EXPLORING THE VALUE OF PEER INTERACTION DURING ONLINE INQUIRY WITH A QUESTION GENERATION TASK

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EXPLORING THE VALUE OF PEER INTERACTION DURING ONLINE INQUIRY WITH A QUESTION GENERATION TASK

BY

CHANGHEE LEE

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN EDUCATION

UNIVERSITY OF RHODE ISLAND AND RHODE ISLAND COLLEGE

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DOCTOR OF PHILOSOPHY DISSERTATION

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2021
ABSTRACT

Many learners have difficulty making sense of and using multiple and diverse texts and applying complex reading strategies to solve problems on the Internet in academic settings. Some research suggests that opportunities for working together may help scaffold learners’ learning and develop multilevel comprehension strategies. Despite the potential of peer interaction in educational contexts, more work is needed to explore how working with a partner to solve problems influences specific literacy outcomes, such as gains in knowledge, strategic use of comprehension processes, or comprehension outcomes. This study used a quantitative-based qualitative approach (Chi, 1997) (a) to examine the value of peer interaction by comparing the individual and pair’s online inquiry-based question generation task (online QGT) performance and results and (b) to determine the factors that influence the online QGT results. Through an independent samples t-test, this study compared the quality of the questions generated by the students and the use of strategies by individuals and pairs during the online QGT. Two sets of two-way mixed ANOVAs were used to analyze both pre–post and individual-pair differences in knowledge and the attitudes toward tasks. Multiple regression analyses were conducted to predict the quality of the outcome of the online QGT. Follow-up qualitative analysis was conducted to illuminate shared or unique patterns of frequent strategy use between individual and paired participants who performed well on the online QGT.

