by reading words under the logo. She made an informed decision on whether to trust or not while she was still unsure. Participants used such information to decide whether to trust (or continue to build trust) particular sources.

Besides, participants saw fonts of how written words were presented as one of the credibility-checking strategies. It is a visual-focused evaluation of the text's credibility and quality. Chloe, who self-declares a visual learner, reported:

> I definitely think fonts, these look very professional. You know more professional than arial or something. Or I don't know what's like the go-to. One of those weird fonts. So, it definitely looks official with this font and everything.

For a few participants, fonts and design aspects were one factor used to determine the trustworthiness of the information.

Video evaluation strategies for trustworthiness

Participants assessed video credibility with evaluation standards developed from prior OMR experiences. When asked about the criteria to determine the video's credibility, Chloe reported the following standards: professional looking, good sound quality, good image quality, many people should have watched it, and check who made it. Here are her accounts:

> If it looks more professional or more amateurish. So, for instance, if I look for a video on a psychological concept, cause I have to teach about it. If it looks very homemade and very just not very good quality or the sound quality isn't very good or I feel like this looks so amateur, that I don't know if I can trust the information in this video. So that's definitely, if it looks professional and I mean that's tricky because something can look professional and not be trustworthy. So that's a trap that I would fall into. But usually if something looks professional and the sound and image quality is good, that's the first indicator for me. And then of course I look at who made the video and how many people watched it is usually a big indicator.

She accounted that she learned these video evaluation strategies from her course teaching. She developed her standards to pick good quality, trustworthy videos, and she relies on the number of views. Hannah's video-judging strategy overlapped with Chloe's. She reported, "I think sometimes there can be videos that are just if you're on a gossip website or something, the video could just be pictures with words over it or whatever, and that's not that informational. You might as well get that in the article. And here it was, something more specific or more interesting or whatever. Sometimes it can be very clearly an ad or something, so I guess I'd check it." Jamie also decided that the video on the researcher-provided text seemed trustworthy because "the person sounds scientific (the doctor), and there are a lot of figures like this to show it's upside down." Not only does the credibility of the video matter, but also what modes the text has mattered for these readers as they evaluate texts. Dylan also reported a unique multimodal video evaluation strategy.

> I mean you see people like the water diving, it looks nice, it tells you, oh it's a wonderful place which you try to save (ellipsis) Similar in the second video, there's bunch of cool ads-ish feeling. Yeah, please donate to us. That's what I should get sense out of it. It is a bit upbeat music and also it does not provide any information. It doesn't sound like science teacher-ish giving out the information. It's more like this is what happening, please help us type of things.

He sought to determine if a video or video excerpt was an advertisement or not from contents, scenes, and music combined. Namely, these readers evaluated the contents that the modes deliver, as well as the modes themselves when they determine credibility.

Checking author's intention or purpose

Lastly, readers checked the author's intention or purpose from the websites. George read a paragraph and thought aloud,

> So, it looks like they are more interested in promoting or say advancing coral science and promoting sustainable ocean use. So, I don't know if they're actually the ones, if they're actual scientists or they're more of an advocacy organization. Probably both.

When he clicked on the 'Highlights of 2021' from the Nature Conservancy website, he described that he thinks, "They're writing this for their donors and they're using this to get grants. So, I didn't pay as much attention to it." Jamie watched the whole video silently and reported about the second researcher-provided website. She reported,

> Everything is okay until I saw it emphasized that it will be bad for tourism. So, once I heard that I kind of blocked myself because I don't know if they really want to protect the nature or protect their economic benefits. If it's the latter, I don't think they will do a great job because they just wanna let more people watch the colorful thing. But it's not really good for nature.

The reason she stopped trusting the video was that she thought that the video mentioned tourism. She added, "If there are a lot of people in the water, I don't think it's a good thing for the sea. But I'm not for, I just don't like their intention." Therefore, the video's quality and the contents it delivers mattered to the readers to evaluate videos.

Analysis and further description

Online multimodal reading involves various evaluation strategies for the readers to determine the credibility of text sources: dates of the text was written, source and domain names, logos and words on the text, fonts and design aspects, video's contents and quality, and author intentions. Evaluation of text credibility was one of the most common online reading strategies studied from online reading research. However, the strategies abovementioned were more focused on the multimodal nature of text reading as the readers examine credibility. Multimodal evaluation strategies included judging the credibility of the text the participants read. Readers checked logos (Goldman et al., 2012) and text designs (Klawitter & Hargittai, 2018) like the participants from this study. The readers also read various modes (e.g., images, words, and videos) to support their understanding and ensure credibility (Cho, 2014). Evaluative strategies involved written word reading as well as the visual and audiovisual examination of text credibility, including logos, fonts, and videos.

5.2.2. Evaluating task relevancy of modes or multimodal texts

Definition

Participants evaluated modes or multimodal text's task relevance during OMR. Evaluating goal relevancy is not about credibility but about examining the relevancy of the information to the task (reading modes that contain information that is relevant to the goal), in this case, constructing meaning that is sufficient to answer questions (i.e., Coral bleaching: what it is, why is it problematic, and how to stop it), and to reach goals and sub-goals. This evaluation of task relevancy involves the reader's metacognitive thinking of understanding and determining the reading task, how close (or far) they are from goal attainment, and constant monitoring of what multimodal text or modes are useful for them to accomplish reading tasks in a limited time. Skipping or not reading unnecessary modes is coded under this category because both decisions to read or not are derived by the reader's determination of the necessity of a mode. In addition, participants evaluated the task relevancy of the video before playing it. Forward inferencing of the video was useful as the readers anticipate the contents of the video prior to watching it to save time and avoid possible information redundancy. It was one of the most useful and important evaluation strategies for examining task relevance during OMR because the incidence of videos in this study (as well as on the Internet) is considerable. Participants evaluated videos by (1) reading the text that accompanied the video or (2) checking the video's thumbnail based on the expectation of getting certain information based on their knowledge level.

Verbal report example, complemented by interview data

To begin with, readers used the 'Reading the mode that is relevant to the goal' strategy. I could infer the usefulness of this strategy from readers' verbalizations, such as "it helps that one was great, to the point saves time, it was informative, it had what I need," and so on. Visual modes were one of the most frequently used modes as readers determine goal relevancy. Blair stated that she clearly likes infographics, saying, "They're very to the point. So, I thought that was an easier way for me to understand what coral bleaching is. And it also saves me a lot of time." She goes to the infographic with the expectation of information value. In OMR, it is a luxury for readers they have options to go to visuals or videos if they do not like the style of information delivered through written words.

Readers also evaluate the goal-relatedness of a text at first glance. They passed the decision quickly once they opened the texts that I gave them. Emily also took a glance at the text and decided to read this. "Coral bleaching Great Barrier Reef foundation. This one looks pretty specific to coral bleaching in particular, so let me take a look at that so I can make sure I learn enough about that topic." Evaluation of goal relevancy is an ongoing process before text reading or reading separate modes in a text. Therefore, it is common for a reader to think the text is relevant at the beginning but not soon enough after reading it.

When the readers think the mode or the text is not worth reading, they skip it and keep reading other parts. This skipping strategy applies to all three types of modes (visuals, words, videos). For example, Felix, a written word-focused reader, skipped the photo and went to the paragraph to find information. Since he is more used to focusing on written words as he studies, he seems to be used to skipping the visuals upon fast decisions. His skipping strategies are shown below:

> [Reads second paragraph under it] (Highlights/HL: "dripping off the rocks", "That's when you realize...animals") [Goes up and reads 1st para above it] (HL: "leaving a ...behind") marine graveyard. [Skips the third 360 photo and goes to the paragraph below] (HL: rainforests of the sea) Rainforests of the sea. (HL: "1% of world marine environment...home"). [high volume voice] Yeah. Why do we care? Okay. Why do we care. (HL: "but they provide home… algae") [Takes notes] home to ¼ of marine species. Fish, turtle.

From this verbal report, he needs written information about why we care about the coral bleaching issue. He skipped viewing photos and highlighted some phrases about why corals are important (e.g., rainforests, provide home). Finally, when he found sentences about it, his voice turned much louder as if he had found something he was looking for. To focus on goal-relevant information, readers tend to skip modes they deem unnecessary, at least for a while, to find what they need from multimodal texts.

Amy also evaluated information relevancy and skipped the 360-degree photo of underwater to go to the paragraph reading under it.

> [Skips the 360 photo and reads para under it] Last year beat out... warmest year on record (Reads: reading the paragraph silently) [HL: 1'C above average to upset corals…bleaching → notetaking]. Linear reading: "unlike anything we've seen before."
>
> [Views four color coral diagram below the para] Healthy, fluorescing, bleached, dead.

She kept skipping 360-degree photos and focused on written words as she learned information from the texts. She read a diagram explaining four colors of corals as it gets bleached.

In terms of written word reading, participants also skipped certain parts of written words if the words were assumed unnecessary for goal achievement. Felix also skipped certain parts of written words because he thought they were unrelated to the task.

> Hmm (reads the first paragraph) (HL: commercial fishing industry) It's a (inaudible) commercial fishing. There's nothing that tells me, nothing here that tells me anything about why fishing was an issue.

He accounted, "I just didn't end up reading cuz it didn't seem like it was relevant to the topic overall I realized it was very specific to just one region and one aspect versus overall ideas about coral."

Video also was the mode that the readers showed various strategies to evaluate its necessity. First, participants read texts related to the video to anticipate certain information, such as the title or descriptions under the video. Chloe recalled reading the subtext of the video first to see what the video was about.

> If it was relevant and I was hoping to see a visual of the actual reef cuz I still, I thought

> that was gonna help me understand what was going on. And then I think I won; I scrolled through the video to figure out if there was anything relevant.

This interview shows her forward inferencing process to anticipate what she might get from clicking on the video. She read the title of the video saying, “How the generation brings new life,” and skimmed the written description below the video. Once she knew this video was about students passionate about the ocean joining in to save corals, she said, “Okay,” and played the video. Her strategy demonstrates that the readers may combine written words around the video to evaluate goal relevancy before they click and watch it.

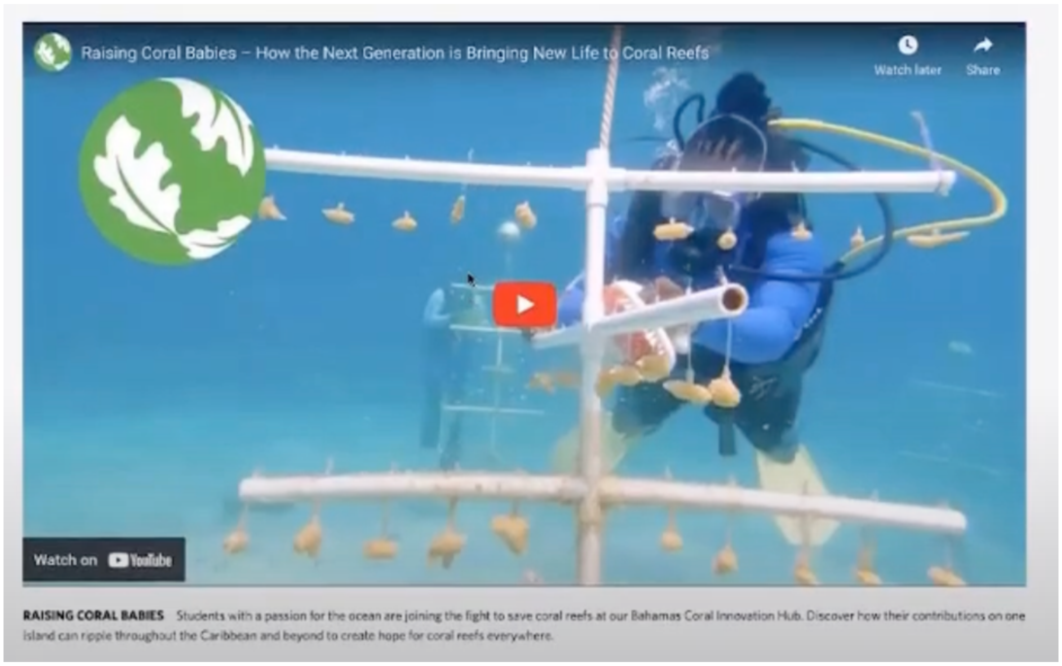
Hannah also read the video titled ‘Raising coral babies’ and viewed its thumbnail image to guess the relevance to the topic before she clicked on it. “It looks like this is the raising coral babies. It's a cute name. So, this is probably related to the propagation.” When asked if she uses this strategy often, she answered,

> I'd probably do that often. I think sometimes there can be videos that are just if you're on a gossip website or something, the video could just be pictures with words over it or whatever, and that's not that informational. You might as well get that in the article. And here it was something more specific or more interesting or whatever. Sometimes it can be very clearly an ad for something, so I guess I'd check it.

Namely, she clicked on this video because she evaluated its thumbnail image and decided that it was topic-specific and appeared interesting. On the contrary, Felix did not watch the video after checking the thumbnail image because it “seemed to be more like, beautiful.” His choice shows that this strategy also applies to skipping the video and finding other ways to collect information.

Figure 12

Video thumbnail image of 'Raising coral babies' (Captured from Hannah's screen-recording video)



When the information was delivered from the worthy video, they decided to click on it and spend time on it to get information from it. Below is George's interview:

> This video I helped, I thought was really helpful and relevant. This is maybe what, when I said that it was very visual, very clear, very easy to understand, especially given the topic, carbon markets and carbon capture and it's an economic idea, which is hard for me to always wrap my head around. So, seeing the video and having it explained in lay terms I thought was very helpful. And then also useful one day if I wanted to explain this topic to someone else.

However, when the reader feels she has accumulated enough knowledge about the topic, she decides not to watch the video to reduce time and focus on the new knowledge. In this case, readers skip the video based on goal relevancy. Hannah reported, “Here we have a 360 video, but I think I kind of got an understanding of what this is like from other videos and [quickly skims the paragraphs under the video] it seems that this is just a problem that continues to get worse.” When I asked why she did not click on it, she answered, “I could have, but I think I felt like I understood what this all looked like from the videos I had already seen.” Jamie, who watched full videos and repeated several times, I think I got the main ideas, some specific things, then I don't need the rest of here. It shows that the reader can be strategic in collecting necessary information by revisiting certain parts of the video and stopping when they think they got the knowledge they aimed for. Readers also check the usefulness of visuals instantly and just skip them when there is nothing they can learn. For example, Felix strategically decided when to stop watching the video. “I watch that part again. I think it been like eight minutes on this video. Even though it was four minutes because it was informative, and it had what you need. So, I went down, and read some more stuff, what is coral bleaching.”

Analysis and further description

Participants chose or skipped visuals (charts, graphs, photos), written words, or videos to focus on the modes that contained information most task relevant. It is an ongoing thinking of examining and determining what information is needed for the reader to achieve goals in a given time. It is also related to metacognitive thinking because it is based on the decision to read or not, depending on each reader’s task procedure. Still, it is closer to evaluation processes that encourage readers to determine whether certain mode is needed, so this strategy is categorized as evaluation.

Prior research describes readers evaluating the usefulness of multimodal text design features (Brante, 2019; Cho et al., 2018; Cho & Afflerbach, 2015). From these studies, readers evaluated visual aspects (e.g., fonts, pictures, website design, videos) from multimodal texts in accordance with written words to evaluate the credibility of information. *Evaluating goal relevancy of modes or multimodal texts* strategies found in this study have overlapping aspects with the literature. However, I found more elaborated procedures of this strategy from readers' verbal protocol and interview data and determined that online multimodal readers strategically (1) evaluate goal relatedness of a mode or a multimodal text in a first glance, (2) skip visuals, words, or videos during OMR if they think the mode is not relevant and (3) use the video mode and they evaluate its necessity.

Guessing or forward inferencing the video was helpful for the readers. It helped them determine if the anticipated contents of the video were valuable to the task and goal. It also related to participants' judgments of the trustworthiness of the video. If a video was judged not trustworthy, there was no incentive to view it. This OMR strategy is essential because the online space is replete with audiovisual information, which demands the reader's strategic time and focus. There were video evaluation strategies found in the literature as well. Online readers evaluated the credibility of the video from the video contents and reading images or words around it (Cho et al., 2018; Salmerón et al., 2020). This study adds OMR video evaluation strategies, demonstrating how readers combine written words around the video to evaluate goal relevancy before they click and watch the video, and how they evaluate thumbnail images to determine its credibility.

5.2.3. Evaluating information by cross-checking modes

Definition

Participants evaluated information by cross-checking modes if they found it confusing. This strategy involved evaluating the credibility of two different modes or sources of information. Readers did this by revisiting prior texts and modes or comparing information by switching tabs. This strategy is similar to the first evaluation strategy: evaluating text credibility by reading modes (see 5.2.1). However, I separated this strategy from it because it focuses on cross-checking modes and switching texts to compare two modes, not only evaluating the text in large.

Verbal report example, complemented by interview data

Blair and Dylan found information that appeared untrustworthy, so they tried to determine the source's credibility. She felt uncertain when Blair read the text stating that coral bleaching is a natural process and there is no need to be concerned. "Okay, since they said that it's a natural process and not a particular concern. This makes me wanna look at the actual source." She interviewed,

> So, this is where I got a little sticky cuz I read this first blurb and it said that it's a natural process and not of particular concern. So then that's why I was like, okay, maybe I should check the source because everything else is talking about how pertinent this is. Even the prompt itself is asking me about the importance of it. If the source isn't saying that, then I'm going to be a little bit more skeptical.

When Dylan saw a video saying that the organization was arguing that they have been striving to protect and restore, he checked the original source to check if that was credible. He reported,

> I start jumping, not and then see these are service influence like, looking at where TNC, what are these? Society making, the bridge, the partnership. Yeah, fact check. But it could be another website saying like, oh you should save coral reef, let's donate to our chemical or let's buy this chemical.

These readers switch, or “jump around” modes and texts to compare and clarify the information when they are presenting conflicting or confusing information.

The information that most of the participants found confusing was the stages of coral colors as they bleach. From three researcher-provided texts, one described that brown and green colors indicate corals being healthy, and another one said that it is a sign of starting to get bleached. Hannah reported,

> So perhaps not really my understanding of from the last video might not really be true of what kind of healthy coral color is. [Linear reading paragraph] A drop in local temperatures have helped them recover.

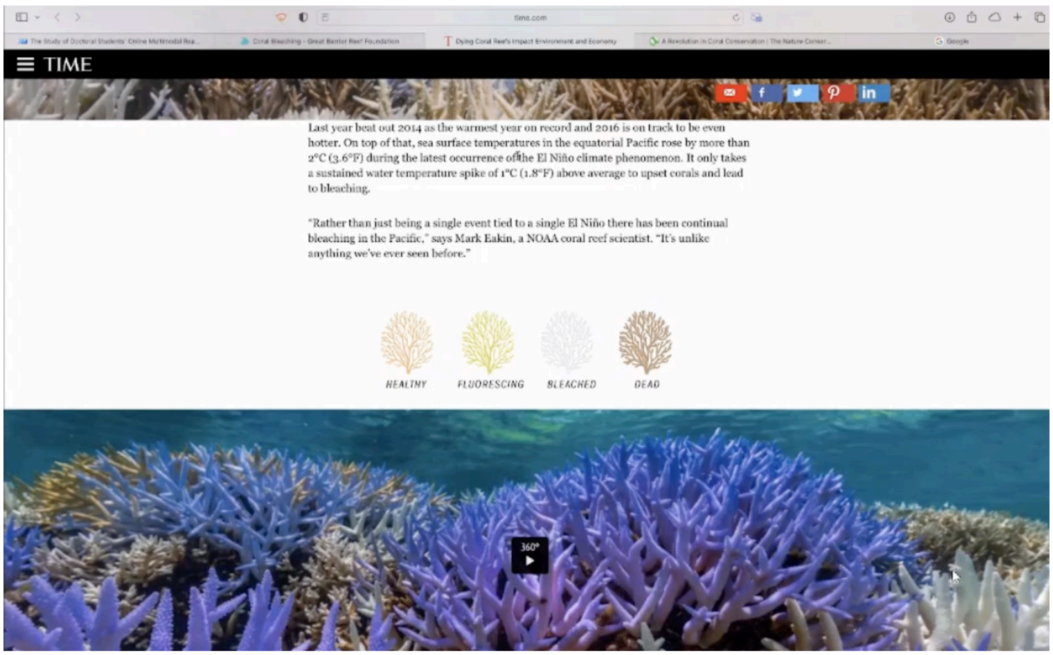
When asked if the four coral colors diagram matched her knowledge, she answered:

> No. So this one was the one where I was like this, he kind of talked about coral being more this brown color, and he was talking about the plants on it, which might be the difference, but I would assume coral is full of plants. So, they could be talking about two different things. But he was kind of saying that these lighter colors are more the damaged ones and this brown and green are the healthier ones. And so here, this kind of challenges what I thought I understood from him.

She finds contradictory facts from the visuals and goes back to the first text to check again. Then, she concludes that her original thought of healthy coral might be right, from the healthy orange coral color diagram (Figure 13).

Figure 13

Four coral colors diagram (Captured from Hannah's screen-recording video)



Finding conflicting information in different modes may be common in OMR. Therefore, readers should be able to cross-check modes to vet and determine the most useful, most trustworthy information. Jamie also confronted this conflicting coral color stages when she saw that diagram.

> (Cursor on the coral diagram) "Healthy, fl…belached, dead!" Oh! Brown is dead. Actually, it was brownie… [Goes back to Text 1-replays the first video from the front part (what coral is)]

She frequently switched tabs to the first text, where she found the video describing that brown corals are healthy. She repeatedly watched the video to clarify the information, which was apparently the opposite (brown is dead or healthy). After cross-checking, she seemed to have reached her own conclusion.

> I looked at that, I make sure that it is wrong and then I go back to the first one. If there is no first page, it's okay. But if after I, because I read that first. Yeah. So, it's confusing for me. But eventually, I found the answer.

Analysis and further description

While trying to understand confusing information, readers showed a similar process of assimilation, accommodation, and equilibrium (Piaget, 1983) of understanding how corals bleach. Assimilation refers to solving new experiences using existing knowledge (schemata, mental structure), accommodation refers to changing existing knowledge to solve new inputs, and equilibrium refers to the state when the existing schemas can explain new knowledge. Through these stages, participants actively constructed their knowledge about coral bleaching by finding and reading various modes as inputs.

From the literature, I found strategies encompassing evaluation of the relatedness of modes mostly focusing on the similarity of information. Strategies included determining the contribution of information from different modes (Oh & So, 2018), connecting different modes to better understand the topic (Cho & Afflerbach, 2015; Goldman et al., 2012; Wolsey et al., 2015), or to find equivalent or complementary information in words and images (Chan & Unsworth, 2011; Wolsey et al., 2015). Thus, this evaluation strategy of cross-checking modes adds to the current OMR study as one of the useful strategies for the readers to resolve conflicting or confusing information as they construct multi-modal understanding.

Summary

Multimodal evaluation strategies used by the participants were in four types: (1) evaluating text credibility by reading modes, (2) evaluating goal relevancy of modes or multimodal texts, and (3) evaluating information by cross-checking modes. I included an evaluation of the credibility of the information as well as an evaluation of the goal relevancy of information delivered in various modes. Subjects reported using these strategies continually to determine if the text was trustworthy and if the information presented helped them to reach their goals.

Evaluating text credibility by reading modes strategy was used when readers decided that the mode or the whole text they were reading was trustworthy and could be used in constructing meaning. With this strategy, participants checked dates, source names, domain addresses, logos used in a text, fonts and design aspects, video qualities, and authors' purpose to ensure the text was credible. Evaluating goal relevancy strategy was also helpful for readers to choose or skip certain modes and focus on those most relevant to the topic. Evaluating the task relevancy of the video was helpful when participants evaluated videos by reading texts around the video or thumbnails to forward inference of its usefulness. Lastly, evaluating information by cross-checking modes was useful as readers find confusing information and make their own conclusion out of comparing modes.