Results show that all participants learned content knowledge and developed positive attitudes toward online inquiry activities. Among the two groups, pair students produced higher quality joint outcomes, but there was no difference between
individuals and pairs in knowledge and attitude. Another main finding of this study is that performing an inquiry task together through peer interaction activated the use of reading strategies, such as self-monitoring and meaning-making of participants. In particular, as revealed through multiple regression analyses, self-monitoring and meaning-making strategies were significant variables in predicting the quality of outcomes. The verbalization of thinking (e.g., think-aloud) and the negotiation process (e.g., peer interaction) played a major role in the activation of participants’ reading strategies and consequent cognitive development. In particular, when performing tasks together, the joint monitoring process increased the likelihood of performing tasks more successfully. Implications for educational practice, theory, and research are discussed.
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>ii</td>
</tr>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>iv</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>vi</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>x</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xii</td>
</tr>
<tr>
<td>CHAPTER 1</td>
<td>1</td>
</tr>
<tr>
<td>Statement of the Problem</td>
<td>1</td>
</tr>
<tr>
<td>Purpose of the Study</td>
<td>2</td>
</tr>
<tr>
<td>Research Questions and Hypothesis</td>
<td>3</td>
</tr>
<tr>
<td>Methods</td>
<td>6</td>
</tr>
<tr>
<td>Participants</td>
<td>6</td>
</tr>
<tr>
<td>Instruments</td>
<td>7</td>
</tr>
<tr>
<td>Procedures</td>
<td>8</td>
</tr>
<tr>
<td>Data Analysis</td>
<td>9</td>
</tr>
<tr>
<td>Significance of the Study</td>
<td>11</td>
</tr>
<tr>
<td>CHAPTER 2</td>
<td>12</td>
</tr>
<tr>
<td>Theoretical Perspectives</td>
<td>12</td>
</tr>
<tr>
<td>The Online Inquiry-based Question Generation Task (Online QGT)</td>
<td>14</td>
</tr>
<tr>
<td>Inquiry Tasks</td>
<td>14</td>
</tr>
<tr>
<td>Online Inquiry Tasks and Online Reading Comprehension</td>
<td>18</td>
</tr>
<tr>
<td>Question Generation as Part of Reading Comprehension</td>
<td>22</td>
</tr>
<tr>
<td>Question Generation in Online Inquiry Tasks</td>
<td>23</td>
</tr>
<tr>
<td>Online Reading Comprehension Strategies</td>
<td>26</td>
</tr>
<tr>
<td>Information Location</td>
<td>28</td>
</tr>
<tr>
<td>Meaning-making</td>
<td>34</td>
</tr>
<tr>
<td>Source Evaluation</td>
<td>39</td>
</tr>
<tr>
<td>Self-monitoring</td>
<td>46</td>
</tr>
<tr>
<td>Chapter Title</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Peer Interaction and Reading Comprehension</td>
<td>51</td>
</tr>
<tr>
<td>Peer Interaction from a Constructivist Perspective</td>
<td>51</td>
</tr>
<tr>
<td>Collaboration and Collaborative Learning</td>
<td>52</td>
</tr>
<tr>
<td>Peer Interaction in Reading Comprehension</td>
<td>57</td>
</tr>
<tr>
<td>Collaborative Peer Interaction in Reading Comprehension</td>
<td>59</td>
</tr>
<tr>
<td>Teaching Methods Using Peer Interaction in Reading Comprehension</td>
<td>66</td>
</tr>
<tr>
<td>Transferability of Reading Strategies through Collaborative Peer Interaction</td>
<td>69</td>
</tr>
<tr>
<td>CHAPTER 3</td>
<td>76</td>
</tr>
<tr>
<td>Participants</td>
<td>77</td>
</tr>
<tr>
<td>Instruments</td>
<td>81</td>
</tr>
<tr>
<td>Pre-post Knowledge Assessments</td>
<td>82</td>
</tr>
<tr>
<td>Pre-post Attitude Survey</td>
<td>85</td>
</tr>
<tr>
<td>Online QGT</td>
<td>86</td>
</tr>
<tr>
<td>Procedures</td>
<td>94</td>
</tr>
<tr>
<td>The Training Session</td>
<td>95</td>
</tr>
<tr>
<td>The Task Session</td>
<td>102</td>
</tr>
<tr>
<td>Data Analysis</td>
<td>106</td>
</tr>
<tr>
<td>Qualitative Phase</td>
<td>107</td>
</tr>
<tr>
<td>Quantitative Data Analyses</td>
<td>125</td>
</tr>
<tr>
<td>Qualitative Data Analysis</td>
<td>131</td>
</tr>
<tr>
<td>Chapter Summary</td>
<td>134</td>
</tr>
<tr>
<td>CHAPTER 4</td>
<td>136</td>
</tr>
<tr>
<td>Quantitative Results</td>
<td>136</td>
</tr>
<tr>
<td>Research Question 1</td>
<td>136</td>
</tr>
<tr>
<td>Initial Data Review</td>
<td>136</td>
</tr>
<tr>
<td>Mann-Whitney U Tests</td>
<td>138</td>
</tr>
<tr>
<td>Independent Samples t-Tests</td>
<td>140</td>
</tr>
<tr>
<td>Descriptive Comparison of Detailed Strategies</td>
<td>141</td>
</tr>
<tr>
<td>Research Question 2</td>
<td>159</td>
</tr>
<tr>
<td>Topic Knowledge</td>
<td>162</td>
</tr>
</tbody>
</table>
Self-Monitoring Strategy Use Is Central to the Quality of Inquiry Task Outcomes ................................................................. 221
The Relationship Between Learning Gain and QGT Outcome .................. 222
Implications from RQ3 ........................................................................................................................................ 223
Summary of Findings from the Qualitative Comparison of Comprehension Strategy Use among Higher-Performing Individual and Paired Readers ................................. 226
Implications from RQ4 ........................................................................................................................................ 229
Limitations .................................................................................................................................................. 231
Concluding Thoughts ........................................................................................................................................ 234
APPENDICES .................................................................................................................................................. 235
Appendix A: Consent Form ................................................................. 235
Appendix B: Knowledge Test .............................................................. 240
Appendix C: Attitude Test ................................................................. 244
Appendix D: Scoring Rubric ............................................................... 247
Appendix E: Handout for the Training Session ................................. 249
Appendix F: Handout for the Task Session (Individual) ...................... 256
Appendix G: Handout for the Task Session (Pair) .............................. 260
Appendix H: Google Doc .................................................................... 264
BIBLIOGRAPHY ........................................................................................................................................ 265
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1. <em>Demographics of Participants</em></td>
<td>80</td>
</tr>
<tr>
<td>Table 2. <em>Instruments</em></td>
<td>82</td>
</tr>
<tr>
<td>Table 3. <em>Three Evaluation Criteria to Consider for Generating a Compelling Question and Related Justification</em></td>
<td>97</td>
</tr>
<tr>
<td>Table 4. <em>Number of Spoken Words, Number of Speech Segments, and Length of Recorded Videos</em></td>
<td>109</td>
</tr>
<tr>
<td>Table 5. <em>Brief Description of Four Reading Strategies Used in the Online Reading Process (Adapted from Cho (2014))</em></td>
<td>111</td>
</tr>
<tr>
<td>Table 6. <em>Coding Scheme of the Reading Strategy with Detailed Strategic Actions and Their Explanations (Adapted from Cho (2011))</em></td>
<td>114</td>
</tr>
<tr>
<td>Table 7. <em>Average Frequencies of Reading Strategy Use and Average Scores of Questions and Justifications</em></td>
<td>132</td>
</tr>
<tr>
<td>Table 8. <em>Most Frequently Used and Unique Detailed Strategic Reading Actions Selected for Follow-up Qualitative Analysis</em></td>
<td>133</td>
</tr>
<tr>
<td>Table 9. <em>Descriptive Statistics and the Result of Shapiro-Wilk’s test of Four Reading Strategies</em></td>
<td>137</td>
</tr>
<tr>
<td>Table 10. <em>Results of Mann-Whitney U test of Information Location and Meaning-making Strategies and the Scores of Generated Questions and Justifications</em></td>
<td>139</td>
</tr>
<tr>
<td>Table 11. <em>Descriptive Statistics of the Four Reading Strategies</em></td>
<td>145</td>
</tr>
<tr>
<td>Table 12. <em>Descriptive Statistics of the Detailed Strategic Activities of the Information Location Strategy</em></td>
<td>146</td>
</tr>
</tbody>
</table>
Table 13. Descriptive Statistics of the Detailed Strategic Activities of the Meaning-making Strategy................................................................. 148