5.3 Mode Selection Strategies

Mode selection strategy refers to purposefully choosing modes from the multimodal text. For example, the reader must construct a path by browsing various modes presented on the Internet blog and choosing what modes to view or read based on their immediate rules regarding the purpose of reading. In this section, I focused on the participants' direct verbalization about mode selection, where they selected, ignored, or skipped certain modes based on their knowledge accumulation and/or task management. As a result, participants used mode selection strategy (includes skipping modes) in relation to (1) task relevance, (2) mode preference or interest, (3) reading ability or difficulty to understand modes, and novel strategies found here, such as (4) time and task management, and (5) skipping modes if established high prior knowledge.

Table 19

Mode Selection Strategies

OMR Strategy Name	Definition of the Strategy
Selecting modes based on goal relevancy	Choosing modes based on the expectation that they will provide information that the reader needs to achieve the goal
Selecting modes based on mode preference or interest	Choosing certain modes that matches readers' preference or interest in certain modes
Selecting modes based on the reading ability or ease of understanding modes	Choosing modes to read considering the reader's reading levels with regards to text complexity, length, levels (e.g., this text or mode seems easy or difficult to understand for my level)
Selecting modes based on time and task management	Choosing certain modes considering the time or effort allocation for goal completion (e.g., selecting a video since watching a video might take shorter time and effort compared to written words reading)
Selecting modes based on prior knowledge level	Choose to read certain modes because the reader thinks the information is needed or no longer needed compared to their established prior knowledge or the knowledge from ongoing reading

5.3.1. Selecting modes based on goal relevancy

Definition

Selecting modes based on goal (task) relevancy means readers' strategy to choose to read certain modes to get information that the reader needs to achieve the goal. Participants from this study selected or unselected visual modes, audiovisual (videos) modes, maps, or written words on their determination of goal relevancy to comprehend coral bleaching. I separated each mode selection below and described how readers chose modes with their excerpts.

Verbal report example, complemented by interview data

Selecting visual modes to achieve the goal

First, readers selected visuals if the visual had relevancy to the topic comprehension. Blair decided to read an infographic because she determined it was simple, to the point, so she thought that was an easier way for her to understand what coral bleaching is.

> I also like simplicity. So, I'm gonna go to this visual here [image tab]. I like infographics cuz they're to the point. Okay we go. So, it's from the National Ocean Service. I'm not familiar with it but it does look like it is legit. Okay, so here I just go to the title. Coral bleaching. Have you ever wondered how coral becomes bleached. Healthy coral, coral and algae depend on each other to survive. If stressed algae leaves the coral and corals left bleach. Okay, so I didn't know this didn't that it is not, it's not the coral itself, it's coral plus algae.

She could choose visuals that can be helpful for getting lots of information. She also selected a diagram of coral anatomy, saying, "Um, okay, coral anatomy [clicks on the diagram]. This is helpful for me. Okay. I don't really see what I'm looking for in terms of the little algae dudes. So, I'm gonna just see if there's anything else. I'm assuming that's just what they look like [clicks on rounded cell photo]. They're kind of cute. Okay, going back." She purposefully chose visuals to see what the coral anatomy and algae looked like. Although the diagram did not help her find what she wanted to learn, the initial decision to see it shows that she knows that it is easier to learn about algae through visuals when it is something small and actual visuals would be helpful.

Similarly, Chloe verbalized that she wanted to see pictures as she was trying to understand what bleached coral looks like because the texts were "talking so highly about it in that article that it was the most amazing thing that he'd ever seen. I was wondering what it looked like."

> I wanna see pictures. [Clicks on Getty images link] [Scrolls down] Don't feel like it's the same thing. Oh, maybe this (blue coral image) is it. They're supposed to be fluorescent because they're dying. Bleaching [Search: Pictures of fluorescent bleaching corals Caledonia] corals. Maybe they're purple then, let's see (clicks on the Bright neon yellow link). Right. Neon yellow, fluorescent coral in global coral bleach. Oh's. Environment. (ellipsis) These are bleached (blue coral photo) too…. Okay. They have a lot of pictures of bleached.

Chloe clearly states that she needs pictures to understand bleached coral colors. She searched and chose to view different coral images and understood that they culd be various neon colors and expanded her understanding of what they looked like.

Selecting audiovisual (video) modes for topic comprehension

Second, readers selected videos strategically when they thought it was relevant to the topic comprehension. Chloe selected the video of the Bahamas and interviewed,

> Oh, see I read the subtext first. See what the video is about. If it was relevant. And I was hoping to see a visual of the actual reef cuz I still, I thought that was gonna help me understand what was going on. And then I think I won. I scrolled through the video to figure out if there was anything relevant.

Chloe sought visuals of the reef and read the video's title first. This quick reading made her watch the video and see the scenes she anticipated. Her strategy for choosing this video based on its thumbnail is also related to the forward inferencing of the video strategy (see 5.2.2). Emily, a written-word-focused reader, also used this video selection strategy, but she muted the sound of the video before she watched it. Her unique strategy was to select written words and visuals on the video to understand the content more easily. Her verbal protocol shows her decision to mute sound and turn on the transcript as she viewed the video on Nature Conservancy's works:

> [clicks on the first video] Sound muted, and transcripts are on. Right away, I like that they're involving young people in the project, and it looks like the local people. I'm wondering too, if they're having people internationally come into this experience.

This was her active sensory selection of visual senses – written words and images – as she learned the information on the screen. This learning has much in common with Mayer's (2020) contention that people may learn better from words and images combined as opposed to words alone.

Selecting maps to locate areas

Based on the type of topic, some readers also chose maps to locate places (e.g., Great Barrier Reef, The Bahamas) they were reading on the visual maps. In her interview, Chloe reported:

> Because there was a map of Australia, and I didn't actually realize before where the Great Barrier Reef was. So, cuz I'd been looking for a map on the other sources. So, this was really good. So, the map helped me visualize. (ellipsis) And then I have a hard time

placing it somewhere in my brain, which makes sense. I know that that makes sense. But I know definitely this was a really a ‘aha moment’, finding this map and seeing where the reef is located.

In his verbal protocol, Dylan reported similarly:

> The Caribbean is the place that we're looking at. Just to double check on where Caribbean is. I wish they have a map somewhere. I'm looking for a map to understand where that exactly is and things. It's Google and let's just do it. So, the map loading… Okay, so it's somewhat in the south of the US Yeah. So that's where also I know in Asia there's bunch of coral reefs there as well.

Dylan explained, “I tend to look at where things are, where everywhere, so I know what happens and where it is happening because I think in Caribbean and Australia is different in culture and other ways like Northern, Southern atmospheres are also different. So, I do want to know where that is.” He describes himself as “I'm a bit location person, so I like when they show the map of what could be at.” He likes to travel, so he says he wants to know where he should go first to see corals, just in case. These readers’ tendency to find maps to locate information can be derived from the topic of coral bleaching because they need to understand where it is happening and why it happens based on related scientific facts about global warming, ocean temperatures, etc. If the topic had changed, the frequency of subjects using this strategy would have changed.

Selecting written words to understand the topic

There were several participants who preferred written words reading rather than viewing visuals or audiovisuals, just like traditional print reading or online hypertext reading focusing on written words. For example, Emily read mostly words and tended to skip of the other types of modes. When asked why, she explained,

> When I think about reading for information, a lot of times I try to do things, at least at the beginning in a linear way, like, oh, I can look at some basic information first and then find out what sort of details I want to explore. (ellipsis) I like to get an overview first of what do I not know. So that's why I use those tabs first because it actually, reading some information, gives me more direction for what I might wanna look for.

In other words, she selects written words first to get the overall comprehension and set reading paths of what she could read from multimodal texts. She gets to the linear written words reading first to get basic information about the topic. Next, she reads other tabs, sees the matching information she has read from the initial reading, and expands her understanding. Another written words-focused reader, Felix, added, “Even though the visuals really speak to me, I just completely ignore them as a reference in a text. So, when it says figure one, and I read, I won't actually look at figure one until it passes me.” Based on his original habits, he described that he focused on written words at the beginning of the OMR task because he did not know much about coral bleaching. “I had to just learn more before I could ask any questions. That's what I did, just taking in information.” ‘Taking in information’ was what both readers did, and they did it so by strategically selecting written words.

Unselecting modes because the reader has enough prior knowledge

With regards to unselecting modes, readers skipped visual or audiovisual modes that did not meet the goal or help make progress towards the goal. For example, many participants skipped visuals that accompanied paragraphs when they thought they were irrelevant to the goal. This frequently occurred when the readers saw four movable 360 degrees photos of coral underwater and skipped one or all of them. Amy focused on written paragraphs and skipped two of these photos. From this verbal report, she does not even mention skipping it, but I capture it from her screen-recording video.

> [Skips the 360 photo and reads paragraph under it] Last year beat out... warmest year on record (reading the paragraph silently) [Highlights: 1'C above average to upset corals…bleaching --> Note taking (NT)]. Linear reading:" unlike anything we've seen before." [Views four color coral diagram below the para] Healthy, fluorescing, bleached, dead. Wow. (NT)

Figure 14

One of the four 360 photos from TIME magazine (zoomed in using cursor)

She also skipped the video after reading two paragraphs about reef structures. Felix skipped most of the videos to focus on written words because he thought the videos were not directly related to the topic. This efficiency-focused OMR strategy helped readers to focus on their thread of learning and to achieve reading goals in a limited time, bypassing modes that were considered to contain redundant, superfluous, or irrelevant information.

Analysis and further description

OMR readers select modes (e.g., images, videos, written words) based on their best estimate of relevance to the goal: the possibility that the mode will provide the information needed to achieve the goal: understanding as much as they can about coral bleaching. All ten participants used this strategy frequently to choose certain modes that might guide them to more robust topic comprehension. Selecting modes inevitably involves unselecting other modes from the reading scene. I also coded unselecting of other modes as important strategies.

From their data, subjects chose to read certain modes strategically based on their preferences on modes, interests, or, most importantly, task relevance. They demonstrated this strategy based on various reasons. Readers selected visual modes because they gave lots of visual information (e.g., colors, corals, anatomy) that they thought necessary to see. They selected videos (audiovisuals) when they thought it was relevant to the topic comprehension to show them what was happening. They selected maps too, which is a form of visual mode, to locate information due to this topic's characteristic of location emphasis. Some readers focus on written words because they start with linear reading to get the basic information of the phenomenon or prefer written words over visuals. These strategies inevitably involve unselecting other types of modes around it because readers can allocate their focus and time to achieve the reading goal (understanding coral bleaching) in a limited time.

5.3.2. Selecting modes based on mode preference or interest

Definition

Participants selected modes based on their personal preference or interest in certain modes as they learned about the topic. There were overall three types of mode selection based on the reader's interest or preferences: (1) visual modes, (2) audiovisual modes, and (3) written words modes selection.

Verbal report example, complemented by interview data

Preference on using visual modes

Some readers described themselves as "visual learners." They tended to choose visual modes (e.g., images, diagrams, photos, infographics) as they read. Many participants used at least one of the four 360 photos from the visual dominant text I provided. Jamie accounted for why she selected the 360 photos saying, "Because they said 360 figure and I thought it would be interesting. But it's not that beautiful though. It's not that colorful, or they want us to see the dead reef." She selected this visual because of her interest but expecting to see something goal-relevant (e.g., color of reef). When asked why she checked the 360 underwater photos, Amy also answered, "I just really liked the picture and water and seeing what I'm about to understand what it looks like, what this they're seeing and the scope of how large the coral bleaching is," showing her personal preference in pictures. Isa also opened and viewed all four 360 photos to see what fluorescent looks like. She reported,

[Opens 360 photo and views around-goes back to the text, reads para under the photo]

> [Search: “our ocean conference” on image tab. Goes to News tab and skims search results hyperlinks and short descriptions under the link] [Clicks 2nd 360 photo] We have… fish (drags the photo more carefully to see around and focuses on the apricot-colored coral, zooms in and out).

She accounted her active use of these underwater photos,

> I think just curiosity more than anything. (ellipsis) I was like, hey, I wanna see too (laugh), what’s happening. And then I think that it is also because it’s something kind of stimulating when you’re just reading a bunch of words you want, it’s almost like a little reward for focusing. You’re like, okay, now I get to see there’s beautiful ocean view and then I’ll read on a little bit more and then you pause again. So, it was a really good way to break up the reading and keep focused instead of getting distracted.

She used photos for several reasons combined: interest, task relevance, and a form of self-reward to keep herself motivated. Based on this and Amy’s interview, readers use certain modes for various reasons combined, although the major reason for selecting visuals for her was her interest.

George also used this photo but in a more distracting way.

> [Opens 1st 360 photo] (Drags around) That’s really pretty. So, you can see the dead coral here (points with the cursor on the white corals) and how it contrasts with the colorful alive coral (cursor on the yellow, purple ones). Look at that It’s really shallow too. Looks beautiful. I would love to visit. (Closes the photo)

He explained, “I loved looking at this picture these 360, not necessarily to help me understand what yeah was going on, but just because they were so interesting to look at. And I think I was also kind of looking at the people. I was looking at the fish. So they distracted me kind of from coral bleaching.” This interview excerpt hints at a possible detriment of OMR: different modes may entice readers’ use and contribute to off-task behavior. He used the picture only because it was interesting to look at, and he consumed various inputs following what seemed interesting. This tendency of visual selection was increased when the readers were distracted. Amy viewed insect images and explained, “I liked the visuals with all the different species. And just the numbers, the pure hundreds thousand six of seven. It's a natural wonder.” Jamie also got distracted when she was looking at turtle photos. “I thought about our school. I used to hate turtles because it looks ugly, but now I like Turtle because it's our spiritual animal.” She chose photos when she was distracted.

Infographics and diagrams were fruitful information sources that readers frequently relied on. Blair searched an unfamiliar word, ‘industrial emission,’ and viewed photos on the result page, which was visual and words multimodal reading. She reported,

> I need to know what industrial emission is the same definition. [Search: What is Industrial emission?] I always go to the side cause I like pictures (looks at the right photo) is a, oh nope, that's not on topic cause it's a directive, it's a union. I guess (found wrong info).

From the interview, she accounted, “I always go to the right portion first. Especially cuz it has pictures. If it has an infographic, I just go for that.” She said she “just looked at that infographic honestly, just cuz of the colors and the simplicity. So it was just a clear animation style.” So it was just a clear animation style.” She loves watching YouTube videos and documentaries using infographics or simplistic illustrations. She added, “Cuz like a photo. I'm the one interpreting it.

But in infographic it's more so somebody has already consolidated that information and synthesized it and they're not presenting it in a very simplified fashion. So, I think that's why I prefer them more.” She also prefers infographics more than photos (and among visuals) because she thinks the information has already been interpreted and synthesized in a simple format. She states a preference for pictures, and it is also metacognitive thinking that she knows what she likes and what can be efficient in learning knowledge.

The diagram user, Chloe, saw four corals diagram and reported, “[Reading four corals diagram] Oh, fluorescing, bleached, dead. It’s (dead) also thicker than that (healthy).” She was the only reader that found that the corals illustrated on the diagram are different in their thickness.

> I really like this visual. [4 corals diagram] I was very surprised by this. But this is really good because they also, this is a little thicker than that. And then there’s the fluorescent stage in between that they were talking about. So, it's chronological and realistic, which helped finalize my understanding of what it was. The branches are a little bit thicker. See here, they’re really nice and thin (pointing to the coral diagram).

From the interview, she realized that she uses visual modes more than she thought. “I would not have guessed that I gravitated toward visuals, but apparently, I do and then I use it to make sense of the text. Like from the very beginning I was looking for a picture that illustrated bleached corals because otherwise I couldn’t make sense of it in my head.” I could reaffirm that she selects visuals to understand the text more clearly.

Lastly, participants chose not to select certain visuals because the mode does not match personal interest. Here’s Dylan’s verbal report.

> [Clicks on the 3rd 360] They have these amazing pictures of the purple ones, but the white ones right beside it. The yellowish, I know it, but the (goes to the original text and points the diagram) picture does not show me what is purple/blue means, which would be helpful to identify those.
>
> [Clicks on the 4th 360] All right. Start a bit sick of the 360. It's cool for a bit, but a bit too much now (turns off and goes back to the text) also they have a broken link (laugh).

Likewise, Dylan lost interest in watching the 360 photos and began to skip them. When I asked if he figured it out what purple/blue means, he answered, "it doesn't tell me what is purple and blooming. It only tells me like this is healthy, this is somewhat bad. That's bad. (Looking for fish) It just looks interesting. <laughs> No particular reason. And then just looking at it (360 photo), third one, and then by the fourth, I'm tired of it." This account shows how he first got interested in a photo and then the phase of him losing interest in it.

Preference on using audiovisual (video) modes

Some readers preferred to use videos for their understanding. Dylan and Isa both watched embedded videos in the texts, but they clearly verbalized their preference or boredom from their interviews. For example, Isa watched the full video about the nature conservancy, and she described her strategic choice to stick to watching it by:

> I think that was the one where I was okay. I've gotten to a point where I need some other type of stimulation to actually retain. So, I was like, let me go to the video that works well the first time. And then I was just watching them to see how they (do micro fragmentation). (ellipsis) But what I was really watching the video to see if I could see an

example of what they were doing.

She stated that she chose the video of researchers raising corals as a type of stimulation retention and to see an example of how they actually do it from the video. On the contrary, Dylan decided not to watch the same Nature Conservancy video saying, “I just skip. I see that video is boring. Then I just found the page and it’s scrolled up and then to the next page. Yeah, I did it slightly better because this one at the beginning I did not watch those two videos.” He thought the videos were boring to him and skipped them purposefully, illustrating the strategy of mode selection based on the reader’s preference.

Preference on using written words

Few readers selected written words (e.g., paragraphs, quotes, numeric values, drop-down menus, people also ask) to understand coral bleaching. All participants used written words as they read texts, but here these readers particularly relied on written words reading exclusively, not giving attention to visuals or videos compared to other participants. Participants used drop-down menus or ‘people also ask’ sections of search results. Blair accounted, “If I have it, especially if I’m looking for just a quick definition of something, then definitely use the dropdown. Because usually it just parses it up. If I could get the least amount of information, then I, I’ll do it.” She reported,

> [Clicks on People also ask] What is the meaning of emission from industries? (Opens drop-down menu) [Linear reading] Industrial activities from the production of electricity and cement to waste management. I could just kind of BS it and just say it’s any aspects associated with industrialization. So, creating manufacturing and distributing as well as

getting rid of things. Click out, reiterate myself.

Blair seeks concise written words modes to get relevant information in relation to her time management and the ease of accessing and understanding the information.

Some participants focused on numeric values among written words. While Amy checks out various animals, she explained, “These numbers and stuff. Looking at all of these, I thought I like these as a quick sum, quick facts, 20 minutes trying to learn all I can as opposed to this is a good way to start.”

[Sc down to see diagrams and numbers] Reef animals. 600 types of corals. HL: "215" Wow. 133 sharks and rays. Wow. It's 30 species of whales Wow. 25% percent of all known marine species. Wow. Lots of animals (NT) Nots of...numbers.

Various readers reported using and valuing numeric summaries of facts, which might be based on those participants’ majors where data-driven quantitative values are regularly used.

Analysis and further description

When asked if their preferred type of modes, participants tend to describe themselves as ‘visual learners,’ ‘I like reading texts,’ ‘I’m a location person,’ or so. Although research does not explicitly support these self-designated learning styles, participants did describe themselves in terms of their mode preferences from their everyday OMR. There were three types of preferences: visuals, videos, and written words. For the visual selection strategy, subjects chose photos based on their interest, and also, they preferred infographics and diagrams as a form of visual and word multimodal text. They used these visual modes if they wanted to observe something beautiful or interesting or something to the point so that they did not lose interest in learning. Subjects also selected videos based on their preferences because it stimulated their understanding of animated scenes. Lastly, readers chose written words when the words provided a brief information summary. These mode selection strategies were based on each reader's interest, so it depends on the individual reader's multimodal reading experiences that they determine that certain modes are interesting or boring.

5.3.3. Selecting modes based on the reading ability or ease of understanding modes

Definition

This strategy refers to selecting certain modes based on what mode seems easy for them to understand compared to their reading abilities and the modes' difficulty. This quick decision occurred when the readers selected modes based on the: (1) simplicity of written words; the information it contains is simple (or parsed into small bits of info) regarding the task, (2) brief FAQ menus because they look easy to read, (3) selecting modes based on their reading abilities, and (4) sensory selection of modes depending on the difficulty of the video.

Verbal report example, complemented by interview data

First, different from the written words selection strategy based on preference (see 5.3.2), the readers selected written words based on its simplicity regarding the task. From his interview, George accounted for his selection of an article full of written passages,

> I felt it was really well written and easy to understand. I don't know why, but it's something about sometimes when I'm reading, there are authors that I feel like are writing in a language that I understand better. If that makes sense. And so pretty soon after I start reading a passage, I can tell if I'm gonna be able to understand this writing easily or if it's gonna take extra effort. (ellipsis) I'm like, oh, I'm gonna enjoy this or this is gonna be a

> drag.

For him, the paragraph he was reading was rather easy and suited to his reading ability, so he continued to learn from it. It was his subjective feeling of what is easy writing that made him keep reading. Similarly, Dylan chose to read brief FAQ menus because they were easy for him to understand. He was strategic in his choice of written words in this parsed-into-openable boxes format because he thinks the FAQ menus have already sorted out fundamental questions for the readers.

> I think the FAQs are very good because it's asking what is coral? and what is coral bleaching? So, this is the answer I should know. So, I know that caught my eyes. And also, it only gives a small piece of text, so it's easy to read carefully and understand it and somewhat memorization of it for the question coming up. And also, these FAQs are pretty much the questions that people care about and talk about.

Participants used these FAQs frequently to get brief information from opening the dropdown menus if there were questions that they wanted to learn from. Also, these written words were relatively easy to understand because they were presented in small chunks.

Readers chose not to read certain infographics if they seemed complex. Although Blair was an avid visual-focused reader, she skipped a graph depending on its complexity and time management. “I did not pay attention to that graph. It was too complex that I didn't have the time for it. I got what I needed. So, I think I move on to the last one,” She showed an integration of two strategies – monitoring for time management and mode selection – to accomplish the task.

Lastly, Hannah’s strategy to mute video sounds can also be interpreted as the mode selection strategy based on reading levels. When I asked her what strategy she used to view the video, she answered, “I think I tend to look at subtitles in general, so I probably was doing that here too. And I think I've kind of taken both. I sometimes, I don't think this was in this case, but sometimes I can look away just to focus on the audio. But in this case, I think it was easy visuals to look at. It wasn't too distracting. You kind of get a sense of what's going on. And I thought I, I looked up and took in both audio and visual. I think here it's a little easier to…It's not so distracting, but at the same time I guess appealing.” She mindfully selects senses (subtitles + visual + audio) conditionally, depending on the difficulty of the video. Her video muting may look similar to Emily’s video muting (see 5.3.1) on the surface level, but here Hannah did it because it is easier for her to understand the contents compared to Emily’s strategy that she focused more on task relevancy.

Analysis and further description

It was important for subjects to reduce difficulty, suppress background “noise,” and stay focused on comprehending and learning. Therefore, the readers selected written words that appeared accessible, often parsed into brief sentences. They selected modes that matched their reading abilities and selected sensory modes to reduce the difficulty of the video. These strategies can be applied to other modes during OMR, but the essential point is that these readers gauge their reading levels and difficulties of modes at the same time to select the best modes from multimodal text reading. If they cannot do this, they might not understand the topic and may fail to accomplish reading tasks by letting themselves struggle with difficult texts. Knowing their reading ability can also be influenced by their metacognitive thinking. The fact that their mode choices are affected by knowing their reading levels was interesting to see.

5.3.4. Selecting modes based on time and task management (self-monitoring)

Definition

One criterion for readers' mode selection is related to time and task management. Although participants' focus levels were assumed to be sustained and high, I required 25 minutes of OMR. To accomplish the task and learn as much information as possible in the allotted time, the readers had to be strategic in their task and time management, which appeared to influence their mode selection. Readers strategically selected or skipped modes considering time, difficulty (complexity), and amount of information.

Verbal report example, complemented by interview data

Participants selected modes considering the time management to complete the reading task. This strategy was reported as participants noted preferred modes that could 'save a lot of time' or that were 'not too complex that does not require much time' with other factors (e.g., easy, goal-direct) intertwined. For example, Chloe verbalized her process of unselecting a video based on time management. "(Skips the video 3 times forward) This is too detailed. (Healthy/bleached coral contrast image) As the coral is expelling the single self…cause it's... (stops video) Okay it's too long." The complexity of the information and the anticipated time invested in the mode was the major cause for them to use this strategy. Chloe accounted for the reason she skipped and gave up watching the video:

> So, I was like, this is not the most efficient way for me to learn about this. I need to go to either another video or another source. I felt like I was wasting my time a little bit. I wasn't as efficient as reading this about what is, cuz this is what is coral bleaching. But here in 20 seconds I knew what it was. So, I was like, okay, no, this is not efficient. And

that's why I stopped.

She tended to ignore or skip the videos when she felt that they were too detailed and de mandingtoo much time. She said, “I watched a little bit and then I thought, no, I need to make better use of my time. This is not gonna teach me more than I already know,” confirming that time management is what she was concerned about, just like Dylan who skipped the same video reporting, “a bit too long. I don't know how much time I have or how detailed I should go on things.”

George decided to watch a scuba diver’s video hoping that “it could help me understand coral bleaching without having to read the passage a little bit more quickly.” However, he soon stopped the video for time management because it “was very difficult to understand. (ellipsis) I had to work a little bit harder to understand and I think I would've just gone back and read it. That would've been easier.” He described his reading style as ‘always looking for information shortcuts.’ “I’m looking for keywords. I often skip over helping verbs and other syntax that is more procedural. So, in this, I'm looking at water quality, sun exposure, low tides, and it's easier to just infer what that means so I can read it quickly.” He chooses to read infographics to make his inferences quicker. His strategy targeted the time management.

Jamie was also strategic in time managing. When she had five minutes left to read, she checked what more there is left to read, reporting, “[Checks what more to read] And works. 3, 3, 4. Yeah, I thought I opened four tabs, but I, oh, this is just a Google search.” In the matter of time, she keeps the rest of the text unread and finished given texts, and once she completes first round reading of all three texts, then she goes back to the part of the information she has left unread and resumes viewing/reading. This strategic time allocation and strategy adjustment can be a strategy of executive functioning and self-monitoring as well.

Analysis and further description

Participants selected modes strategically for time and task management. They allocated time effectively to make progress toward the reading goal. They discontinued viewing videos when they demanded too much time but also selected videos if they determined they could be time savers. Participants divided time strategically for each text and monitored their reading times for texts to keep their task accomplished within the provided time. Time and task management are important in reading because OMR and online hypertext reading, in general, are complex. This might prove distracting and time-consuming. Therefore, readers should be careful in selecting what modes to read. This was reflected in the study participants' consistent monitoring of their time and task management.

5.3.5. Selecting modes based on prior knowledge level

Definition

Participants selected modes based on their prior knowledge level or the ongoing knowledge accumulation of the topic. Readers made decisions to read certain modes or not based on their judgment that they had sufficient prior knowledge or needed more knowledge. These decisions were made in conjunction with the appraisal of the particular mode. These strategies are related to the metacognitive decision to choose what to read based on one's knowledge, but here I focus more on the strategic mode selection, which demonstrates selecting or skipping modes. The strategies were: (1) reading modes thoroughly to learn basic knowledge, (2) investing more time watching videos that are relevant to prior knowledge, and (3) skipping modes because there is no new information.

Verbal report example, complemented by interview data

Readers constantly gauge their knowledge level during OMR. Their related mode selection based on this prior knowledge level is also demonstrated by Chloe:

> Because this was the first text that I read. So, I can see that I was really reading almost every sentence. And also, because I knew that the goal was to learn, right? So normally if I wasn't investing in this, I might have skipped over a lot of this, but I was really invested in understanding what was going on.

Her decision to read the full text was based on her low prior knowledge level about the topic. This strategy was also shown in the video watching by Isa, who watched the full video on coral bleaching because she thought she did not know much about it. Here is her interview on her full video watching and her prior knowledge:

> I thought that would be the most helpful to capture everything. If it's a topic I'm familiar with, I don't necessarily play the videos. I like reading. But for something like this, it's kind of science related. A little bit more out of my comfort zone. I thought a video would be really helpful because that's gonna be where they, they're purposely trying to reach to people who don't familiar and they're gonna break it down all the key concepts for me. And that way I could get both right? I could still read through it, which I continued to do, but I could now, this was kinda my basis instead of having the reading as my basis, what he said when I was thinking, I was like, oh yeah, like he said that, okay, yeah, I remember that. I know that because this was now my knowledge base. Instead of starting from zero knowledge, everything he said was like, okay, now this is what I know.

Isa thought the video about basic coral bleaching facts was a good starting point compared to reading a bunch of written words. She selected the video for new information because coral bleaching was unfamiliar. Also, she chose the video because she thought it was made for people unfamiliar with the concept so that they would have broken down information for them. She decided that this video was her knowledge base which helped her think ‘he (the researcher from the video) said this and that’ as she read other texts.

Readers also selected modes because they believed they had enough knowledge, skipping modes that did not appear to contain new information. For instance, Jamie repetitively watched a video that contained information about coral bleaching stages and stopped playing it when she felt that she learned enough knowledge from it. She said, “I think I got the main ideas, some specific things, then I don't need the rest of here.” Hannah watched another video (about nature conservancy) fully, too, “I think more with the video, I was thinking about these [prior knowledge about policy, community and stuff]. This is something that was good that these community members were invested in.” She knew more about the fact, so she watched the video.

Subjects also skipped visuals – 360 degrees underwater photos – when they felt that they had already seen it or they thought they got an understanding of it. They reported, “I skipped that one (2nd 360 photo) because I already had something similar.” “I think I kind of got an understanding of what this is like from other videos and [quickly skims the paragraphs under the video].” I infer that they are skipping certain modes based on prior knowledge level if they want to allocate their limited time and focus span to more valuable, goal-directed reading.

Analysis and further description

From this study, the ‘selecting modes based on prior knowledge level’ strategy was shown to be threefold: (1) reading modes fully to learn basic knowledge, (2) investing more time watching videos that are relevant to prior knowledge, and (3) skipping modes because there is no new information. First, participants demonstrated their modes selection based on their prior knowledge of the topic, and when this knowledge was judged minimal or non-existent, they watched videos in full and used them to build a knowledge base. Next, subjects also chose the videos and spent significant time watching them when they sought to expand their understanding. Lastly, readers skipped modes when they found nothing new from reading/viewing the modes.

From the literature review, I found two types of prior knowledge use in OMR, using prior knowledge about multimodal reading or about the topic. Mode selection strategy is related to the reader's topic or conceptual knowledge that makes them decide whether to read or skip certain modes. Although both use prior knowledge in OMR, I coded 'Prior knowledge use to understand multimodal texts' separately (see 5.6) because selecting modes is more focused on how readers choose or skip the modes compared to their prior knowledge, not on applying prior knowledge on understanding modes or multimodal texts.

Summary

Mode selection in OMR is one of the most prevalent multimodal strategies. Participants from this study used mode selection strategies based on: (1) task relevance, (2) mode preference or interest, (3) reading ability or ease of understanding modes, (4) time and task management, (5) design features), and (6) prior knowledge. These mode selection strategies helped readers establish knowledge and reading path of OMR uniquely and helped them stay interested, motivated, and focused on accomplishing reading tasks in a given time.

From the literature, readers' mode selection strategies during OMR were divided by reading purpose (Hovious et al., 2020; Karchmer-Klein & Shinas, 2019; Smith, 2019; Park et al., 2020), mode preference (Rasmusson & Eklund, 2013), or reading ability (Hamdan et al., 2017). It requires readers' ability to make choices while reading, understanding of multimodality, and metacognitive thinking that can monitor readers themselves.

The data indicated that readers selected modes based on reading purpose, preference, and reading ability. Insights from the data include that participants selected or skipped modes based on their time and task management chose a mode based on design features, and chose a mode based on the self-appraisal of their prior knowledge. Based on my data analysis, accomplished readers constantly examined the necessity and relevancy of modes and decided to read or skip them. OMR is an ongoing process of this strategic decision-making, which results in time and focus management, knowledge building, and task accomplishment.

5.4 Multimodal Searching Strategies

Multimodal searching is defined as the reader's search across modes for information to improve their understanding of the topic or to achieve the reading task. It involves identifying search engines and websites, using search boxes, typing search terms in, or scrolling through modes (e.g., images, videos, menus) to seek information. In this study, all participants used Google search or Google image search function for multimodal searching. They did word searches on a Google search box, word searches. Then they connected to images, image searches on the Google image tab, or opened drop-down menus after searching where it shows 'People also ask' to see popular answers. Based on the data, I determined that participants used three types of multimodal searching strategies: (1) image searching (image tab, maps), (2) word searching, and (3) word searching and connecting to images.

Table 20

Multimodal Searching Strategies

OMR Strategy Name	Definition of the Strategy
Image searching to view and understand concept	Conducting search on the web and going to the image tab or maps to find information in visual forms (e.g., diagrams, photos, maps) or searching at the image tab to only find images to comprehend certain concepts
Word searching to understand concepts	Conducting search on the web in words or phrases on the search bar and reading results in written words forms (e.g., paragraphs, brief summary of the most relevant search result, opening 'People also ask' menu and reading them)
Word searching and connecting with images to understand the text	Conducting word searching and connecting to the adjacent image shown on the search result or visuals form other pages or vice versa to comprehend certain concepts

5.4.1. Image searching to view and understand concept

Definition

Participants used image searching strategies to locate information in visual forms to assist in understanding a word or a concept and then return to the original reading thread. Image searching means putting search terms into the search engine and going to the image tab or maps to find information in visual forms (e.g., diagrams, photos, maps) or searching at the image tab only to find images to comprehend certain concepts.

Verbal report example, complemented by interview data

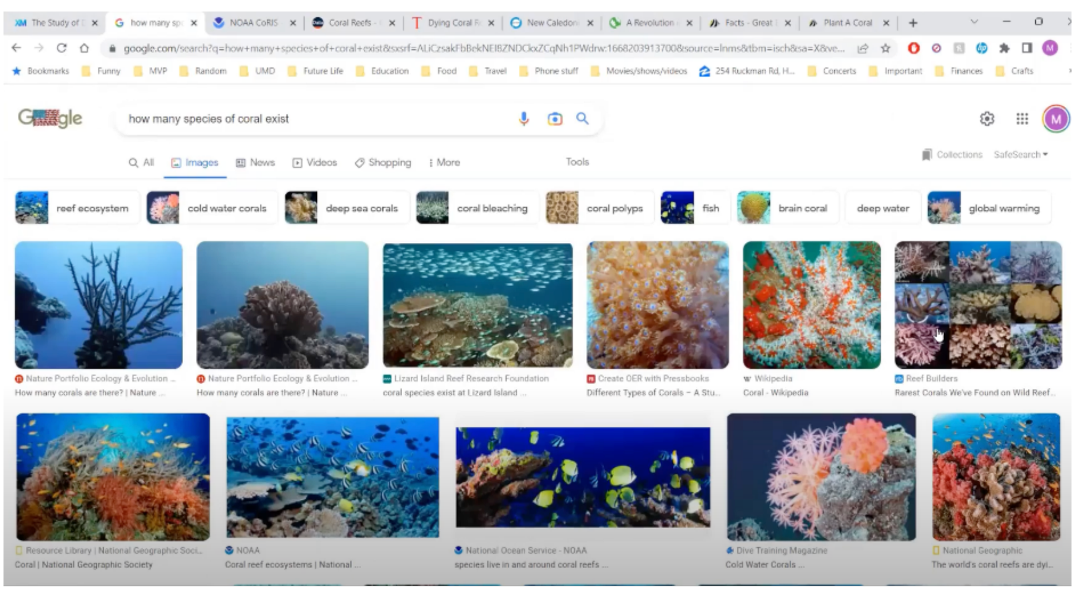
Jamie was not familiar with the term El Niño, so she searched using this term and viewed images to learn about it.

[Searches "El Niño", clicks on the 2nd link "What is El Niño? (NOAA)"] Ocean temperature in the…So it's… really helping.

About this scene, she explained, "At that moment, I don't know what it means. But I come with that. It's about temperature, but I want to know what exactly means." She constructed an understanding of the term from the pictures and described, "I didn't read all of this, but I looked at the pictures, just the figure. It means the water temperature is high." She searched and scanned images to quickly learn an unknown concept, El Niño, so she used an image searching strategy. Amy also Google searched 'how many species of coral exist' on Google. She clicked on the Images tab from the search results to see different coral photos. She said in her interview, "I just searched. I just looked at the pictures. Oh yeah, I just went to images. (ellipsis) I would say I'm visual. But I would describe myself as visual, but what I've learned about learning."

Figure 15

Amy's image search results on 'Images' tab (Captured from Amy's screen-recording video)



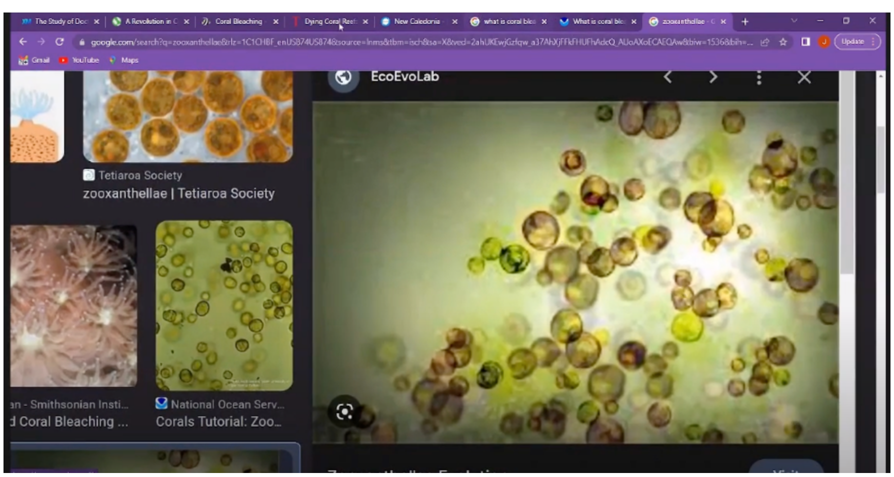
When I asked her why she searched images, she answered that it depends on the topic. Since coral bleaching naturally involves visual information regarding the colors and looks of bleaching events, images in the form of photographs effectively convey meaning.

Images were helpful for the readers to find uncertain words or concepts and to clarify what it means through quick visual forms. Blair found the term 'zooxanthellae' from the written paragraph reading, and she searched for it, assuming that it was some sea plants from the context, and went directly to the image tab to see what it looked like. .

> This is just for my own curiosity, [Search: zooxanthellae] I'm gonna look up what they look like. [Image tab] The little algaes. Um, okay, coral anatomy [clicks on the diagram]. This is helpful for me. Okay. I don't really see what I'm looking for in terms of the little algae dudes. So, I'm gonna just see if there's anything else. I'm assuming that's just what they look like [clicks on rounded cell photo (see Figure 16)]. They're kind of cute.

Figure 16

Blair's image search results on 'Images' tab (Captured from Blair's screen-recording video)



She described her image searching scene in her interview, saying:

> I think I was just trying to understand what its makeup was. So, it's easier for me to see an image of the different components rather than somebody explaining what those components look like. You know what I mean? Yeah. Cause especially the algae I'm assuming is very, very small. So, I would assume with my prior knowledge on biology and cells that you need some type of actual diagram to show everything.

Her interview demonstrates how searching for images fosters understanding a new concept. Blair anticipated that the visual mode would help her understand this concept.

Participants searched visuals when the written words were deemed insufficient for visualizing and understanding the coral bleaching process and results. Chloe searched for pictures of fluorescent corals described with written words, noting that she could not really imagine. Isa searched ‘coral reef belize’ because she “just wanted a visual to go along with it and to be able to imagine what they (written words from the text) were talking about.” This inclination to image searches showed in various visual searches such as maps, graphs, diagrams, and photos, using diverse unfamiliar concepts (e.g., hard vs soft corals, crown of thorns starfish). Dylan said, “It doesn't matter much to the topic we're trying to look at. And also, I don't want to go too much on the biology track.” Image searching strategies were useful for immediate checks on the looks of those terms.

There were reports of images serving to prompt participants’ prior knowledge. For example, Isa went instantly to the Google images tab after she searched “microscopic algae” and reported that the algae images give “flashbacks to high school biology. (Views 15 algae images).” From the interview, she described:

> The interesting thing for this one was immediately seeing; this took me back to high school biology. So, I could kind of picture, yeah, I could picture looking at. So, I was like, okay, this makes sense because coral, I just kind of think of it as its own thing. So, this was kind of helping me contextualize it as this living creature, not just something that's just sitting there, but I'm like, oh, okay. It has this commonality with, I mean, he'll go on to say it was an animal, which was like, blowing my mind. But I was thinking of it at this point as a plant.

The images helped Isa determine that algae were not a "simple thing," she stated that these are like animals like those she learned about in high school. She activated prior knowledge and contextualization of the concept through image searching. She also searched "New Caledonia Barrier Reef bleaching" on the Image tab and saw similar blue ocean photos. Similarly, the images helped elaborate her understanding. "I know where those places are on a map, so I didn't need a map. Googling that would just probably describe it, which the article was already doing, but I wanted to see a visual. So, they had said they had some of the worst bleaching, but I wanted to picture, well, what does it look like? So, then I saw it down here, and I felt like, oh, okay, that's what I'm looking for. Something to imagine."

Lastly, for readers whose first language is not English, image searching strategy was also a quick use for them to understand words conveniently.

> [Linear reading paragraph] What is coral bleaching? When corals are under stress. Um…. Expel microscopic algae. [Searches: "microscopic" on Google] (reads dictionary definition) So small to be visible only with a microscope. [Goes back to text and Search: "algae"] Oh! (Checks image and goes back to the text)

She quickly searched for those two words and then returned to reading written words. When I asked about the image search on algae, she described,

> I think the letters and the sound and the image, all the things together, will help me remember. I didn't read that. I just watched the picture. And then, because I kind of get what this is, but I wanna see how it looks like. And then, I confirmed that my understanding is correct, but I still don't know how to pronounce it.

Analysis and further description

Seven participants searched on Google and went to the image tab or clicked on images to see what the concept looked like in visual forms. The searches were influenced by participants' prior experiences with searching and knowledge of the possible complementary nature of information found in written words and images. As participants determined that viewing images might be helpful, they did so and then returned to the reading. The image searching strategy was helpful for readers to understand unknown words when the written words were not enough for them to imagine the phenomenon when readers want to know about the concept as quickly as possible, and finally, to contextualize the overall situation by seeing various images in a search result. In addition, image searching was an effective strategy for readers whose first language is not English. From their image searching scenes and interviews, I determined that the 'Image searching to quickly view and understand concepts' strategy was efficient and convenient for the OMR readers to learn unknown or unfamiliar concepts by viewing various images in a short amount of time.

5.4.2. Word searching to understand concept

Definition

Word searching is very commonly used in online hypertext reading. Readers search and then get the results that can contribute to understanding. All participants used the Google search bar or the address section to search different terms or sentences to clarify word meanings or to find further information out of curiosity.

Verbal report example, complemented by interview data

First, participants Google searched words and terms that they were unfamiliar with. For instance, Isa searched using the term “sugar from coral,” which was mentioned in a video but was not explained. Jamie searched using “algae” because it was the “haunting word” for her that bothered her the whole OMR time, and she went back to search it just to make sure she understood the word.

Next, participants also searched for sentences. A typical sentence searching looks like Blair’s:

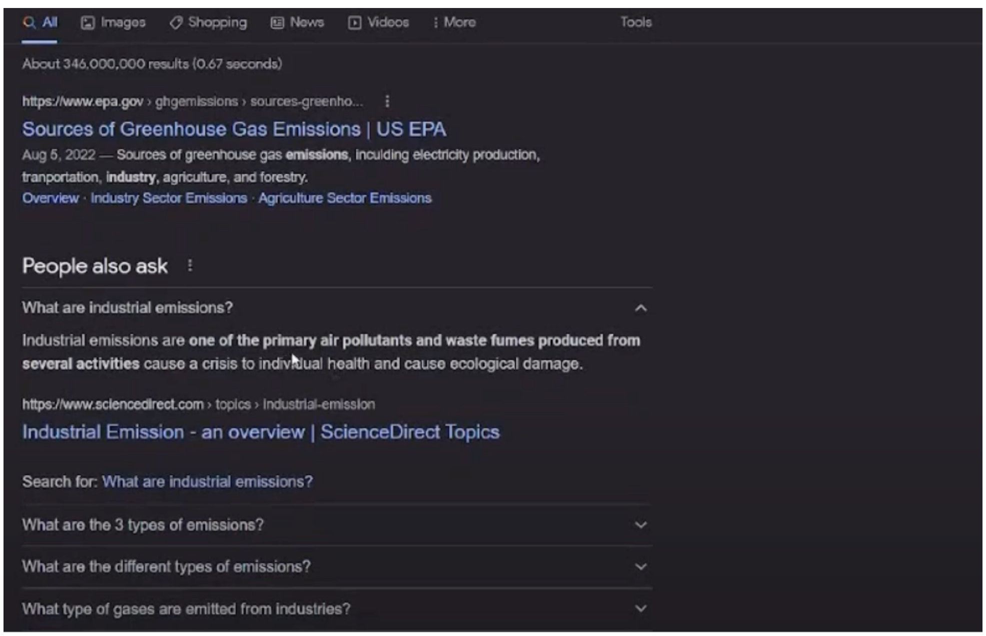
> Okay, so I usually start with the simple portion. So, what is coral bleaching? Just gonna search that. [Google Search: what is coral bleaching] It is the process for corals become white due to various stressors such as change the temperature, lighter nutrients. Okay. So those are the main portions that I am concerned about.

She explained, “I just started off with a simple definition so that way I could understand what it was” from her interview. She did similar words search with another question. “Okay, so why is it problematic? [Search: why is coral bleaching bad] I guess? Let's say for humans [Adds for humans on search term]. Cause people only care about themselves.” She searched for short questions and edited her search term to get more accurate information as a result. Advanced online readers like her and participants from this study seemed to be used to searching words, phrases, and sentences and even editing them to get accurate information.

Third, participants often used the 'People also ask' menu under the word search results to quickly read the brief answers to the search question. For example, Blair typed "industrial types of emission."

Figure 17

Blair's use of the 'People also ask' menus (Captured from Blair's screen-recording video)



Once she found People also ask dropdown menus, she immediately opened them to read answers.

[People also ask: Three types of emissions.] This is getting into things that I think are too complex for me to understand in this period of time. So, I'm just going to avoid it just because I have the topical aspect of transportation, farming, and I'm assuming industrial. Industrial types of emission. So, sources, industrial emissions primary. [People also ask:] Yeah, "one of the primary air pollutants and waste fumes."

She clicked on this menu twice to find quick answers to her curiosity, not necessarily in order. This function was used by Felix too, who opened two questions and reported, "This one. [Opens: "Is coral bleaching caused by overfishing?"] Stress overfishing. Okay. (Reads the titles of the menus) Okay. Didn't know that. [Opens: "Why is fishing threat to reefs"]." Both readers quickly read the questions there, opened the dropdown menus, and got simple and commonly asked questions and answers using this written word mode. Blair explained, "Because usually it just parses it up. If I could get the least amount of information, then I, I'll do it."

Lastly, the participants often used Wikipedia to get information as one form of word search result. Dylan read Wikipedia on the Great barrier reef, Jamie searched "coral," and Emily searched "coral.org Wikipedia" to check the website. Their evaluation of the credibility of Wikipedia was different according to their interview on why they used it. Dylan said, "Since I have last three minutes to kill. So just search it. I then figure out." Emily reported," I did fact-check or checked whether it was really an organization or just any kind of .org." Jamie reported, "I think the scientific keywords, I always use Wikipedia. I think it's authoritative. " Participants' use of Wikipedia and related epistemic beliefs appeared to vary, but those who used Wikipedia valued the information presented.

Analysis and further description

Participants used words, phrases, and sentences to find information in written word mode. Under the words searching strategy, I coded both searching in words, getting results in words, and reading them to learn about the concept or the topic in general. It is one of the most basic and essential OMR strategies. These participants were avid online readers who were used to searching. It seemed seamless for them to use search engines and get results. These readers used various search terms and edited them to get more precise results, used Google's 'People also ask' menus to open and read quick answers in written words format, and they also used Wikipedia as written word results as an information source to learn coral bleaching.

5.4.3. Words searching and connecting with images to understand the text

Definition

Some participants advanced this searching strategy. Their searches yielded information from written words and visual modes, which were combined or synthesized to better understand the text. This strategy was one of the essences of multimodal search result integration. The most frequent form of integration was word searching and connecting with images to understand the text.

Verbal report example, complemented by interview data

Blair got curious about the meaning of 'industrial emission' and searched it.

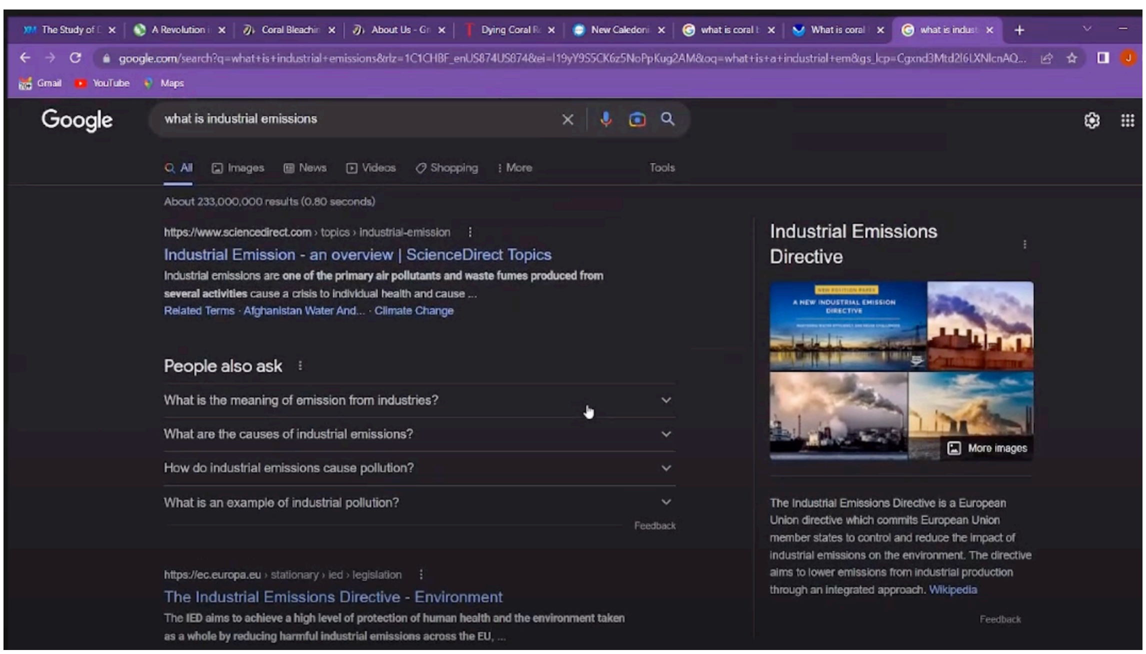
> [Search: What is Industrial emission?] I always go to the side because I like pictures (looks at the right photo) is a, oh nope, that's not on topic cause it's a directive, it's a union. I guess (found wrong info). [People also ask] What is the meaning of mission from industries? Industrial activities from the production of electricity and cement to waste management. (ellipsis) So, creating manufacturing and distributing as well as getting rid

of things.

Blair combined the photo on the right side of the initial search result page and written words answers from people also ask menus. Blair reported, “Looked at that (photos). Cause I always go to the right portion first. Especially cuz it has pictures. If it has an infographic, I just go for that. But this was not relevant cause it was about a company. So, then I went over to the actual portions of dropdowns (people also ask), what's the meaning?” This interview and verbal report demonstrate how fluidly and typically readers combine written words and visuals from search results to learn a concept.

Figure 18

Blair’s search result page (Captured from Blair’s screen-recording video)



Analysis and further description

Participants combined words with visuals from search results to understand concepts or texts more deeply. Since there are various modes shown on the initial search results, the readers may choose to read written words or view images from the result page and combine them. Sometimes this integration does not work depending on the reader's desired modes. Isa searched 'microfragmentation,' found a text, and read paragraphs. However, she did not view the picture in the text because “the pictures didn't help as much. I feel like I was more visualizing in my head. So, I know there's another image or video on the bottom. I think there's a little quick video.“ She had no time left to watch the video, so she could imagine what it looked like based on the written words. This report indicates that readers do not always combine visuals with written words even though they see visuals around the text. Also, time and task management got involved with this decision. They might need the visuals but in other modes, or they prefer just to stick to written words to imagine what the concept looks like.

Summary

Searching is a key strategy for navigating online space. Participants used specific terms to search across modes, including written words and images. Moving beyond the three researcher-provided texts, participants used multimodal strategies to expand their knowledge. Searching strategies also gave participants agency to learn more about specific concepts or phenomena they were more invested.

Readers used search strategies in various modes (e.g., images, graphs, maps, videos, written texts) on the search engines (e.g., Google, YouTube, search tabs) according to the task or the topic. I found three major multimodal searching strategies: image searching, word searching, and combining those two to understand concepts or texts. While image and word searching has been documented in prior research, the multimodal searching strategy of combining written words and visuals was evident as an archetypical multimodal reading strategy to comprehend. Since the result pages yield multimodal options (e.g., menus, visuals, written words), searching is a valuable strategy for the readers to learn and develop in OMR.

5.5 Understanding Meanings of Modes

Understanding meanings of modes refers to the reader's strategic reading to understand multimodal texts from words, images, or videos combined. I found four different categories of strategies under it: (1) multimodal integration, (2) forward inferencing of the mode, (3) understanding the main idea, and (4) updating or clarifying knowledge through modes reading.

Table 21

Understanding Meanings of Modes Strategies

OMR Strategy Name	Definition of the Strategy
Multimodal integration	Reading various modes and integrating two or more modes to comprehend meanings: • Integrating visuals with written words and vice versa • Video and written words integration • Integrating different visual modes to comprehend • Multimodal integration of more than two modes
Forward inferencing of the mode	Inferring what information the reader might get from clicking on a mode or a link before the reader opens it (e.g., from search results lists, from hyperlinks, from menus, before clicking videos)
Summarizing idea(s) of multimodal text	Finding and understanding main ideas as result of using different modes
Updating or clarifying knowledge through modes reading	Clarifying knowledge from the ongoing reading and updating it as the reader reads new information from different modes, like schema development: assimilation, accommodation, equilibration.

5.5.1. Multimodal integration

Definition

Multimodal integration refers to reading various modes and integrating two or more modes to comprehend meanings. Participants used multimodal integration strategies as they read different modes to comprehend the topic or certain words or concepts. It involves all types of modes I provided (written words, visuals, and videos). The readers gathered information from various modes and combined the information to construct meaning. There were four types of multimodal integration found from the participants: (1) integrating visuals with written words and vice versa, (2) video (audiovisual) and written words integration, (3) integrating different visual modes to comprehend, and (4) multimodal integration of more than two modes.

Verbal report example, complemented by interview data

Isa's interview is representative of how a multimodal reader learns, using a multimodal integration strategy.

> I definitely used written words and the visuals because both the 360 pictures helped me, there was some graphics in point but also video. So, I would think all of them were really kind of almost required for me to understand it and to stay focused. So, I think for helping me understand the top one, the videos and the written words, but the visuals really help flesh out the story to keep me engaged, to keep me making personal connections and things like that, which I know for me is super important to my comprehension.

Isa integrated written words, visuals, and videos as she learned about coral bleaching. There are different multimodal combinations for information integration in different modes formats among three modes – written words, visuals, videos – I provided through three OMR texts.

Integrating visuals with written words or vice versa

Readers integrated visuals – photos, infographics, maps – with written words as they make meanings from multimodal texts. It is a commonly used multimodal reading strategy for traditional print reading as well. Here I focused on modes combination of visual and written words, which frequently occurred from participant reports. For example, Amy read paragraphs describing coral colors and matched this new knowledge with the 360 degrees photo below, which showed real corals.

> I just really liked the picture and water and seeing what I'm about to understand what it looks like, what this they're seeing and the scope of how large the coral bleaching is. It's next to areas that weren't bleached too. As far as I could tell. So, I was like, huh, It's interesting. I mean if it's yellow, I guess it's not bleached.

She applied what she read from the paragraph on the photo to see if her knowledge could be matched by the visual. This is a valuable strategy for multimodal readers to use because there are fruitful visuals on the Internet, and online readers can match them with what they read to improve or consolidate their knowledge. From the interview, George described,

> I found my attention going to the pictures first, and then when I saw something interesting in the pictures, I wanted to look at the text to make sense of what was going on in the picture. In the picture, you see an airplane flying over this beautiful island, you're like, oh, what are they doing? And then I have to go to the text and figure out that they're mapping the coral reefs.

From this excerpt, he viewed images first and applied what he saw from the written words to understand what he saw from the visual. It shows that the visual and word integration and their order of reading and viewing can work in either order. Similarly, Blair described her infographic reading, where she integrated images and written descriptions.

> The visuals itself, I would say are more decorative in nature. So, it's more so just a quick scan. Okay. A thermometer matches temperature, runoff matches pollution, and they just represent those things. Like, here I would say I was maybe a little bit confused cause I know that we need to have some type of conceptual overlap between the text and the visual.

As indicated in this interview, it is assumed that online readers have experience integrating visuals and words and that how those two match and complement each other begets comprehension.

Jamie, a bilingual reader, used this strategy to clarify unknown words. From her interview, I clarified that her integration strategy also helped comprehension.

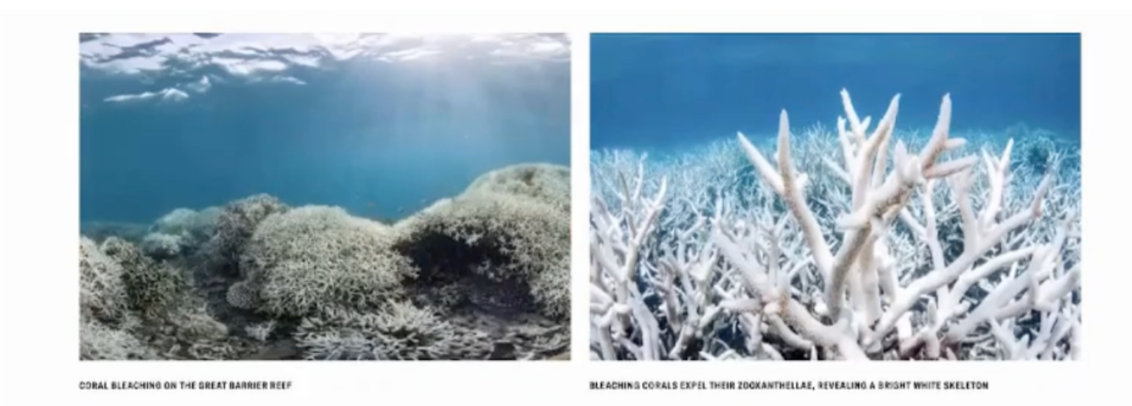
> I combine (images with words), I'm very like a visual person. I want everything visualized. And sometimes maybe because my English is not my native language, if it's a lot of words, I will get lost a bit. If there are pictures, I will feel more comfortable and helpful. But maybe in (foreign language) I still want pictures (laugh). I get bored if I look at the words.

Felix read written paragraphs about what coral bleaching is and reached the two photos of bleached corals at the end. He tried to match what he read to determine how healthy the corals in the photos were. He reported,

> I think I did a fair bit of just reading and rereading and then the image was very helpful. (ellipsis) I just saw the one on the right first because it stood out to me, was like, it's zoomed in most so the white one. So, it just stood out to me more than the left one. And I thought therefore, because it was whiteish that was a bleached one. (ellipsis) So I really had to combine the photo with a text to see that they were both exemplifying coral bleaching, even though I thought the one on the left was the healthy one. And the one on the right was the actual, the discolored one. So that was a surprise to me.

Figure 19

Two coral bleaching images that Felix viewed (Captured from Felix's screen-recording video)



It was interesting to see how Felix uses this integration strategy because he was a primarily written word-focused reader and described himself as not liking the visuals. However, since the topic was related to the colors and the actual underwater environment, readers demand visual information to understand the topic better, he might have been viewing more visuals than he used to. Even when he opened the visual-dominant text from TIME magazine, he skipped the title photo and went right into the paragraphs reading.

> [Opens visual-centered text (Time)] (Skips the title) (scrolls down) Maybe this tells me something. (Goes to the first title & Highlight "South Pacific") South Pacific. (Skims through the 1-2 paragraphs) (Highlights "Great barrier reef") Great Barrier Reef. Okay. That's huge by the way. [Zooms into the map and zooms out]

He focused on the map to find the Great Barrier Reef and applied what he had learned from reading to that point to strengthen his comprehension. When asked why he zoomed in the map, he accounted, "This one (map) was illustrative because, I didn't really know how big the reef was. I think more about it because it wasn't really reflected in the text how big it is. But I think it more for me, helped bring the point of how much is affected by coral bleaching and to the extent how big the area is that it is being threatened."

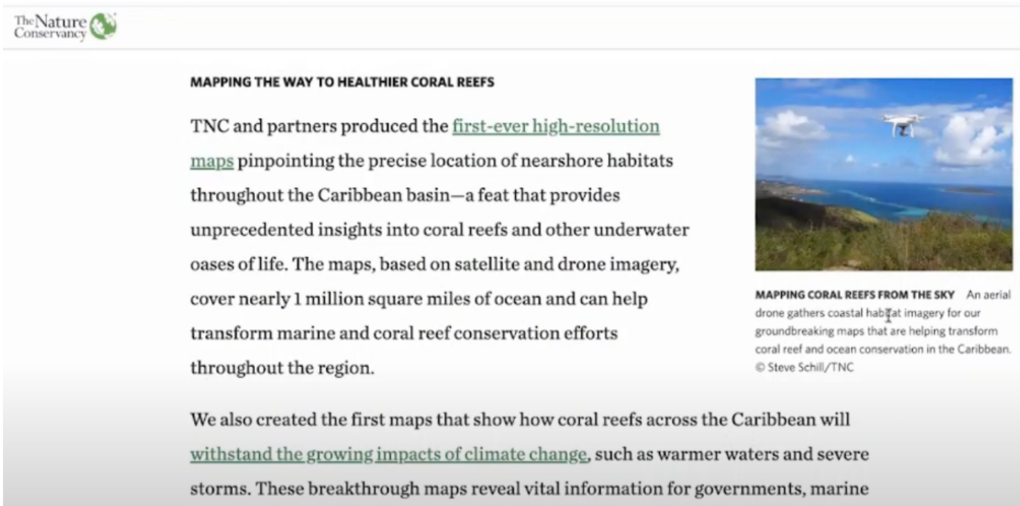
Hannah also combined written words and a photo. Her verbal report demonstrates the process that she sees the image of a drone on the right side first, reads the paragraph on the left, and then understands the reason for mapping with drones by this organization.

> Looking at this picture of a drone, I assume an aerial drone gathers coastal habitat imagery for groundbreaking maps. Um hum. Maps pinpointing the precise location habitats. (SC down and skim) It's a little vague to me on what they actually use these maps for. Oh, prioritizing conservation efforts. Yeah, that makes sense.

She viewed the maps, combined her understanding with the written descriptions around them, and concluded that it helped prioritize the conservation efforts. In summary, the strategy to integrate visual and written words information was one of the key strategies used by advanced readers to comprehend and then elaborate on that understanding during OMR.

Figure 20

Written words and photo integration (Captured from Hannah's screen-recording video)



Videos and written words integration

Since the videos delivered considerable foundational information, readers tended to combine videos and written words to comprehend coral bleaching. From the word-dominant text, there was a video of a researcher describing basic facts of coral bleaching at the beginning of the text. Most participants relied on this video and used it as a knowledge anchor to compare information that they learned from other texts. For example, while Isa was reading coral bleaching FAQs dropdown menus, she went up to view the video again to enhance her knowledge of what causes it. Her verbal report shows this process:

> [Scrolls down to FAQs → Opens] ["What causes coral bleaching?" and reads] (Scrolls up to the first video she watched, finds the scene with what causes coral bleaching and plays it again) Cold temperature… (Stops video and takes notes: heat [climate change] or temp

change, flooding, pollution)

During the interview she stated "The video was meant to just have a different format to share this information as long with some of the graphics that they had to really express the information to. So, as you could see, I was literally rereading that to get the information in my brain pretty strong." This strategy often occurred when video and written words provided the same information. This happens oppositely: reading written words first and watching a video showing that in an audiovisual process, as George did. "I'm really excited to look at this video because I think I'm going to actually get to see the hands-on process of how they introduce baby coral," he said.

Multimodal integration not only occurs when the video and written words have common information. Hannah watched a video about conservation in the Caribbean from the video-dominant text and read paragraphs from other parts. She integrated these two modes and "learned stuff that I (she) didn't learn in the video." The two modes contained different knowledge, and she combined them to expand her knowledge.

Participants also learned from video and written words integration. Felix, a bilingual reader, was helped from videos to learn more accurate meaning of the unfamiliar words.

> I know something about algae, but I didn't know exactly how they use photosynthesis and stuff for that. So it was nice to see some animations for that and to see the process being tied together rather than for instance, I didn't know the word limestone, could have known it. I know it's a word, I know what it means, but I couldn't make it out myself. It was helpful to be offered that information through the videos.

From watching videos, he learned more accurate meanings of words, such as algae or limestone.

Therefore, videos were helpful for learning words when it is combined with related written words.

Integrating different visual modes to comprehend

Multimodal integration for meaning-making occurred not only in two different modes but between two different visual modes. There are many kinds of modes under the umbrella of visuals (e.g., infographics, graphs, photos, illustrations, cartoons), and readers integrate two or more visual modes to deepen their comprehension. For example, Dylan integrated a diagram (4 coral color stages) with a 360 photo to learn the bleaching stages.

> [Scrolls down to the 4 colors diagram] All right. This is helpful (highlights all 4 diagrams) of this image to see which one's bleaching, which is healthy, which is fluorescing, but it doesn't tell me what's a purple one means (scrolls down to see the thumbnail of purple corals 360 photo).

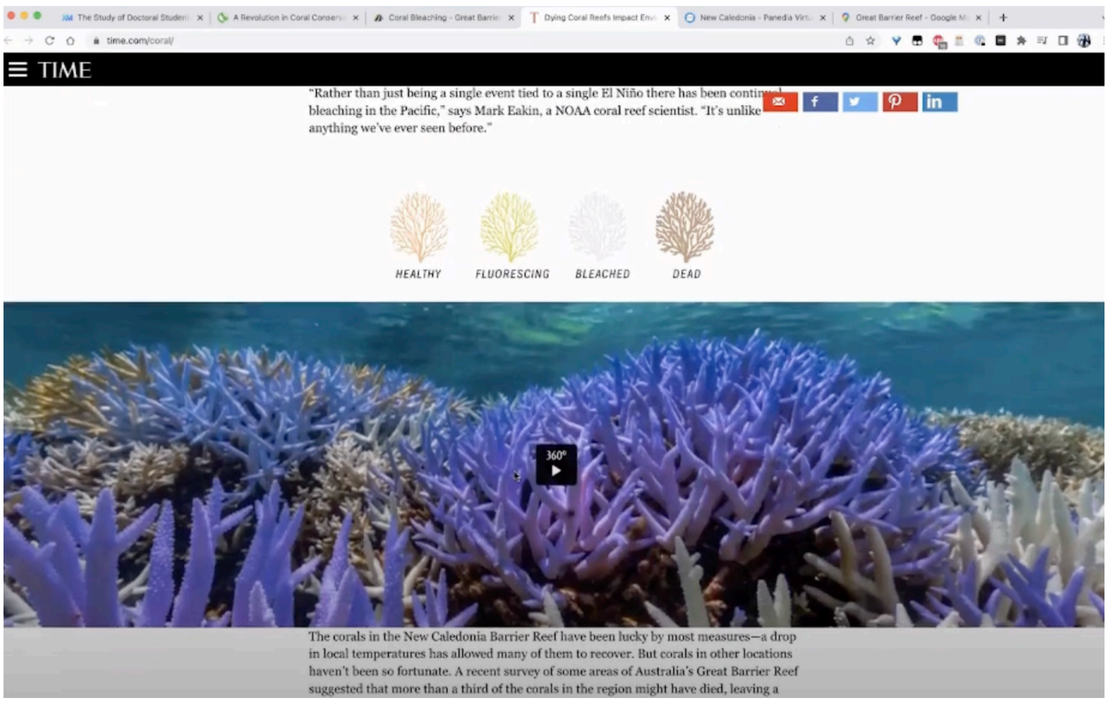
When asked if the diagram helped, he accounted that “It helps me to know what's what I'm looking at on the 360 pictures to figure out which ones bad, which ones good, and which one's bad. Otherwise, I don't have an example to refer to as what is good and what is bad.” He matched colors he had seen from prior visuals and the current diagram, which is an exemplary intertextual reading of visuals (see Figure 21). Hannah and Felix also used this strategy when they were reading the same part and two same visual modes as Dylan’s to compare the diagram with 360 photos to match colors. Hannah reported,

> [Opens 3rd 360 photo under it, drags around] (This time focusing directly on coral colors-stops photo at the purple, white, orange mixed) (Turns off the photo and re-checks the

diagram.) Picture… Healthy (inaudible) [Opens the photo again] healthy… umm (zooms into the white corals, checks two purples and close)

Figure 21

Dylan's visual integration: diagram and photo (Captured from Dylan's screen-recording video)



She accounted, "I was trying to see what I was reading. How does that manifest in the picture? (ellipsis) I can apply what they're telling me directly to an image right away." She sounded determined that she was trying to apply what she read from the paragraph and the diagram of four coral colors onto the photo of real corals and directly see what they were describing. Felix also reported, while being unsure,

[Circles cursor above the diagram: 'fluorescent coral'] Oh, this is what happens. This thing you know.

[Opens the 360 photo and browsing] Don't really tell which are (unclear), or it's just me.

He explained, "I was trying to find out in the video or in that 360. Yeah, what the fluorescing coral was, but I still don't know. I think the purple one is the stuff that is already further starved by lack of algae. I'm not very certain what the fluorescent was and why that was beautiful or important." He seemed unsure of how exactly the diagram colors could be applied to the 360 photos. Still, this strategy integrated two visuals to build and elaborate knowledge.

Multimodal integration of more than two modes

Lastly, readers integrated more than two different modes (e.g., written words, visuals, audiovisuals) to comprehend the concept or the topic. This strategy was the most multimodal in nature since it helps readers integrate diverse modes at the same time to comprehend the text. For instance, Hannah integrated visuals, audio, and written words altogether.

> (Listens to the video narration) [Shows the white, dead corals scene] "But across the Caribbean, once magnificent coral reefs are dying at an alarming rate, living coral cover in the region has." (Stops video at the dead corals scene) So I assume this is, and it was kind of what I imagined when the term coral bleaching was, as the topic, the pictures that I see of these dead corals or these dying corals are them being much less colorful, much more white and gray, as if you were to bleach it.

There was no explanation or narration about what bleaching looked like, but she observed the video with the narration and learned that it looked white and grey. From the next text, she watched a video about basic facts about coral bleaching. She applied what she learned from the video to the paragraph below it. Next, as she reached the two coral photos, she applied the knowledge about coral expelling algae. She integrated the video, written words, and photos to comprehend the bleaching mechanism as a whole. Her verbal report shows these strategic processes.

> [Video 1] So, that's specifically coral bleaching, the other one didn't really talk about that term. [Reads first paragraph] When corals are stressed, I spell microscopic algae, they'll live in their tissues. So, it seems to be describing the process. [Scrolls down to the Facts] Rising ocean temperatures seems to be the primary cause. So again, I don't know how sort of the first …thing I learned about with their efforts (meaning the coral planting) would really combat this. It seems like it would be a problem for all kinds of coral. (Reads next box) A temperature in just one degree Celsius can for four weeks can trigger bleaching. Interesting. [Scroll down to FAQs] So here, FAQs. [Scroll down to the two coral photos after it] Pictures of corals expelling their, what I think is the algae they were talking about, with different, maybe a more specific term.

Since she has already built her knowledge on bleached coral, she could view the white coral photos and state, "I think looking at an image that it already kind of triggers, it's already uncomfortable to see something about it being white that feels wrong. So, I think it has an impact."

Readers also integrated images, written words (captions or descriptions under and around the video), and audio (human voices, background music) from a video. For example, George saw a video, sensed its tone or ambiance, and compared it to other texts. He reported, "I really like the tone of this. A lot more. It's a lot more hopeful. It makes it seem like the difference can be made, or the other articles were a little bit just so dooming" while watching the video. He inferred, "The music was very upbeat, and it kind of signaled to me that, oh, this is gonna be a little bit more of a success story. It was kind of a really jolly tune." He tried to understand the author's intention in this video and why they put music to elicit certain feelings. He accounted,

> When they made that video, it was intentional. They were trying to inspire people either to get involved and volunteer or donate or something. And I think music does. It can definitely set the tone for a video. I think it's just been shown to put people in a good mood or a bad mood. And so, I see them as having chosen that song very strategically.

Hannah also used this strategy to integrate different modes from a video as she was watching the same video as George. She reported,

> I think I tend to look at subtitles in general, so I probably was doing that here too. And I think I've kind of taken both. I sometimes, I don't think this was in this case, but sometimes I can look away just to focus on the audio. But in this case, I think it was easy visuals to look at. It wasn't too distracting. You kind of get a sense of what's going on. And I thought I, I looked up and took in both audio and visual.

She integrated subtitles, visuals, and audio from the video but focused more on written words. Seemingly, the focus was different by the viewers' preferred modes.

Analysis and further description

Four types of multimodal integration were found from the data under multimodal integration strategies. Integrating visuals with written words was used 32 times among the readers. All readers used this strategy more than once. They combined visual modes and written words as they built concept or topic understanding to clarify or get more improved learning.

Video and written word integration was used when readers applied what they had read on the video or vice versa or when they wanted to expand new knowledge from each mode. Integrating different visual modes to comprehend was used when the readers integrated two or more different visual modes to augment or clarify their comprehension. Lastly, multimodal integration of more than two modes was also used, which was the most complex multimodal reading strategy as they combined written words, visuals, and audiovisuals) to comprehend the concept or topic or when observing videos and referencing other modes to best comprehend the video. As a result, multimodal integration strategies helped readers to comprehend the topic or related concepts under the topic more accurately.

5.5.2. Forward inferencing of the mode

Definition

Subjects used forward inferencing of the modes, which means anticipating or predicting what information they might gain before actually clicking on the link (Coiro & Dobler, 2007; Riddell, 2016). The strategy may prove useful strategy with hyperlink text reading because it helps readers reduce the problem space of what sources to access. The readers forward inference what might come as a result and decide whether to click the link. The participants used this strategy for various modes.

Verbal report example, complemented by interview data

Participants used forward inferencing of the video before playing it. Chloe passed the decision to play the video about the Bahamas, anticipating seeing some visuals. She accounted,

I read the subtext first. See what the video is about. If it was relevant and I was hoping to

> see a visual of the actual reef cuz I still, I thought that was gonna help me understand what was going on. And then I think I won. I scrolled through the video to figure out if there was anything relevant.

She expected to see coral before playing the video and skipped some parts of the video to find the coral reef scene. Hannah approached this forward inferencing of the video with the intent to further her knowledge. She watched a video because she felt that she had insufficient knowledge about coral bleaching. Since it is an unfamiliar topic, she expected to see something new, and that led her to play the video.

> I think when I watched this I was thinking, am I going to see a lot of the same information that I saw before? Which I think I kind of did see. Maybe they're different visuals, but I think maybe here I talked about the bleaching, how it looks like. (ellipsis) I think one, this topic already is something I have some idea of what coral looks like. I don't have a ton of experience looking at coral. It's not something we go out and if maybe we're about trees and forests, maybe I wouldn't have watched it so much because I am more familiar with that landscape. And then coral bleaching, I wasn't exactly sure what it was. Looking at the videos gives me an idea of, I think I click them because I know that I'm going to, I expect to see this underwater, this underwater footage that I either haven't seen in a long time or I don't have a lot of experience with.

She clicked on the video to get more information about what coral underwater looks like because she knew she was unfamiliar with it. She wanted this exposure to visuals through videos in hopes of getting underwater footage and landscape to help her build more knowledge about coral bleaching.

Emily used forward inferencing while reading written words. She first saw the visual logo of Nature Conservancy at the top of the text and read the title of the text. She guessed what she might read from these modes and reported, “New hope. That tells me that this is probably going to be a little bit about preventing coral reef bleaching.” She added in her interview that “When I was opening up this website, I think that the title of it, hope, was what I think it said. That to me meant that I was gonna be maybe learning what we can do, cuz that's what that title means to me.” She also used this strategy as she was viewing images, guessing visual information she might get before searching.

> I would love to read a little bit more about them. So, I'm gonna go over to Google search real quick and look up [Searches: crown of thorns starfish]. It's probably really beautiful and cool looking and really bad for corals. Oh yeah. Let's take a quick look at what we can learn about Crown thorns starfish. [Clicks on the Wikipedia] Large starfish. Preys upon. Yep. Preys upon coral.

Analysis and further description

Subjects used forward inferencing of the contents or the mode of information from videos, written words, and visuals. They used forward inferencing of the video to get certain information in expected modes (e.g., visuals, written words) or to get the knowledge they needed from the videos. Therefore, this strategy is used to anticipate information the mode has not only for hyperlinks or written word modes but also for visual or video modes. Anticipating what to expect from clicking links is an essential strategy in online hypertext reading as it is goal-directed in the effort to complete the reading task. In OMR, readers want to strategically choose links depending on the information around the video before they click the play button or written descriptions or context around the hyperlink before they click on the hyperlinked texts. Based on the data, I determined that in OMR, readers strategically click on links with an expectation of the mode and nature of information that can be used to construct meaning. This multimodal forward inference strategy was a unique finding from OMR.

5.5.3. Summarizing ideas of multimodal text

Definition

Summarizing ideas means finding and understanding the OMR overall gist or the most important information. All participants tried to understand and summarize the ideas of each text to some point based on the question to answer: what coral bleaching is, why it is problematic, and how to stop it. They accumulated knowledge to answer those questions after the reading.

Verbal report example, complemented by interview data

From the post-reading interview after OMR, I asked participants to share the main ideas of the three researcher-provided multimodal texts. Four participants shared their main ideas after reading the texts. Here is Dylan's report, who was one of them.

> Overall, it's more like please save coral reef, save the environment. I think Text A is coming from Caribbean side, B is coming from the Australian side, so it's more like geographic difference. But the message they're trying to send is the same. A and B are both written by the organization, so they want money to donate to them. And then the Times one is more slightly neutral.

Emily described main ideas from two texts, and she also found the granularity of the texts.

> I think that the first tab was more, I felt like it was more of a general overview. I guess

they did talk about some partnerships, which I found interesting. And I think the way I navigated the Nature Conservancy (the third tab) one was more from general to specific, which I think is mostly how I read when I'm learning about a topic I don't feel like I'm an expert on. So, it started off with, yeah, I confirm my, it's fishing and tourism that impacts it, coastal flooding. And then, I clicked on links that I thought would give me more granularity, so to speak.

Blair took notes and summarized her thoughts about main ideas of each text on her notes. At the end of OMR, she revised her notes and cleaned the information she jotted down.

> What is coral bleaching? I know what it is. I'm just kinda gonna go through my understanding. So where coral bleaching, I feel like I have enough prior knowledge mow. What is dependent on its different types of wildlife as well as humans. We use it to prevent storms, repercussions, animals use it for safety as well as food. How do we prevent it? Essentially just climate change. We need to drop the temperatures of the sea, which is caused by global warming.

Instead of summarizing each text I offered, she focused on answering the reading task -- answering the question at the end -- and successfully summarized facts about coral bleaching by taking notes.

However, some participants vaguely summarized texts. They might have forgotten or not focused much on each text's main idea because there were many texts they accessed during OMR. Hannah reported,

> I don't know how much I really looked at the second one, but I think I understood that that was more informational. And then the last one was more of the Times one was more

> of a main article piece, or I think I might have said investigative, but it's not necessarily investigative more highlighting this problem and what we know about it.

Unlike other participants, she focused on the tone or genre of each text and described the word dominant text as informational, where she got the most fundamental knowledge from, and the visual dominant text (Time article) as investigative. While she could not exactly state the main ideas, she could understand the tone of each text and what text was informative and investigative helped her decide what text to focus more on. Thus, her strategy is related to understanding the main ideas.

Summarizing OMR texts strategy is used in individual modes as well. Jamie demonstrated how readers summarize the main idea of the video.

> I think he tries to let us see the dead, the reef, and then ask us to protect it. So, I think I got his idea. I think. If I can do something, I will protect them. And then I feel like I don't have the scientific thing, but I can do something from my end to protect the environment and don't put make pollutions in the environment.

Like her, participants tried to understand the main idea of the video. It shows that summarizing ideas strategy can be applied to getting the main ideas from the text set as a whole, individual multimodal text, or a video.

Analysis and further description

Understanding the ideas of the text is one of the fundamental goals of much reading. When the main idea is not explicitly shown in the text, readers must find the main ideas because it is crucial for comprehension (Afflerbach, 1990; van Dijk & Kintsch, 1983). Finding main ideas strategy was found from the literature encompassing traditional reading through online hypertext reading, which also applies to OMR. Printed reading research found that readers use strategies such as explicitly looking for related words, concepts, and ideas in a text and using them to construct a main idea or summary statement (Pressley & Afflerbach, 1995). Those strategies were also found in this study. During OMR, participants summarized parts of the text or the whole text.

> (New tab) Coral, what it is, how it happens, and what we're doing to help. "What is coral bleaching? The corals are under stress. They expel the microscopic algae that live in their tissues. Without these algae coral tissues become transparent, exposing their white skeleton." Ah. So that's the bleaching. Bleached corals are not dead but are more at risk of starvation and disease.
>
> Okay. I like this, because I like the short questions and then very sort of to the point answers. Yeah. Cause I don't think I read in that previous source an exact definition of what coral bleaching was. So had I started with this source, I probably would've read that other one differently because this is really good for building vocabulary and really sort understanding. They really did a good job with visuals here. Because I remembered a lot from this

This summarizing strategy helped them answer the question about the topic at the end. Thus, I determined that readers used summarizing ideas strategy for online multimodal texts as well as they do for printed and written words focused hypertexts.

5.5.4. Updating and clarifying knowledge through modes reading

Definition

This strategy refers to clarifying knowledge the reader had learned from the ongoing reading and updating it as the reader reads new information from different modes. In the assimilation stage, readers tried to solve new knowledge on coral bleaching based on what they already knew. On accommodation, readers updated existing knowledge or decided to stick to the original knowledge to understand coral bleaching more accurately. Some readers reached the equilibrium of knowledge of coral bleaching by being able to explain what coral bleaching is. I mentioned this process from the 'evaluating information by cross-checking modes' strategy, where the readers focused on the evaluation of the information credibility by comparing modes (see 5.2.3). While it uses the same procedure of clarifying knowledge, here I focused on meaning-making and constructing knowledge, not on evaluating the trustworthiness of the information.

Verbal report example, complemented by interview data

George went through these knowledge updating stages as he learned the concept that 'bleaching is not dead' from reading a paragraph.

> [Linear reading first paragraph] So when corals are under stress, okay, they expel the microscopic algae that lives in their tissue. Oh, bleached corals are not dead, but they're more at risk of starvation and disease. Okay, I got that wrong. Earlier I thought bleached coral was dead. I'll watch this video (plays the 2nd video below the paragraph). [Points to the 4 corals diagram] This is really a healthy graphic here. So, I think this helps me understand a little bit better that the bleached coral isn't dead yet but it's getting close. But when it's still bleached, it can go back to good health if steps are taken.

As he read additional multimodal information indicating that bleached corals are not dead yet, he updated his existing misunderstanding to the new, accommodated knowledge. All participants used this knowledge-updating strategy during OMR.

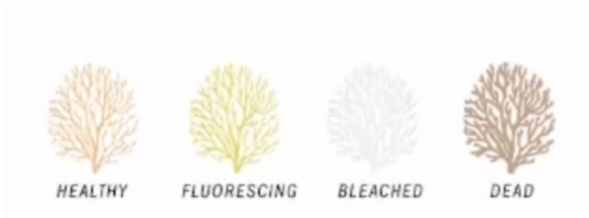
Some aspects of the OMR texts confused participants. Bleaching stages and different coral colors were confusing because two texts (written words dominant one and visual dominant one) associated different colors as the corals die. Jamie was also confused about these colors, so she checked the video (on the right) several times to clarify what was true. Her verbal report and interview show this process of updating and clarifying knowledge.

> [Linear reading next para under the map] “vibrant rainbow colors of thriving coral”…Hmm. I thought they (the video from the first text) said healthy color looks brownie and green. And when they are bleached, they turn transparent. (Jamie’s verbal report)
>
> But that's the point that I was confused about the color (laugh). And they said brown is dead and then I feel like no healthy is brown and green, so I go back to the first one. (ellipsis) I'm confused. I thought this (dead coral) is healthy because it's brown and green. I thought it's healthy, but it's a most beautiful death. So, it's contradictory from what I know. (Jamie’s interview)

She reached a conclusion by integrating the image and video to construct her version of coral color stages. “I wrote down this. So coral, if it's healthy, brownie and green. And when they die, going through bleaching, it becomes transparent and white. But coral reef, when they are healthy, they are colorful. And then when they die, they're brown. That's my conclusion.” Hannah also reported confusion. Her prior knowledge before reading is updated with new information from the video (Table 22, right) and once again updated by the diagram (Table 22, left) to make her own conclusion.

Table 22

Conflicting multimodal information from two texts delivering conflicting information

A diagram from tab2 (visuals dominant text)	A video from tab1 (written words dominant text)
	
Brown color means the coral is dead	Brown and green colors mean the coral is healthy

Oh yeah, and he was talking about the colors of it, and later I think it was a little confusing. I think he was trying to say that from what I got from that video that the plants on here, healthy plants on the coral would make it look brown and green and those colors and more of, or the ones that are unhealthy. And the ones that might be going through this bleaching process are more the light lighter colors and the light pinks, which made me think about what I think coral looks like, which is more of that light pink. And perhaps I'm, the visions I have of it are more the damaged ones. But then in here, there was a picture of what coral, like an infographic of the color coral should be or, and the healthy one was this kind of pink color. So that made me question then what I thought I had learned from before.

Her verbal protocol demonstrates this knowledge updating process:

> I guess he's talking about, and this being a brown color, I would assume that would be with plants, but perhaps trying to emphasize that coral isn't necessarily the color kind of pink that we would think about. [Video] “The coral will then start to look eventually either white or it can look a brilliant shade of yellow or pink or blue or purple…” (ellipsis) So, it seems like perhaps even that kind of pinkish, palish pink that we think about with coral is actually coral that might be already going through this process.

She learned from the video that pink corals might not be healthy -- contrary to her understanding prior to reading. But as she goes to the next tab and sees the four coral colors diagram, she updates her knowledge once again, saying, “So this one was the one where I was like this, he kind of talked about coral being more this brown color, and he was talking about the plants on it, which might be the difference, but I would assume coral is full of plants. So, they could be talking about two different things. But he was kind of saying that these lighter colors are more the damaged ones and this brown and green are the healthier ones. And so here, this kind of challenges what I thought I understood from him.”

> [Sees the coral colors diagram] they describe what happens with the plant, with plants and in the coral that are expelling the algae. And here their picture of healthy is actually a little bit more the coral that I would've assumed. So perhaps not really my understanding of from the last video might not really be true of what kind of healthy coral color is.

She reaches another conclusion that her original thought of healthy coral might be right based on the healthy orange coral color on the diagram. Isa, who went through the same confusion and conclusion process, reported from the interview how she got to the equilibrium stage.

So that's the one which is opposite ends of the spectrum (laugh). But those are the two where I'm like, wait, but every time I saw it was dark brown, I presumed that was dead. So, some were a little iffy cuz they were orange. I'm like maybe that's actually still healthy. But I imagined if they got to, I was trying to make my own conclusions by some that I read. So, I was like, okay, well if they're showing so much is fluorescent, so much is bleed, so much is dead, is it likely that much of it is still healthy? Probably not. And I was kind of going through all of that, my own little exercise, as I was reading.

Updating and clarifying knowledge constructed from written words reading was another strategy the reader used. Jamie initially was confused about the topic itself because she thought coral meant coal. She searched for the picture of the coral and realized it was sea plants, not coal mine.

So, the first one, after I saw that picture on the website, I immediately knew that I misunderstood the word before reading. So, I know it's not coal, it's coral. And bleaching, I kind of get it. It's, but not that clear. So, I only know that I misunderstood that one. By seeing this one (picture) Picture, Yeah, I know it's not coal.

Updating and clarifying knowledge is an ongoing process during OMR, where readers used various modes in doing so. This strategy helped readers update their understanding of the concept or the topic. This procedure of knowledge clarification was one of the most active strategic learning from OMR.

Analysis and further description

Participants brought different levels of knowledge and conceptions of coral bleaching. As they read multimodal texts, they might find information that conflicts with their existing knowledge. They used additional modes in OMR (e.g., visuals, videos, written words) to refine and clarify their knowledge. This knowledge-updating procedure is based on constructivism, a theory of comprehension and learning. It argues that knowledge building is an active process of the learner and not passive knowledge absorption (Kintsch, 2008). Also, it is related to readers' metacognitive thinking of acknowledging misconceptions or finding knowledge gaps and trying to revise them. For example, metacognition OMR strategy, such as creating a problem space to construct meaning (see 5.1.1), can be used along with updating knowledge strategy because, through metacognition, the readers can find a place in their comprehension to fill in with the new knowledge from the texts. Seven participants showed that readers updated and clarified their knowledge about coral bleaching using this strategy, and if there were any misconceptions or confusions of words or terms, readers updated the knowledge to help accomplish the reading task.

Summary

Participants understood meanings from multimodal texts with these strategies: multimodal integration, forward inferencing of the mode, summarizing ideas from multimodal texts, and updating and clarifying knowledge through modes. For multimodal integration, participants integrated visuals with written words, videos and written words, various visuals, and/or more than two modes to construct understanding to clarify information. For forward inferencing strategies, participants anticipate knowledge or certain modes of information they can get from videos, written words, and visuals. For summarizing ideas, participants remembered and summarized the ideas of the multimodal text. They also summarized part of the text or a mode as they understood the topic. Lastly, for updating knowledge through modes strategy, subjects consulted modes (e.g., visuals, videos, written words) to gain and consolidate knowledge. They actively constructed their knowledge about the topic using various modes, and they updated the knowledge if there was something confusing during OMR.

Existing research on OMR describes strategies that include integrating modes to make coherent meanings, making intertextual connections, understanding context, and understanding concepts. The verbal report and interview data revealed that readers used variations of these strategies under the umbrella of multimodal meaning-making. Based on these strategies, I described more specific OMR strategies focused on readers' understanding of the texts using written words, visuals, and videos. Cho (2014) found three meaning-making strategies for online hypertext reading, which overlaps strategies from this study: making sense of hyperlinks, comprehending webpage content, and building linkages across multiple texts. He accounted that reading on the Internet demands the integration of information into a metarepresentation of meaning which can be interpreted as the overarching meaning of multimodal texts or modes that the subjects found during OMR. In summary, the data from this study extended the existing meaning-making strategies to the OMR meaning-making for topic comprehension.

5.6 Prior Knowledge Use to Understand Multimodal Texts

All participants reported checking on and using prior knowledge. There were two types of prior knowledge that these readers activated: (1) prior knowledge (e.g., what they have learned from somewhere, knowledge from the ongoing reading, knowledge based on personal experience) related to the topic, and their (2) prior knowledge about OMR, multimodal reading, or reading on the Internet in general.

Table 23

Prior Knowledge Use to Understand Multimodal Texts Strategies

OMR Strategy Name	Definition of the Strategy
Activating and applying prior knowledge about the topic	Activating prior knowledge about the topic automatically or purposefully while reading modes or a multimodal text to understand the text better (e.g., declarative, factual knowledge about coral bleaching) or personal experiences or feelings regarding the situations from the text. (e.g., I had a trip last summer and we saw corals during scuba diving)
Activating and connecting to prior knowledge about OMR or online reading	Activating prior knowledge of online multimodal reading automatically or purposefully while reading the text to understand multimodal texts better and to read the text more strategically (e.g., I focus on visuals when I search for words, search terms should be concise)

Prior knowledge can be automatically or purposefully activated during OMR. Once the reader's prior knowledge gets activated, it becomes the resource that she can apply to understand the text more deeply by connecting prior knowledge or experience to the ongoing reading portion. Therefore, whether it is activated automatically or not, the use of the strategy to comprehend text was what I coded as prior knowledge use strategies as long as I could see the reader applying it to comprehend the text. I also asked each participant at the end of the interview about what prior knowledge or experiences might have impacted their reading. All participants answered that prior knowledge influenced their reading, and these prior knowledge reports were coded into those three strategies categories. For example, Emily reported her prior knowledge use, which overarched all subjects.

> I'm a big prior knowledge person. Then my next question is usually what do I need to know? What am I looking for? If I happen to see some other things, great, that's awesome. But I wanna find out what I need to know first. And then, if time permits, I'll go down a rabbit hole and look at something for fun. But I like to be focused on. And I

use skimming and scanning. I mean those are my two big. I skim and scan a lot, and then I'll stop and reread something if I feel like I didn't quite get it all, or if I feel like, well, my takeaway from that, I'm not sure it's accurate. I need to look at a couple of details. I use that as I use deeper reading as a way to check, my skimming and scanning.

Here she described herself as a prior knowledge person, which indicates that she is aware of the possible existence and usefulness of prior knowledge related to the topic of OMR, in this case, coral bleaching. She also demonstrates prior knowledge related to the act of OMR by describing the procedure of goal setting, skimming, scanning, and rereading strategies. Similarly, other participants showed different prior knowledge that they brought to OMR to understand coral bleaching.

5.6.1. Activating and applying prior knowledge about the topic

Definition

This strategy refers to searching for and using prior knowledge about the topic. Of note is that if the knowledge is activated automatically, it is not a strategy. Readers used activated prior knowledge while reading modes or a multimodal text and applied this knowledge (e.g., declarative, factual knowledge about coral bleaching) to understand the text, which counts as a strategy. Participants also had prior knowledge of their personal experiences and applied them to topic comprehension. Most were related to ocean and water activities, swimming, and seeing corals. Various modes, especially visual modes and videos showing the beach and underwater, seemed to activate readers' memories. These are knowledge of experiences or feelings regarding the situations from the text.

Verbal report example, complemented by interview data

Using prior knowledge related to the topic

Blair used prior knowledge of factual knowledge she learned from a scientific documentary. She reported a range of prior knowledge regarding biomes, climate change and pollution. Using this prior knowledge helped her better understand the bleaching phenomenon.

> Okay, so what causes coral bleaching? That's my next question [Linear reading right side description on the infographic] Increased ocean temperatures caused by climate change is leading cause. A runoff in pollution, storm generated precipitation can rapidly delete water. These bleach near-shore corals. I know a little bit more about that just cause the documentaries I watch where there's a lot of stuff that overlaps with sewage as well with toxins and medications that are going through our sewage that could affect it.

Emily also used prior knowledge of scientific terms, as reported during her reading.

> [The solution] Right, Improve water quality, land runoff. Again, Eastern shore of Maryland has had a big issue with that. That had to do I think a lot with impacting oyster populations, so that's always interesting to me. (Connecting with prior knowledge) (Reads the box to the right pointing out the main ideas) Reducing emissions, restoration, promoting recovery. Venomous. Oh, I think I've read about this because if you use scuba dive or snorkel in Australia and you happen to step on one, it's a really big problem. I think I saw this in a documentary. Australia seems to have a lot of things that can hurt you.

Emily's verbal report indicates a wide range of prior knowledge, including facts about oyster populations in Maryland and venomous underwater animals. She also used prior knowledge as she was comprehending paragraphs about the cause of coral bleaching.

> [Linear reading 1st paragraph to the end] Uh… Let's see. Coral cover declined by 60%. That doesn't sound good. Threatened by warmer waters. I assumed that. Harsher storms, I hadn't thought about that one, and I am aware by watching the news that a lot of this is really becoming a problem. (ellipsis) I'm actually really interested in that. Mostly because I am from the eastern shore of Maryland and I know that oyster recovery there has been a big issue for years.

For Emily, the use of prior knowledge was accompanied by metacognitive routines that helped her keep track of known and new information. Her prior knowledge also appeared as a motivation factor, provoking her interest in the topic.

George stated that prior knowledge helped him comprehend texts. “Number of factors can irritate corals. I felt like this corroborated what I already knew that climate change and the water temperature becoming warmer is the primary factor of coral bleaching. But that there were other factors, pollutants that can cause it too.” He used prior knowledge to match the ongoing reading and to solidify his knowledge, but still added some new content to expand his learning.

Readers also used “new” prior knowledge they accumulated from the ongoing reading. For example, they remembered what they had just read from prior text, video, or paragraph and applied this knowledge to ongoing comprehension of the mode at hand. Isa accounted, “I found that once I had watched that video, that was kind of on tab A was my basis for everything else that I was reading. I kept going back to what I had learned there, what I had written down from there. So even though it was very recent background knowledge, that really helped me engage with the other tabs.”

Using academic background knowledge to understand the topic

Participants' majors and academic backgrounds also encouraged them to connect to their prior knowledge with regard to certain topics. For example, when Isa read about how the tourism industry suffered, she described, "I was very interested in that knowing, I think it's because I come in with a social justice critique thing, so I was already knowing that how detrimental it is for the Caribbean islands to really rely on tourism at the same time." She applied her knowledge of social justice to comprehend this issue. Jamie also recalled her architecture major on understanding a temperature map. "Because I used to learn landscape architecture. So, I draw that picture to show the altitude. Oh. So, it just looks like that. So, I think the more red area means the temperature is high. The blue is low temperature."

Using prior experience related to the topic

Isa activated her experience of going snorkeling and having seen bleached corals. She said,

> I had the experience of going snorkeling and having seen bleached in dead, coral reef. So that kind of immediately got my interest and got my attention and I was able to visualize and understand what they were talking about even though I had no idea what was specifically causing it.

Her experience of snorkeling helped her understand the topic more personally. Her experiences and feelings from that trip was activated as she read texts and she applied this knowledge to her understanding of underwater corals. Jamie used similar experience to understand coral bleaching.

> I love scuba and I have a certificate in foreign country. I went to the sea and at first, we test it in the pool and the final test is in the sea. (ellipsis) [Q: What corals look like?] Not

as beautiful as this. And the water is not clean. So, it's a lot of a mixed vision. So, I cannot see clearly what the reef looks like. So, I think they did a better job or their plants are more beautiful than us.

It seemed that if the reader has similar prior experience, it can be more helpful for the readers to understand the topic. George accounted, “I felt like it could help me understand coral bleaching without having to read the passage a little bit more quickly.” Readers construct knowledge by relating modes (e.g., picture, table, diagram, video, audio) with prior knowledge, either from the existing texts or other previous ones” (Hamdan, 2017). As situation model construction is fundamental to OMR, using prior knowledge strategy underlies any process of OMR. Readers recall and use their experience to understand the information presented from the modes (Hovious et al., 2020; Park et al., 2020).

Living in a similar area and having a family background in the region helped the reader to activate related experiences and apply them to have a deeper understanding of coral bleaching. George had a family history of living in Florida, fishing, ocean, and scuba diving.

> I go swimming and see the fish and the ocean and my dad, my grandpa was actually born in The Bahamas, which is where this is too. That was really interesting. My dad is from Miami. (ellipsis) But so I feel like my family has connections to this geographic area. (ellipsis) I think I care about this more because of where I grew up and my connection to the region in Florida and the Caribbean, not that I have a personal stake in it, but because I had admired, the natural beauty of the Caribbean for so long, and the Gulf of Mexico, which is where I grew up, that I cared more about it because there's a personal connection.

He had this geographical familiarity with his family around the Bahamas, which made him feel of personal connection and interest in this topic. This background, combined with his experience of scuba diving and seeing corals.

> It's glass type (corals), very dangerous. I never really read about it in detail, though. Yeah. I've never gone in-depth and read an article about bleaching. I think I've just been told about it, or I've heard something about it on the radio. But whatever I've heard about coral bleaching, I didn't really seek out on my own. Yeah. I think I just learned it kind of anecdotally.

About the coral colors, he had an experience of seeing their colors under the water. He showed me a photo of the corals that he actually took from the family trip and recalled that the colors were not as bright as the picture he had seen, but he could tell it is healthy.

> (Searching for photos on the phone) Let's see if I can find a diving picture. So, oh, that's actually my younger brother. Oh, whoa. And my mom. Oh gosh. But this is what it looks like. Oh, so it's not really as colorful. But you can tell that it's healthy. If you weren't seeing it through blue, it would look more wow like that.

Participants used their personal experiences in understanding the video as well. Jamie left an interesting report about how the online reader perceives prior knowledge while reading.

> I think those background knowledge was already embedded in my mind. But when I watched this video, it connected back to my previous living experience in foreign city. used to live in the province, which is similar to that. The trees and the environment are

> very similar. So, I kind of think about the lives back there and then watch the video to see how they protect the reef.

Embedded knowledge gets connected during OMR, and this procedure keeps occurring several times whenever the readers face some modes that provoke their memory. Isa also described that her prior experience makes her feel connected to or relate better to the texts.

> I haven't been scuba but snorkeling, yes I did. And I feel like they were actually in the dead portion. Cause they weren't white but they were just very bland. And they were telling us this was in Fiji, so South Pacific, which is what one of the areas they're talking about, they were saying how you can't see as much, which now we know is the second layer anyways, they're telling us that a lot of it was very brown at that point. And some of it had been kind of died off. And then I went once in Key West in 2020 and I had this similar experience. It wasn't a lot of bright, and colorful, so I was able to pull those. At least though having those visuals and having those experiences gave me more sense or otherwise I will have no connection to coral whatsoever. So that was helpful to imagine that, to picture that. And same thing with, they were talking a lot about Australia and the South Pacific. And again, since I had been to Fiji, that's the only time I've been on that side of the world. So, I was able to feel a little more connected to it or relate better to the materials too.

Since she had this experience of scuba diving and seeing bleached corals that the texts also described (e.g., brown or bright colors), she could activate this experience and apply it to comprehend the topic more elaborately. She felt more connected to the topic, and this knowledge activation might have helped her feel more comfortable learning about coral bleaching from

OMR.

Using prior knowledge influences readers' motivation and interest

When I asked Emily about her prior knowledge use, she accounted, "I see prior knowledge confirmed, it builds my confidence. And I know as a teacher, I mean I think that's a reason why we used prior knowledge a lot is to build confidence in reading. So, when I first saw on that first paragraph when I saw that warming ocean was, and that makes me feel good and it makes me think I'll probably be right on a couple more things. (ellipsis) because of that confidence boost, that you have that feeling a little bit of a feeling. I kind of know what we're talking about here. So that means I'm ready to learn more." Here, prior knowledge serves not only to support comprehension strategies and knowledge gain but also the reader's self-esteem and self-efficacy.

In addition to boosting confidence, prior knowledge also helped Felix become more interested in understanding coral bleaching and climate change issues altogether. He reported, "I think that once I knew or had some confirmation for the temperature of the water and the climate change and the fish disappearing because of, for instance, reduction in algae or overfishing. I saw more of the relation between those things. (ellipsis) So that was interesting just because it kind of came together with coral and climate change, how clearly they are related. So I think that was interesting. That stands out to me."

Isa used prior knowledge from her high school biology classes because the topic was related to biology. "I mentioned some of the images brought forth biology classes, so when they were using terms about algae and larva and different things, I was like, oh, microscope. I was like, okay, I can kind of visualize what this might be." She was able to predict some terms as she was reading. She reported, "…even beforehand when I was predicting I was, was probably climate change. We know that probably pollution, I think climate change was what I referenced specifically. So, I think just having that knowledge of how that, I know that we are choices is causing it." Therefore, prior knowledge helps readers anticipate some information before they go onto OMR.

Analysis and further description

Strategic prior knowledge use supported readers in understanding multimodal texts and the topic. Readers used metacognition to access and account for prior knowledge on coral bleaching. They brought declarative prior knowledge from their memory of news, books, documentaries, academic majors, or even what they learned from school. Their prior experiences also worked as prior knowledge that helped them comprehend the text. The readers applied their experiences to understanding the part they were reading or the topic, coral bleaching as a whole. Readers applied this activated knowledge to their ongoing text reading to understand the multimodal text and the topic to accomplish the reading task. Prior knowledge also helped motivate readers as they made connections between the current task and prior experiences and interests. Readers used the prior knowledge they have learned from the ongoing reading, such as a prior paragraph or a video just saw, to apply it to comprehension of the further OMR. Images, videos, or written words all contributed to their prior knowledge recalls and activated prior experiences, supporting their learning in a more fruitful way in return. Prior knowledge was already embedded in the reader's mind, and it gets connected automatically during OMR. This connection occurs whenever the reader sees some modes that provoke their memory. Once the reader has related knowledge that was activated, they apply it and feel more interested, understanding, and comfortable learning from multimodal texts.

5.6.2. Activating and connecting to prior knowledge about OMR or online reading

Definition

This strategy refers to purposefully activating prior knowledge or using automatically activated prior knowledge of online multimodal reading during OMR to understand multimodal texts better and to read the text more strategically. Participants had some knowledge specifically related to online multimodal reading, online reading, or multimodal reading. This knowledge comes from their prior experiences using computers, laptops, tablets, or smartphones to find information and read multimodal forms of online texts. Since these participants are all doctoral students who must be fluent in using the Internet and reading online for their research, I assumed they would bring some knowledge of it. It turned out that they brought various types of knowledge to the task, which helped them comprehend the topic better. For example, one participant's prior knowledge about climate change helped him understand the factors that can irritate corals. He said, "I felt like this corroborated what I already knew," while he applied this knowledge to comprehend that warmer water temperature and pollutants are factors of coral bleaching. There were four types of prior knowledge specifically related to OMR: online text evaluation, multimodal reading, Internet searching, and mode preference strategies.

Verbal report example, complemented by interview data

Online text evaluation strategy

Amy and Dylan reported that they learned how to evaluate online texts from the courses they took. Dylan said, "I would say to go back and forth on stuff and then especially keyword searching between multiple tabs or multiple sources to try to figure out if it's credible. If it's reliable." Amy also replied,

> Cause it's not always reliable. That is so that's also true. So yeah, I don't know. It's hard. I've been questioning things now that she (the professor) said that…I don't know. I think it's reliable. It looks reliable. It's like, who's it written by? When is it written? What's the website? What's their agenda?

Amy actively applied the questions learned from the coursework on digital reading and fact-checking and used them to determine the credibility of the text. These excerpts show that advanced readers used OMR strategies to navigate and learn from the Internet.

Knowledge of multimodal reading

Amy used her knowledge of multimodal reading coming from her reading experiences.

> I don't just like large paragraphs. So, I think it's helpful not only for me as a reader, but when organizing things. It has a little break or if you're directing me to something, then I can see what you're referring to. So, I guess sometimes matching pictures with the words or just if I read a paragraph, taking a break or taking a note or going to something else. So, I don't know what mode I use…probably just probably the reading and then looking together with some pictures.

She reported that she has prior knowledge of OMR related to using visuals to complement reading written words and matching visuals with words as she does OMR. Blair also reported her knowledge of the order of modes reading. "I usually started with the visual cuz I, it's just easier to understand it, especially for infographics and stuff. But if I didn't get what I needed from the visual, then I moved on to the text." She is also strategic in OMR and based on prior OMR experiences, understands that visuals can complement text.

Prior knowledge on Internet searching

Blair was strategic in writing and updating her search terms. She reported, "Let me just look up [Search: major influencers of global warming.] No, no [Search: major types of human emissions.] More specific. I don't know how to spell (clicks on the emissions right spelling)." Her prior knowledge of Google searching is a good example of fluency with the Internet to search and find pertinent information. She knows image searching and when to do it. She reported, "I do image searches in Google, depending on the phrases that I'm looking up very often. Throughout life, whether I'm reading or just listening to something." Isa was also aware of her searching knowledge. She described, "I would say maybe generation and age because of how much I Google things. So, I always think about that in daily life is that I got a computer when I was 11 or 12, so I've always grown up now going if I'm interested in something, I have Google on my fingertips to look it up. So that was a big one." Based on this background of being familiar with everyday online reading and searching, she had confidence that she could search for information using Google, and she did frequent searching during this task too.

Prior knowledge on mode preferences

Some readers have mode preferences (e.g., visual, written words, videos), and this self-awareness was shared in verbal reports and interviews. They seemed to have experiences where they felt they liked a type of mode, and it helped them understand. For example, the words-focused reader Felix reported, “Even though the visuals really speak to me, I just completely ignore them as a reference in a text. So, when it says Figure one, and I read, I won't actually look at figure one until it passes me. It doesn't even arise in my cognition that I should go to figure one when it's referred to in the text. I just wait until I see it.” When I asked him what made him view videos and visuals from this task, he accounted, “Just because I see them. Okay. So, for me, mostly that's why I was, I was triggered by the right one. (ellipsis) Hey, this looks like something that's interesting. So, they can be distracting to me too.” He preferred written words and considered visuals as distractions. However, half of the participants said they prefer visual modes, and some of them even described themselves as visual learners. George, who focused on visuals during reading reported,

> I think sometimes I think reading is a form of visual learning. (ellipsis) Figures, diagrams, maps, are more helpful to me when trying to make sense of an accompanying body of text because the figures are like to the point when you draw a map, or you draw a chart, you're only including the relevant information as it relates to whatever's written next to it. But when you include a picture, there are all these little details, people in the background, the colors, and even though the picture might be helpful, it can sometimes be distracting.

He thinks that visuals help him learn better than written words. He also is able to distinguish figures, diagrams, maps versus pictures and their attributes in meaning delivery. Similarly, Jamie described her strategies regarding the audiovisual mode.

> I like to turn on the captions, if it's an information-loaded video. But for other stuff, I don't turn on captions. But they have a lot of academic words and scientific words that I

> don't know. So, I really hope that they have captions. And then I always adjust the speed sometimes. (ellipsis) If after that I think I don't need to go back, I just leave it there.

She is familiar with video-watching strategies, such as when to use subtitles, adjusting video speeds, stopping the video, and revisiting it as needed. In summary, participants had different OMR knowledge, such as what mode they prefer, when they use certain modes, and OMR strategies they use.

Analysis and further description

There were four types of prior knowledge on OMR: online text evaluation strategy, multimodal reading, Internet searching, and mode preferences. Readers reported the evaluation strategies that they learned from the courses. They also had prior knowledge of multimodal reading and multimodal integration patterns. They also activated knowledge about searching on Google and image search and how to edit search terms. They have different OMR knowledge, such as what mode they prefer, when they use certain modes, and what OMR strategies they use. This knowledge of online reading and OMR comes from their accumulated experience in learning from the Internet. These participants activated this knowledge as their strategies to learn from OMR. The strategies of OMR indicate that it facilitates a certain level of efficiency as readers read online. Readers who lack this prior knowledge might have to put effort into both navigating and using OMR and constructing meaning.

Summary

Participants used two types of prior knowledge activation strategies that they applied to the topic learning: (1) prior knowledge about the topic and (2) prior knowledge about OMR or online reading. The first type of prior knowledge is factual, declarative knowledge about the topic that helps readers understand the topic. Next, prior knowledge of personal experiences means the knowledge derived from the reader's experience that is related to the topic. Lastly, prior knowledge about OMR or online reading means the knowledge each reader has about their reading habits, mode preferences, and OMR strategies that they bring to current OMR. This prior knowledge was activated and applied to the readers' ongoing reading, and when it was activated, the readers strategically applied it to understand the text better.

This study found similar OMR strategies to existing studies for prior knowledge use strategies. Existing literature described readers' prior knowledge use, such as prior knowledge about the topic and prior knowledge of multimodal reading. This study added prior knowledge about personal experiences to this body of research, as well as found how multimodal text readers utilize prior knowledge during OMR.

All participants used this strategy during OMR as they were viewing or reading modes that activated prior knowledge. Multimodal reading tends to provoke people to connect their prior knowledge with visual, audio, and linguistic stimulus from the text. For instance, some participants activated their prior knowledge based on their academic majors, such as policy-related knowledge from their academic majors (education/policy/teaching majors), which was factual knowledge that supported their comprehension as they were reading government projects or social influences. Next, the 360 photos of the underwater corals made the readers recall their scuba diving experiences, family trips, how corals felt on their skin, whether there should be more fish, whether they should wear longer sleeves, and so on. Lastly, participants had fruitful knowledge of their laptop use and OMR reading. They already had their own OMR style (e.g., I stick to words and skip images, I thought I was a word reader, but it turns out that I'm more visual than I thought, I like numbers, I watch videos and connect it to words). In summary, strategies for using prior knowledge were important in that modes and information in them make readers activate prior knowledge, and readers purposefully use this knowledge to comprehension of the text during OMR. Applying prior knowledge was effective for participants' topic learning and task accomplishment by helping them connect to their knowledge about facts, experiences, and OMR.

5.7 Intertextual linking through multimodal texts

Participants made intertextual links through modes, texts distributed in a multimodal text, or among different tabs containing texts. Intertextuality refers to the potentially complex ways meanings are constructed through relationships to other texts, discourses, genres, and modes of meaning (New London Group, 1996). It may occur in any text reading since readers bring various references from different modes of information they have read. However, this study focused on the text they were reading, including three researcher-provided texts on three tabs. Subjects performed scrolling, clicking on links, and tab switching to compare or clarify their comprehension. The readers attempted to determine the right information and reached their own conclusion, whether right or wrong and reported that through verbal protocols and interviews. They also used intertextual linking strategies to reinforce knowledge. They switched modes and texts to make their understanding stronger when they found overlapping information.

Table 24

Intertextual linking strategies through multimodal texts

OMR Strategy Name	Definition of the Strategy
Making intertextual connections from different texts	Finding similar or related information from different parts or from different texts and making mental links to connect the information to comprehend the topic
Anchoring certain modes as main information source	Using certain modes or text as a knowledge base due to its rich information or credibility (e.g., coming back to reading it as if it is a knowledge anchor) and connecting it with other parts of texts

5.7.1. Making intertextual connections from different texts

Definition

Participants tab switched to create intertextual links when they found similar or different, or conflicting information from different multimodal texts. Especially the readers found similar information from different modes or texts and made intertextual connections. Reading a paragraph from one text and finding a graph related to that from another tab to understand two parts together can be an example of this strategy. Under this strategy category, I coded readers' linking strategy from different tabs (e.g., using two different texts that are presented on a different tab on Google and learning from two or more multimodal texts).

Verbal report example, complemented by interview data

First, subjects linked similar or overlapping information from different texts. Chloe read across tabs, making links to those texts to understand the color stages of bleaching corals. She did a lot of tab switching, going to the prior tab to read coral bleaching FAQs and coming back to see the diagram.

[Reading four corals diagram] Oh, fluorescing, bleached, dead. It's (dead one) also

> thicker than that (healthy one). And this is what that dude (from the prior tab, the researcher from the video) saw. I guess. Corals in the new barrier have been lucky by most measures, a drop in local temperatures. Oh, that was one of the solutions that they (clicks on the prior tab) say that here (reads the FAQ). Okay. (Returns to the current tab)

She demonstrated this tab-switching strategy as she compared and clarified information. She wanted to check what she remembered was correct, and she went back to the prior tab to reread FAQs and returned to the current tab to see the diagram. She even did this in mind, not actually going back to the prior tab but recalling what the prior tab said. This shows that there are intertextual links in her mind that help her mark where certain knowledge is at. This tab switching occurred when Emily compared information too. She made intertextual links between maps and written words she read so far. She said, “The bleaching when it's stressed, oh, this I have read about before. I remember,” as she could make connections along the tabs. She verbalized similarly when she found the overlapping information from two different texts, “This I have read about before. I remember.” Felix also said, “There’s overfishing again,” when he found overlapping information from two different texts. Namely, readers made intertextual connections when they found similar information from different texts or different modes.

Next, participants also made intertextual links to compare different or conflicting information between texts. For example, Felix wanted to understand the coral bleaching process he saw in the video. He compared the video and the written words on different tabs as he tried to comprehend it. When asked why, he reported,

> Because it (the video) was more structured, because I think the text (written words) doesn't really, it doesn't really give me information in any way that is process oriented,

which there's more facts, but not so much an explanation of how coral functions. (ellipsis) But I wanted to know, okay, so what are the indirect steps? And I kept going back on this video. Just to know a bit more because I even think this part of the video wasn't super clear. Cause they said something about algae, but they didn't really say that the algae gets disrupted first. And that's something that I only found out I think, after reading the second text in combination with what I knew from the first text, the second page combined with the first page.

In this interview, he states that he read texts in combination with the video to complement his understanding of the process of coral expelling algae showing his intertextual reading. He accounted, "I have to do some cross-references too, and I think that if you have a .org site, that should be clear from itself." He tried to read both texts and cross-reference them to ensure they matched.

This intertextual linking strategy for information comparison was reported by other participants too. George also made the comparison of opposing information from two texts.

> [Skips the map and goes to the next paragraph] Coral die-offs caused by process known as bleaching. Okay, so the one (Opens the first tab) website said bleached coral was still alive, it was just missing the bacteria. But this (Back to the 2nd tab) website time says that bleaching and death are seemingly more closely linked.

He described,

> I was comparing information between what I learned here and there. On the time magazine, they said that bleached coral is dead. On the first one, the Great Barrier Reef Foundation, they said that bleached coral was not dead. And so, I was just kind of double

> checking that I understood that there was a contradiction in there. I think I understand that bleached coral isn't dead yet, but it's very close, or it's very susceptible to death. That's what I understand now.

He concluded that bleached coral is not dead yet but close to death. He compared conflicting information from two texts, switched tabs to read them, and concluded to resolve the contradiction. This was one of the archetypical intertextual linking strategies that readers used.

Especially most of the participants were confused when they found conflicting or different information with regards to coral's colors as they become healthy to dead. One text said in the video (written words dominant text) that brown and green mean corals are dead. Another text and the four coral colors diagram showed that brown and green mean healthy (see Table 25).

> (Highlight (HL): "Coral turn to dead brown coral", "New Caledonia Vevers" "vibrant rainbow colors of thriving coral") So here it says that (HL: "stretch of white coral") they're actually colorful when they're thriving (HL: "vibrant rainbow colors of thriving corals") which is exactly what the other source said. But they found something different (reads: "in New Caledonia Vevers found something different"). (HL: "Fluorescently") Fluorescently. I'll watch this video.

While he found overlapping information that the corals look colorful when they are thriving, he also found something different so checked it with the video. She reported, "So it might be that it actually does turn into brown coral in the end. But healthy coral also seems to be brownish. So that was conflicting to me."

Table 25

Conflicting multimodal information from two texts delivering conflicting information (Copied from 5.5.4)

A diagram from tab2 (visuals dominant text)	A video from tab1 (written words dominant text)
	
Brown color means the coral is dead	Brown and green colors mean the coral is healthy

Jamie also compared two tabs of this conflicting information. “So coral, if it's healthy, brown and green, and when they die, going through bleaching, it becomes transparent and white. But coral reef, when they are healthy, they are colorful. And then when they die, they're brown. That's my conclusion.” She accounted, “I wanted to make sure that it is wrong and then I go back to the first one. If there is no first page, it's okay. But if after I, because I read that first. So, it's confusing for me. But eventually, I found the answer.” She focused on the part of the video where the researcher said “most healthy corals most of the time are a brownie green color.” She went back to this part several times, making intertextual links. She said, “I just wanna hear him say it again. Yeah, the house is brown and green and I make sure that I didn't misunderstand his speech.” Whether their conclusion was right or wrong, the readers made intertextual links to comprehend the topic, and to get the conclusion of the knowledge when there were two texts that say the same thing or conflicting things.

Analysis and further description

Participants made intertextual links to connect similar information or to compare different or conflicting information between texts. Using this strategy, readers could establish and consolidate their concept learning or were able to reach a conclusion when there was conflicting and confusing information distributed from two or more texts. To do so, the readers switched tabs frequently to reread the part of the information or made mental links by recalling what they had seen from certain tabs. Especially the verbal protocols and interviews that showed coral colors prompted readers to use this strategy. This portion of data was also coded as '*Updating and clarifying* knowledge through modes reading' under the 'Understanding meanings of modes' strategy category (see 5.5.4) because the participants used this strategy to comprehend the texts and the topic. Still, this part also can be coded to intertextual linking strategy as I focused on their behavior of making mental links or moving between texts to make links. This intertextual linking strategy is essential in OMR, and this study also found that it occurs not only for written words but also in different modes those participants utilized, such as visuals, videos, and written words. They connected information they saw from these modes and built intertextual comprehension.

5.7.2. Anchoring mode as main information source

Definition

This strategy refers to using certain modes or text as a knowledge base due to the information contained, credibility, or both (e.g., coming back to reading it as if it is a knowledge anchor) and connecting it with other parts of texts. Participants used this strategy when they found a mode that could function as an information basis that provides fruitful or accurate information. They used this strategy most frequently with the video from the written words dominant text I provided.

Verbal report example, complemented by interview data

As Isa wanted to use the video as her knowledge anchor, she reported, "I could still read through it, which I continued to do, but now, this (video) was kind of my basis instead of having the reading as my basis." She used the video about coral bleaching as her knowledge anchor and kept coming back to this one.

> I was like, oh yeah, like he said that, okay, yeah, I remember that. I know that because this was now my knowledge base. Instead of starting from zero knowledge, everything he said was like, okay, now this is what I know. (ellipsis) It's a good starting place versus trying to read through a bunch of information that I don't understand.

She used this video as her knowledge base because it helped her with information that she wanted which also matched other texts reading after watching it. Not having to read a bunch of written words was also a plus for her. She explained, "I figured after time was passing and I was reading other pages, I would wanna try to keep these core facts in my head since it seemed very foundational to understanding what coral bleaching is, which was that original question."

Subjects used the video as an anchor when they were confused about texts and wanted to clarify by watching it again. Jamie used this coral bleaching facts video as her main knowledge resource. She made the intertextual link between the three texts as she built knowledge.

Throughout her OMR, she kept going back to the first text and replayed this video, adjusting the speed. She reported, "I wanted to double-check the conclusion (of the coral colors). (ellipsis) It's like confirmed, to clear the first confusion, and then reconfirm that I understand the knowledge." Once the participants think the mode is replete with knowledge relevant to the reading task, they purposefully come back to read or view it as many times as needed.

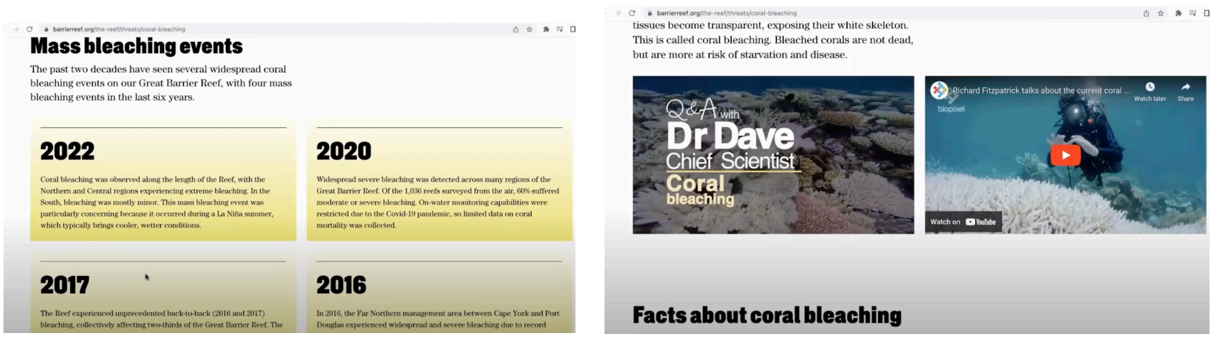
Hannah came back to watching the video in the same text, making the intertextual link within the text but with different modes – video and written words – to build knowledge and clarify information.

> (Reads title) Mass bleaching events. Okay, and this is the great coral, the great Barrier Reef. So, they're talking about different coral bleaching that was happening um…in different areas. [Reads 2022 fact, reading and scrolling down to 2017] So I guess these mass bleaching things happen largely because the water is too warm (ellipsis). Most of this for me seems like it'd be more useful if I knew the geography of Great Barrier Reef. Gonna go back to the video. [Scrolls up and plays the first video]

She read written paragraphs about mass bleaching events and needed to clarify the information with her knowledge anchor (see Figure 22). She scrolled up to the video on the same page, replayed it to get more information, and kept learning. Likewise, readers were strategic in determining their knowledge base, and once it was confirmed, they came back to this mode and got information until the knowledge was consolidated.

Figure 22

Hannah's knowledge anchoring strategy (Captured from Hannah's screen-recording video)



Reads bleaching events, feels the need to find the geography → Scrolls back to the first video.

Analysis and further description

Anchoring a mode as the main information source strategy refers to using a certain source in OMR as a knowledge base due to its rich information, credibility, or both. Participants connected it with other parts of texts or among tabs. They used this strategy to double-check the information, to find matching information between the modes, or to clarify and update their knowledge by checking with the knowledge anchor if there is something unsure as they go about their reading. Participants in this study used a video as their knowledge anchor, but this strategy may occur with any mode or a whole multimodal text as the reader decides.

Summary

Participants demonstrated two intertextual linking strategies during OMR. First, the data describe making intertextual connections from different texts. Readers tab switched to make intertextual links when they found similar or different or conflicting information from different multimodal texts. Next, verbal report data describe the strategy of anchoring a mode as the main information source. Readers used certain modes of text as a knowledge base due to its information quality and connected it with other parts of texts. Both strategies showed readers' active linking strategy within a text or several texts spread through different tabs. Therefore, readers performed lots of scrolling and tab switching.

From coding, concurrence, and complementarity relationships, contradictory or different relationships of modes were analyzed as they make intertextual links (Chan & Unsworth, 2011; Daly &Unsworth, 2011). Concurrence refers to when one mode elaborates the meaning of the other by specifying or describing it while no new meaning is introduced. From the data, concurrence relationships among modes were indicated when readers used written words of coral bleaching, FAQs, and when written words, video, and diagram were linked to determine the degree of confirmation or conflict. Complementarity refers to the relationship when a new meaning is introduced by either written words or visuals. From the data, readers viewing different information about coral colors from the video and the diagram and connecting them would be the case of divergence (image and words convey different meanings).
These intertextual linking patterns were performed across tabs, across modes, remembering where to go back to read, remembering videos and where they stopped, and coming back to that part.

Cho (2014) accounted that proficient readers make intertextual links by changing texts. He described that online readers integrate multiple web sources into a metarepresentation of meaning, and this strategy helped them identify supportive or conflicting ideas among the texts. The data from this study confirm this finding, as participants performed dynamic moves between the current and previous texts (e.g., click-backs) that contributed to the construction of links in mind. In sum, these intertextual linking strategies were efficient for the readers to reaffirm and compare information from various modes and texts, which also applied to multimodal texts in OMR.

5.8 Multimodal Navigation

The verbal report data indicate that reading paths differ for every participant as they read online. Although these paths are all individually created, I focused on the strategic patterns that these readers showed as they navigated through multimodal texts. Multimodal navigation strategies are used in relation to these diverse paths during OMR. For example, readers may skim texts and set up a tentative plan and path, start to read given tabs in order, and revisit modes if that mode has helpful information or needs clarification. The factors influencing reading paths are: insufficient or conflicting information, time and task management, and/or information clarification. From the data analysis, I found two multimodal navigation strategies: (1) checking tabs and planning ahead what and in what order to read, and (2) remembering the information location and coming back to reading it. Multimodal navigation strategies are important for OMR because OMR involves hypertext reading, so readers should decide the order of the modes or links to keep reading. These decisions may include leaving and accessing information for reference, clarification, or exploration (Lawless et al., 2003) of various modes and hyperlinks.

Table 26

Multimodal navigation (path construction) strategies

OMR Strategy Name	Definition of the Strategy
Checking tabs or texts and planning ahead what and in what order to read	Checking and skimming the texts with regards to their contents, main ideas, themes and modes, and planning the order to read them (e.g., scanning tabs horizontally, and scrolling within the text vertically.)
Remembering the mode and information location	Making mental notes or marking certain parts of texts in mind by remembering and revisiting this information to read

5.8.1. Checking tabs or texts and planning ahead what and in what order to read

Definition

This strategy refers to checking and skimming for the texts with regards to their contents, main ideas, themes and modes, and planning the order to read them. In other words, readers scan texts quickly and decide the order to read them to achieve reading goals efficiently. They also scrolled down to check what modes or contents were left to read and scrolled up to the original part of the reading. Readers used this strategy in two ways: scanning tabs horizontally and scrolling within the text vertically.

Verbal report example, complemented by interview data

One participant checked all tabs I provided at the beginning and tried to map her reading orders and paths before she started to read. Other participants began to read right away once the reading time started. Hannah browsed all tabs first, quickly scanned what each text contained, and decided what to read in what order. It took only one minute for her to scan through them and set reading paths. Here's Hannah's exemplary strategic navigation strategy.

[Opens Tab 1-Video centered: Nature conservancy] The first one seems to be similar to the polar bear example (verbal protocol practice session). It's a Conservancy.

[Opens Tab2-Words centered] I'm gonna go to the next, also a foundation. Great Barrier Reef is in Australia.

[Opens Tab 3-Visual centered-Time] And Time, ugh, the most beautiful death. (Scrolls down a little bit) Sad. So, time seems like an investigative piece or one that is trying to bring attention, but more of a main article of sorts, not necessarily news.

She accounted how she used this strategy to set her reading path:

I think even just from looking at the tabs, I saw that one was the Times article, so I went and looked at the other ones briefly, and then started back at the first one. Perhaps in hindsight, I would've actually started at the middle one because it was more specific to coral bleaching. And the first one I started at, I don't even think it really mentioned coral bleaching specifically. Yeah, the first one (tab). I went to the conservation one and took a look at that one and started and reread it.

After checking all three tabs, she started with the first tab. She quickly noticed the main idea of each text and set her reading path to read from the beginning because she did not feel the need to set specific paths. She realized after OMR that it would have been better if she had started with the second tab. Still, the strategy to check all given texts and setting reading order helped her make her reading path more organized and sequential. Emily also used this path construction strategy, and she used the word "thread" to symbolize her reading path.

I guess my thread was, started the first tab, first few paragraphs just by scanning. My thread in the back of my mind was, I wanna know about, I really wanna know about planting new reefs (ellipsis). So, I just went to the next tab, I think mostly because I felt

I'd seen everything I'd wanted to see on that tab. And before clicking around too much on it, I wanted to see what the other tab had to offer. I think sometimes when I have two or three websites going, I'm always slipping back and forth to see which site is good for what kinds of information.

Her interview shows that proficient online readers allocate their time and attention efficiently during OMR. They scan texts before they read what each text has to offer. She described it as ‘slipping back and forth to see which site is good.’ She uses this strategy because she knows that she “can always come back” in OMR. This freedom of navigation in the online space seemed to offer the readers chances to construct their paths more freely compared to traditional, physical book reading, where they physically hold and open the book or newspaper.

On the other hand, some participants scrolled down to the end of the text to see how much was left or what kind of new information it contained. When the readers want to know what they have more portions to read, they quickly scroll down to check the length of the text, go back to the part they were reading, and keep reading. This scroll-checking strategy resembles the horizontal tab-scanning strategy stated above. Except for the fact that it occurs vertically in a single text using the scroll bar function, the purpose of doing so is identical; to check what modes to read, and what more to read to reach the goal.

For example, Hannah scrolled down the text to see what was below and scrolled back to the video at the top and played it. She accounted, “Usually, I just wanted to check, I think, how much more there was another topic being brought up before I watched this (video). I think when I watched this, I was thinking, am I going to see a lot of the same information that I saw before? Which I think I kind of did see. Maybe they're different visuals.” Felix also used this strategy. He scrolled down to the 2/3 point of the Nature Conservancy text and went back to the text to keep reading. After reading the first paragraph, he scrolled down, checked that there were videos, and went up to read the next paragraph. He accounted for his path-making strategy. “That was a nice text, but there were fewer images in here. (ellipsis) Because I didn't really want to spend the entire five minutes watching the video. You can really see me impatiently scrolling.” He wanted to find a more efficient mode to understand the text about the organization’s direct intervention, so he scrolled down to check other modes. He saw the video but quickly passed it because he did not want to spend the last minutes watching it. Of note is that time constraints might have influenced the readers’ navigation patterns. Future research can take this time constraint into consideration in study design. Instead, he scrolled back and read written paragraphs to get the information. Here he shows the combination of mode selection for time management, evaluation of task relevancy of modes, and setting reading paths strategy at the same time.

Emily also used this vertical scrolling to check the information strategy.

> [Reads ‘Mass bleaching events’] Okay. The Great Barrier Reef. All right, so 2017 (ellipsis) 2016. Oh wait, we're moving backwards. I'm gonna start from the bottom cuz I can't really understand information in that way. I do better by starting with the earlier date. (Goes to the bottom and reads 1998 first) 1997 to 1998 (Scrolls up to 2002) (ellipsis) Sometimes there's decent recovery, sometimes not, and that the level of bleaching changes year to year. (Scrolls to the bottom) Okay. Oh, (sees donation link) that's kind of nice. Can go ahead and make a donation. (Scrolls up) Not gonna do that right now.

She scrolls up and down, depending on the year order of bleaching events she prefers and the information the text has at the bottom, which was irrelevant. She checked the very end of the text to skim the contents but realized that it was a donation part and scrolled back to the mass bleaching events part to find topic-related information. These readers were both strategic in using scroll functions to check what more to read and going back to keep on learning.

Analysis and further description

Participants set reading paths by ‘checking all tabs and planning ahead what and in what order to read.’ They used this strategy in two ways: (1) checking and scanning all tabs at the beginning and setting reading orders and paths prior to reading, and (2) scrolling down to the text to see how much is left, what mode it has, and what kind of new information it contains. These two strategies were useful for readers to plan ahead what modes to read before they embark on reading the text. Setting the reading path helped them reduce the time and effort that could have been wasted if they read all modes linearly. Also, it helped the readers to get the overall view of what mode or information each text contains.

5.8.2. Remembering the mode and information location

Definition

Remembering what information or what mode is located is an important strategy for OMR because all information may be distributed in different locations and tabs, links, or even in a video. Some readers were knowledgeable about using this strategy to accomplish the task by memorizing these information snippets on their reading paths.

Verbal report example, complemented by interview data

For example, when Jamie wanted to comprehend information about the word ‘algae,’ she remembered it in her mind and returned to searching it at the end of the OMR session when she thought she had a few last minutes. When asked why she searched algae, she said, “Because this is the haunting word, because I don't know how to browse, so I go back and back.” She also revisited prior tabs to find unread information by visiting each tab and scrolling to the end to see what was left to read. Dylan used this strategy to find the part of the video that he left during reading. “I guess I might go back to the videos [goes to the first tab and keeps watching other last parts of the video he stopped: “Raising coral babies” and keeps playing from where he stopped].” He accounted, “I went back finish my videos.” When there is some information they think is worth reading but left it unread to focus on more important reading, they tend to remember where they left off and go back to finish reading that mode. It looks as if they are leaving a mental post-it on certain parts of the multimodal text and reminding them to go back to read it once they have time left or they feel they have accumulated enough knowledge to focus on the less essential parts.

Emily also remembered the animal ‘crown of thorn starfish’ as she was reading written paragraphs and found the path back to it by making mental notes.

> Crown of Thorn Starfish, that sounds cool. I might come back to that. (Scrolls down and jumps right into the colored box of solutions) [Keeps on linear reading: The solution] Right, Improve water quality, land runoff. (ellipsis) [Reading other paragraphs] I would love to read a little bit more about them. So, I'm gonna go over to Google search real quick and look up [Searches: crown of thorns starfish].

She kept this memory of the starfish and then kept on reading other parts of the text. Still, she wanted to know more about them since she thought it is related to the topic, and she searched the term and read Wikipedia about it. This shows how remembering information impacts readers' navigation.

Analysis and further description

This strategy can be compared to intertextual linking (see 5.7.2), which anchors certain modes as main information sources. However, this strategy differs because here, I focused on navigation patterns and why this path is constructed, not on the importance of a particular mode that may influence reader strategies. The reading paths can be drawn in any way depending on what information the reader values. Readers' remembering certain information (e.g., this concept seems important) and location (e.g., this concept is located on the 1/3 of the third tab below this video) is the key here, compared to the linking for meaning-making strategy. The former is focused on the role of memory as the reader constructs reading paths, and the latter focuses on their intention to make meanings by similar or conflicting information. Therefore, these two strategies were differently coded.

Remembering what information or what modes are located was one of the useful navigation strategies during OMR. Participants used this strategy as they made mental notes and recalled where certain modes of information were placed. They sometimes came back to this portion when their reading time allowed. The readers from this study remembered different concepts and reminded themselves to come back to reading written words about them, watching videos that were left unfinished, or remembering to search the term and learned about it at the end of their OMR to learn the topic fully.

Summary

Participants used two multimodal navigation strategies. First, they used the strategy to check all given texts and set the reading order. This strategy included scanning all texts quickly, deciding the orders to read them, scrolling down to check what was left to read, and going back to reading. I describe these navigation patterns as scanning tabs horizontally and scrolling within the text vertically. Next, remembering what information or what mode is located was used by participants. They used this strategy to accomplish the task by memorizing modes or information during OMR and constructing reading paths.

I found that the participants purposefully set the reading order of modes as soon as they see the new multimodal text (e.g., setting reading paths, selecting hyperlinks). I also found overlapping multimodal navigation strategies in the data, and I focused on common navigation patterns. Cho (2014) discovered the strategy of identifying potential texts to read and described that readers access, examine, and decide upon links on the path to locate useful texts. They make inferences about the texts, and this strategy contributes to the optimized selection of useful texts. I could find the readers' demonstration of this strategy upon OMR from the data. The readers used visuals, videos, and written words as they inferred their usefulness and selected these modes using navigation paths. Salmerón et al. (2006) discovered that readers' hypertext navigation strategies differ based on their prior knowledge. Participants from the current study matched two of their navigation patterns: following coherent links and following the default screen position. I view these two navigation strategies applied to OMR readers because the readers had rather low prior knowledge about coral bleaching. Readers reported that they thought they should learn basic facts first by reading linearly and felt it was easier to follow the order of the texts as provided on the screen. Therefore, most readers followed the tab orders I presented. Still, all readers constructed different reading paths, following different modes presented on multimodal texts.

Chapter 6: The Taxonomy of Online Multimodal Reading Strategies

To answer the next research question: 'What is a preliminary taxonomy of readers' online multimodal text reading strategies?' I present the taxonomy based on the reported and analyzed OMR strategies.

Table 27

Taxonomy of OMR strategies found from this study

OMR Strategy	Subcategorized Strategy	Definition
Multimodal metacognition	Creating a problem space to construct meaning	Deliberately creating a problem space in which reader works toward OMR goal(s)
	Checking prior knowledge	Ongoing analysis of what is known related to OMR texts, how the prior knowledge augments, duplicates or contradicts information encountered in text
	Finding knowledge gap	Determining what gaps in knowledge exist as prelude to reading to locate that knowledge
	Examining usefulness of a component of OMR for reading purpose	Determining if information and mode of information is helpful or appropriate for learning certain knowledge to accomplish reading tasks
	Mode change to enhance understanding	Using different modes of OMR to further knowledge construction as prompted by metacognitive knowledge that more information may be available in different modes, and different mode may clarify information in current mode
	Checking text configuration on the imaginary map in mind	Drawing an imaginary map in mind that describes reader's subjective placement of the information in a part of a text, a whole text, or the group of texts while they read multimodal texts.
	Self-monitoring	Demonstration of top-down strategies using executive functions to control rate of reading, giving of attention and effort
Multimodal Evaluation	Evaluating text credibility by reading modes	Determining the accuracy or trustworthiness of the mode to enhance their comprehension to reach the reading goal
	Evaluating goal relevancy of modes or multimodal texts	Examining the mode's relevancy to the reading goal. This evaluation strategy is not about credibility but about examining the relevancy of the information to the

		goal or a task (going to information that is more relevant to the goal).
	Evaluating information by cross-checking modes	Checking or comparing the information from two or more modes in relation to one another to determine coordination, elaboration, or contradiction in information. Evaluating the trustworthiness of two different modes or sources of information
Mode Selection	Selecting modes based on goal relevancy	Choosing modes based on the expectation that they will provide information that the reader needs to achieve the goal
	Selecting modes based on mode preference or interest	Choosing certain modes that matches readers' preference or interest in certain modes
	Selecting modes based on the reading ability or ease of understanding modes	Choosing modes to read considering the reader's reading levels with regards to text complexity, length, levels (e.g., this text or mode seems easy or difficult to understand for my level)
	Selecting modes based on time and task management	Choosing certain modes considering the time or effort allocation for goal completion (e.g., selecting a video since watching a video might take shorter time and effort compared to written words reading)
	Selecting modes based on prior knowledge level	Choose to read certain modes because the reader thinks the information is needed or no longer needed compared to their established prior knowledge or the knowledge from ongoing reading
Multimodal Searching	Image searching to view and understand concept	Conducting search on the web and going to the image tab or maps to find information in visual forms (e.g., diagrams, photos, maps) or searching at the image tab to only find images to comprehend certain concepts
	Word searching to understand concepts	Conducting search on the web in words or phrases on the search bar and reading results in written words forms (e.g., paragraphs, brief summary of the most relevant search result, opening 'People also ask' menu and reading them)
	Word searching and connecting with images to understand the text	Conducting word searching and connecting to the adjacent image shown on the search result or visuals form other pages or vice versa to comprehend certain concepts
Understanding Meanings of Modes	Multimodal integration	Reading various modes and integrating two or more modes to comprehend meanings: • Integrating visuals with written words and vice versa • Video and written words integration • Integrating different visual modes to comprehend • Multimodal integration of more than two modes

	Forward inferencing of the mode	Inferring what information the reader might get from clicking on a mode or a link before the reader opens it (e.g., from search results lists, from hyperlinks, from menus, before clicking videos)
	Summarizing idea(s) of multimodal text	Finding and understanding main ideas as result of using different modes
	Updating or clarifying knowledge through modes reading	Clarifying knowledge from the ongoing reading and updating it as the reader reads new information from different modes, like schema development: assimilation, accommodation, equilibration.
Prior Knowledge Use to Understand Multimodal Texts	Activating and applying prior knowledge about the topic	Activating prior knowledge about the topic automatically or purposefully while reading modes or a multimodal text to understand the text better (e.g., declarative, factual knowledge about coral bleaching) or personal experiences or feelings regarding the situations from the text. (e.g., I had a trip last summer and we saw corals during scuba diving)
	Activating and connecting to prior knowledge about OMR or online reading	Activating prior knowledge of online multimodal reading automatically or purposefully while reading the text to understand multimodal texts better and to read the text more strategically (e.g., I focus on visuals when I search for words, search terms should be concise)
Intertextual linking through multimodal texts	Making intertextual connections from different texts	Finding similar or related information from different parts or from different texts and making mental links to connect the information to comprehend the topic
	Anchoring certain modes as main information source	Using certain modes or text as a knowledge base due to its rich information or credibility (e.g., coming back to reading it as if it is a knowledge anchor) and connecting it with other parts of texts
Multimodal Navigation	Checking tabs or texts and planning ahead what and in what order to read	Checking and skimming the texts with regards to their contents, main ideas, themes and modes, and planning the order to read them (e.g., scanning tabs horizontally, and scrolling within the text vertically.)
	Remembering the mode and information location	Making mental notes or marking certain parts of texts in mind by remembering and revisiting this information to read

Chapter 7: Discussions and Conclusions

This study examined and categorized online multimodal reading strategies, which refers to the reading strategies used in constructing meaning from multimodal information sources (e.g., images, audio, written words) on the Internet, with the model of Constructively Responsive Reading (Afflerbach & Cho, 2009; Cho, 2014; Pressley & Afflerbach, 1995). I analyzed ten doctoral student readers' online multimodal reading performances resulting in further application of constructively responsive reading (CRR) strategy use on multimodal reading on the Internet. I discuss here how the results of the taxonomy of OMR strategies overlap and contribute to the CRR model, limitations of the study, and the necessity of OMR instruction in K-12 literacy education.

7.1 Overlaps of OMR Strategies with Constructively Responsive Reading Model

Based on my review of the literature and data analysis, I determined that the model of constructively responsive reading guided investigating OMR strategies. This model, as adapted for Internet reading, includes: (1) realizing and constructing potential texts to read, (2) identifying and learning text content, (3) monitoring, and (4) evaluation. I found OMR strategies that overlap with those four strategy categories, which indicates that constructively responsive reading strategies for Internet hypertext reading can be extended to multimodal reading on the Internet. I found eight types of OMR strategies from this study: (1) multimodal metacognition, (2) multimodal evaluation, (3) mode selection, (4) multimodal searching, (5) understanding meanings of modes, (6) prior knowledge use to understand multimodal texts, (7) intertextual linking through multimodal texts, and (8) multimodal navigation. Here are the commonalities of both groups of reading strategies.

First, online multimodal readers use strategies for realizing and constructing potential texts to read. Realizing and constructing potential texts to read is critical in Internet reading because this strategy is related to text location (Afflerbach & Cho, 2009). This strategy supports readers to establish a text environment by collecting and determining the texts to read to accomplish reading tasks. Using this strategy, the reader may scan texts or hyperlinks to find relevant texts, set orders for reading, and navigate through the Internet to reach their goals (Cho, 2014; Lawless et al., 2003; Leu et al., 2013). In OMR, multimodal navigation has overlapping attributes because this strategy involves checking tabs, planning ahead what and in what order to read, remembering the information location, and returning to reading it. Determining what link to choose and what to read is also essential in OMR. Participants demonstrated their navigation using multimodal texts and used written words, menus, hyperlinks, images, or videos to navigate their reading (Davis & Neitzel, 2012). They constructed reading paths through these modes and made intertextual links which the CRR model emphasized. Readers used the 'making intertextual connections from different texts' strategy, which refers to finding similar or related information from different parts of multimodal texts and making mental links to connect the information to comprehend the topic.

Next, OMR participants showed the 'understanding meanings of modes' strategy, which overlaps with identifying and learning text content strategy type from the CRR model. Understanding the meanings of modes refers to understanding multimodal texts from words, images, or videos combined. It is a meaning-making strategy using various modes that multimodal texts offer, just like what readers did for successful meaning construction in Internet reading. From the CRR model, readers make sense of hyperlinks, comprehend the information on a webpage, and build intertextual understandings from hypertext reading (Bråten et al., 2016; Hartman, 1995; Rouet, 2006). In this study, participants used multimodal texts, similar to the naturalistic Internet hypertext setting Cho (2014) used. However, I focused on multimodal integration strategies and their use of various modes to learn the topic for the analysis. Accordingly, I could discover meaning-making strategies such as multimodal integration (integrating visuals with written words, video and written words, integrating different visuals, or integrating more than two modes) as readers comprehend meanings. Participants from this study also used printed single-text meaning-making strategies that Pressley and Afflerbach (1995) described, which was also utilized in the CRR model on hypertext reading in the Internet context (Cho, 2014). In OMR, readers also used traditional reading strategies, such as understanding written words with prior knowledge and identifying and summarizing ideas from the text. Of note is that participants used different modes to understand and summarize ideas from multimodal texts.

Third, OMR readers also used the self-monitoring strategies that the CRR model suggested. Monitoring strategies are related to multimodal metacognition strategies from this study which involves readers' self-assessment of their learning or task accomplishment. Self-monitoring strategies include expansive self-regulated strategies, such as planning searches, monitoring and regulating thinking, detecting reading problems, and so forth (Coiro & Dobler, 2007; Connor et al., 2016). Readers used similar metacognition strategies during OMR, such as determining their knowledge gap, examining the usefulness of a component of OMR for reading purposes, and executive functioning. Especially, executive functioning, which refers to controlling the rate of reading, giving attention and effort, is the key that overlaps with monitoring strategies from the CRR model which indicates that self-monitored thought processes and ongoing self-assessment of how the learning is being accomplished compared to the reading goal is essential in OMR as well.

Lastly, participants used evaluation strategies that overlap with the CRR model. They are evoked when readers make decisions as they read online, and the CRR model suggests that readers examine the usefulness of links, judge the information value of web pages, and assess the quality of a website (Cho, 2014; Bråten & Braasch, 2018; McGrew, 2020). Evaluation strategies were also important for OMR because there are various modes used in the text, and sometimes it is harder to assess credibility once images or videos are used because the text might look more trustworthy (Klawitter & Hargittai, 2018; Salmerón et al., 2020). Evaluation strategies in this study also overlapped with the CRR model. The readers evaluated text credibility and task relevancy using certain modes or multimodal texts. Further, they evaluated the video before clicking on it and evaluate information by cross-checking modes.

In summary, the data of these proficient readers doing OMR fit with the CRR model and enhanced the model by demonstrating that reading strategies based on printed written word reading and Internet hypertext reading can be extended to online multimodal text reading. Thus, OMR strategies taxonomized from this study may contribute to reading strategies and digital reading studies.

7.2 OMR Strategies' Contribution to the CRR Model

As stated above, constructively responsive reading (CRR) theory framed the analysis of OMR strategies. The strategies found from the existing body of literature mainly focused on online hypertext reading, so the strategies in the intersection of online reading strategy and multimodality were limited. This study expanded the strategies found in the literature and focused on readers using various modes and multimodal texts on the Internet to comprehend the topic. Here I account for the OMR strategies that reflected these unique characteristics in readers' strategy use. Of note is that all strategies from this study are based on multimodal reading, which used various modes, so it does not mean that it is not a multimodal strategy if I have not mentioned certain strategies here.

Under the category of multimodal metacognition strategies, three strategies were novel in terms of multimodal and online reading contexts. Strategies such as examining the usefulness of a component of OMR for reading purposes, mode change to enhance understanding, and checking text configuration on the imaginary map in mind count as strategies that highlight readers' metacognitive thinking while focusing on multimodality. Under these strategies, participants focused on modes to determine if the information was helpful or appropriate for their learning or examined their need to change modes to improve comprehension. These strategies could be used because the reader is using modes to self-regulate their ongoing reading task. For multimodal evaluation strategies, readers used visuals, written words, or videos to assess the task relevancy or credibility of the text. Unlike written word-only reading, multimodal readers utilized modes to determine the relevancy of the information to the goal or a task. They especially had video evaluation strategies and inferenced the task relevancy of the video before clicking on it. They also compared two different modes to evaluate trustworthiness.

Mode selection strategies were one of the archetypical OMR strategies distinctive from CRR strategies. Readers used various strategies to select modes based on different standards: task relevancy, mode preference or interest, reading ability, time and task management, and prior knowledge level. Unlike printed or written words-only Internet reading, online multimodal readers can choose or switch effective modes for task completion. The Internet is replete with modes (e.g., visuals, videos) that support individuals with different sensory information (Casey, 2012; Sanacore & Piro, 2014). Readers can choose the mode they need to comprehend texts or choose modes based on their interest and prior knowledge of OMR.

Multimodal searching is also a representative multimodal reading strategy different from the written words-centered model. Participants showed searching on the web and going to the image tab to find information in visual forms (e.g., diagrams, photos, maps) or searching at the image tab only to find images to comprehend certain concepts. They also performed word searching and connected to the visuals shown on the search result to comprehend certain concepts. The Internet offers readers various modes of searching (e.g., images, maps, videos, words) to search for information in multimodal ways (Casey, 2012), which was not emphasized in the original CRR models.

Although understanding meanings strategy is in line with strategies figured in CRR models, there is multimodal emphasis on the coded strategies I found from the data. Multimodal integration is essential, which involves reading various modes and integrating two or more modes to comprehend meanings. This strategy shows that online readers not only integrate written words but also various modes, including videos, visuals, and words, to comprehend texts (Oh & So, 2018). Also, participants used forward inferencing of modes, which means inferring what information the reader might get from clicking on a mode or a link before the reader opens it (Coiro & Dobler, 2007). Clarifying knowledge from the ongoing reading and updating it using different modes was also a multimodal-focused multimodal comprehension strategy.

While utilizing prior knowledge was important in text comprehension in the CRR model (Smith et al., 2021), this study found that readers activate and apply prior knowledge from reading modes or a multimodal text to understand the text. More importantly, readers activated and connected to their prior knowledge about OMR to read texts more strategically. Readers describing themselves as visual learners or location person indicates that they know their mode preference as prior knowledge, and they also were aware of some strategies that they like to use when they read multimodal texts on the Internet. They recalled their familiar OMR strategies and applied them to the current reading task.

Intertextual reading has been essential in CRR models for both printed text reading and Internet hypertext reading. OMR data from this study also figured that making intertextual connections from different texts is still prevalent. Multimodal text readers also made intertextual links as they comprehend multiple texts. More importantly, readers used certain modes or text as a knowledge base due to its rich information or credibility and linked it with other parts of texts as if the mode was an anchor of their intertextual reading.

In summary, I developed an extensive OMR strategies taxonomy based on the CRR model and the verbal protocol data. The strategies described in this study contribute to the evolving understanding of OMR. There is a considerable commonality between the CRR model and the OMR strategies used in multimodal online space. As well, the results of this study include novel OMR strategies necessitated by online spaces and multimodal reading. There was also a preliminary examination of the relationship of OMR strategy use with prior knowledge and readers' ongoing knowledge gain. I believe the study also helps demonstrate the value of inquiry using diverse data collection methods, such as verbal protocol analysis in reading, reader-computer interaction capturing, and multimodal transcription for online reading studies.

7.3 Limitations

There were limitations in using verbal protocol methodology. Turning invisible thought processes into words appeared challenging at times for some readers. Although most readers provided fluent think-aloud data, the preciseness and detail of verbal reports varied across participants. Some of the unevenness of verbal protocol data was countered with post-reading interviews and knowledge unit analysis, and reader-computer interaction videos. Although verbal protocol analysis is suited for finding OMR strategies, data triangulation such as that used in this study should be practiced. A further limitation is the process orientation of this study. Meaning, while I analyzed and taxonomized OMR strategies, there is no concomitant reporting of related readers' comprehension.

I used the knowledge report tasks before and after OMR, asking the same questions to see how much readers learned from the texts during reading. While it might have helped the participants to focus on the topic, there could have been a priming effect on their learning since I notified them that they would be asked the same questions at the beginning. This confined reading task might have constrained knowledge gains and OMR strategy use. However, knowledge comparison can help indicate what knowledge might have been gained from certain parts of OMR and what OMR strategy the readers used as they learned certain knowledge units. Still, there is a possibility that the reader might have used prior knowledge. This limitation will be accounted for mu future research on prior knowledge and knowledge gains using this data.

Implications and Future Directions

The results of this study indicate that OMR is conducted with strategies that are common and well-documented in traditional text reading, as well as new strategies that permit readers to navigate and comprehend the complex spaces of OMR. My analysis indicated that constructively responsive reading is a suitable framework for supporting a strategic perspective on OMR. In addition, the results of this study add to the strategy list as presented in the Taxonomy of OMR strategies.

The results of this exploratory study suggest fertile ground for ongoing inquiry. This would include extrapolation from what proficient online multimodal readers do to create developmental OMR strategy instruction. A complementary line of research—investigating effective means of teaching and fostering students' OMR is needed. Research may help identify suitable OMR environments, texts, and tasks that promote students' ongoing development. Examination of instruction can focus on teaching students to understand different mode affordances, such as the quick delivery of visuals, detailed description of words, and audiovisual information of videos to make the best use of the multimodal texts. To do so, future studies could examine how teachers learn and understand the complexity of OMR: how various modes or multimodal texts are integrated, how modes selection influences students' comprehension, and how students develop mode preferences and multimodal navigation strategies to build understanding. OMR strategies taxonomized in this study are possible candidates for classroom instruction to support students to become competent online readers.

As well, developing the OMR construct has important implications for assessment. It is probable that the frequency of OMR will continue to increase, and that OMR will become firmly ensconced in classroom practices. Formative assessments that inform teachers as to students' incremental development with OMR are needed, as are summative assessments that describe the nature of students' OMR achievement. This prevalence and continuing evolution of OMR demand that we use assessments capable of describing students' growth and identifying their challenges. For example, information on students' strategies from performance assessments can be collected using rubrics, self-checklists, written logs, or screen recordings that focus on specific OMR strategies. It will give teachers sources and information so that they make inferences about each student's strategy development. Teachers can use the product of students' reading comprehension from OMR as their summative assessment resources since OMR aims to learn from online multimodal texts. This information from assessments will guide teachers to properly instruct each student to develop as proficient digital readers.

Based on my learning from this study, I propose a personal future research agenda concerning OMR strategies. First, I aim to examine what prior knowledge influences readers' comprehension in OMR. My research questions focused on taxonomizing strategies, and the design resulted in my limited ability to analyze how OMR strategies categorized through this study affect each knowledge unit development and participants' overall comprehension. Also, the intertwined influence of prior knowledge on topic learning through OMR strategies will be studied in line with it, considering the importance of prior knowledge on text comprehension.

The theoretical focus of the study was on cognitive constructivism, although my theoretical framework considered a conjoined theoretical basis for OMR. I plan to focus on the sociocultural aspect of OMR in future research with an emphasis on the assumptions that modes are the effect of the culture, people shape and transform representations, and modes have different affordances. Third, there were also unique OMR strategies and participants' strategic patterns that were not assigned to the taxonomy due to their idiosyncrasy. Therefore, I plan to address such uncommon behaviors through descriptive case analysis for future research. Fourth, there were various subject characteristics, such as language, nationality, or cultural background which might have influenced their OMR patterns. Participants' online reading habits were also collected that can be grouped and compared to see how they contribute to OMR strategy use. Lastly, OMR strategies might differ based on the online platform, digital devices, or topics. The investigation of these factors deems worthy of expanding the body of OMR strategies. Through the listed future research topics, OMR strategies will contribute to the investigation of digital and multimodal literacy.

7.4 Necessity of Online Multimodal Reading Instruction

While user interfaces might pave the way for different reader-computer interactions, "how users interact with the interface might play a (more) crucial role in how well they accomplish the task" (Leroy et al., 2022, p. 11). Therefore, it is important to teach readers to perform necessary actions on the Internet as they interact with digital texts, which is the OMR strategy in this paper. Kress (2003) focused on the change of literacy "from linguistics to semiotics" (p. 36). It means that literacy which only accounted for language has changed to account for different modes of representation with equal meaning potentials. He foresaw that literacy would move from the dominant mode of writing to the mode of image and digital screen. He also argued that speech would remain the major mode of communication, but images could replace writing. A decade later, Kalantzis and Cope (2013) extended this thought and even suggested educators “supplement the written linguistic text with oral, visual, audio, tactile, and spatial modes, in deeply interconnected multimodality” and make strategic shifts between modes (p. 26). Today’s learners’ traditional written word reading competencies are still fundamental and significant in reading instructions and assessments. However, it seems apparent that the shift to OMR in and out of school is unavoidable. Stein (2008), by extension, argued that all learning is multimodal, and humans have a highly sophisticated ability to move across the senses. Multimodal reading in the classroom is not a new concept because images, diagrams, and written text have been used in traditional classrooms, such as picture book reading for children or tables and charts in a textbook. However, OMR needs more attention than ever because students’ literacy is now highly dependent on digitalized online texts, urging them to read, learn, and participate actively in this virtual space. Educators need to “provide strategies and analytical procedures for our students to be able to approach, navigate, interpret, and discuss the various visual images and multimodal ensembles they encounter in their everyday lives” (Serafini, 2014, p. 44).

Effective strategy instruction derives in part from a well-explained construct of OMR. This study aims to identify and describe OMR strategies to provide valuable information to the construct. There are some global aspects with regard to OMR strategies that the construct should involve: the affordances and constraints of modes (Bearne, 2003; Heydon & O'Neil, 2016), different meaning potentials of modes, and how to comprehend them together (Serafini, 2014), the ways to evaluate the credibility of multimodal texts (Baildon & Damico, 2009), the understanding of context of the text through multimodal reading (Yelland, 2018), and so forth. However, research on OMR strategy or its instruction is relatively scant despite its urgency and necessity (Dalton & Smith, 2012; Fitzgerald & Palincsar, 2017; Jewitt & Kress, 2003; Wyatt-Smith & Elkins, 2008). More empirical studies should be conducted to see readers' efficient strategy during OMR, preferably in a naturalistic, open Internet reading setting. As an initial attempt, I examined the literature to construct a taxonomy of OMR strategies to contribute to the body of online reading research and instruction.

Appendices

Appendix A

Questionnaire about Reading on the Internet

Instruction: I would like you to tell me about your experiences with the internet reading. For example, you may have read internet news articles, blogs, Google search results, and social media feeds that include written words, images, graphs, sounds, and/or videos. Think about the reading activities that you usually do on the internet, not printed texts or book reading. Please check one answer that best describes your reading behavior.

<u>Questions on Internet reading behavior</u>

1. Since when have you started to read on the Internet?

2. Do you like to read on the Internet?   A. Yes B. Sort of C. No

3. For what purpose do you usually read on the Internet?

A. Read for pleasure B. School assignments C. Information searching D. other

4. How much time in one week do you spend reading on the Internet? (   ) hour(s) a week

4. When reading on the Internet, you are usually at … A. school B. home   C. other (   )

5. How much time in one week do you spend reading on the Internet for learning purposes (e.g., assignments, searching for information, reading articles for writing, watching YouTube videos to learn something)?   (   ) hour(s) a week

<u>Questions on multimodal reading behavior</u>

7. Suppose there are various types of information – written words (e.g., linguistic, typed sentences or words), visuals (e.g., images, graphs, maps), audio (e.g., music, voices), audiovisuals (e.g., videos,

Virtual Reality) – representing what you want to learn from the Internet text. Please rank the four types of information representation you like to read or view when you're learning something from the Internet in order of use from 1-4. (1: most likely to use / 2: likely to use / 3: not so much / 4: rarely use)

( ) written words ( ) visual ( ) audio ( ) audiovisual (video)

8. Find the type of text you rated as "1" and "2" in question 7 and write below why you like to use them when you learn from the Internet.

I like to read/view "1" because : ( )

I like to read/view "2" because : ( )

9. Find the type of text you rated as "3" and "4" in question 7 and write below why you are less likely to use them when you learn from the Internet.

I don't use "3" so much because : ( )

I rarely use "4" because : ( )

10. How often do you read the texts that consist of more than two different forms of information (e.g., written words, visuals, audio, or videos)? ( ) out of 10 times when I read on the Internet

11. How often do you use the texts from question 10 for academic purposes (e.g., learning new concepts, searching for information for academic writing, reading academic websites)?

( ) out of 10 times when I do something for academic purposes

12. How good are you at understanding the texts that consist of written words, visuals, audio, or videos? A. Quite good B. Adequate C. Not so good D. Not at all

13. How important is being a good Internet reader to your academic success?

A. Very important B. Important C. Not so much important D. Not at all

Appendix B

Prior Knowledge Report

Please type as much as you know about coral bleaching. There are three related questions that you can write your answers. If you don't know much about it, that is fine. You'll learn more during reading. I'll give you 10 minutes but let me know if you are finished at any point.

Question	Your answer
1. What is coral bleaching? What causes it?	
2. Why is coral bleaching dangerous?	
3. How do we prevent or stop coral bleaching?	

Appendix C

Semi-Structured Interview Questions

Category	Semi-Structured Post-Interview Questions	Purpose
Overall questions to ask about strategies	What did you think when you clicked on this hyperlink?	Understand the reader's strategic meaning-making process
	Why did you click on this mode?	
	Why did you open this tab?	
	Why were you pausing? What were you thinking here?	
	What method or strategy did you use when you were reading this part?	
Multimodal meaning-making strategies	Can you rate the usefulness of each mode or each text?	Discover multimodal reading strategies Focus on reading modes together (in conjunction, in the ensemble)
	What did you understand from reading these modes?	
	Can you describe how you used the different modes to construct meaning from across sources?	
	What type of information (mode) did you use the most or did not use?	
	How did these modes affect your comprehension/learning?	
	How did these modes hinder/distract your comprehension/learning?	
Overall reading and affective domain	How did you feel (motivation, perseverance, difficulties, interest) while reading these texts or this mode?	Find traditional reading strategies applied to OMR
	What was your prior knowledge that you brought here?	
	What did you learn or understand about this topic after reading these texts?	

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