Table 14. Descriptive Statistics of the Detailed Strategic Activities of the Source Evaluation Strategy................................................................. 152

Table 15. Descriptive Statistics of the Detailed Strategic Activities of the Self-monitoring Strategy................................................................. 155

Table 16. Descriptive Statistics of Knowledge Assessment and Attitude Surveys ..... 159

Table 17. Summary of Two-Way Mixed ANOVAs for Topic Knowledge, Cognitive & Behavioral Engagement, Value/Interest, Anxiety, and Attitude toward Working Together (N = 68) ........................................................................................................... 161

Table 18. Means, Standard deviations, Ranges, and Intercorrelations among Learning gain, Information location, Meaning-making, Source evaluation, Self-monitoring, and the Scores of Generated Questions and Justifications (N = 45)................................. 169

Table 19. Summary of Multiple Regression Analysis for Variables Predicting the Quality of Generated Questions and Justifications (N = 45) ......................... 171

Table 20. Summary of Hierarchical Regression Analysis for Variables Predicting the Quality of Generated Questions and Justifications A (N = 45) ......................... 172

Table 21. Summary of Hierarchical Regression Analysis for Variables Predicting the Quality of Generated Questions and Justifications B (N = 45) ......................... 175
<table>
<thead>
<tr>
<th>FIGURE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1. <em>The Whole Procedure of Data Collection and Analyses</em></td>
<td>95</td>
</tr>
<tr>
<td>Figure 2. <em>A Schedule for the Task Session</em></td>
<td>101</td>
</tr>
<tr>
<td>Figure 3. <em>The Procedure of the Online QGT in the Task Session</em></td>
<td>104</td>
</tr>
<tr>
<td>Figure 4. <em>Sub-strategies and Detailed Strategic Actions of Information Location Strategy</em></td>
<td>142</td>
</tr>
<tr>
<td>Figure 5. <em>Sub-strategies and Detailed Strategic Actions of Meaning-making Strategy</em></td>
<td>143</td>
</tr>
<tr>
<td>Figure 6. <em>Sub-strategies and Detailed Strategic Actions of Source Evaluation Strategy</em></td>
<td>144</td>
</tr>
<tr>
<td>Figure 7. <em>Sub-strategies and Detailed Strategic Actions of Self-Monitoring Strategy</em></td>
<td>144</td>
</tr>
<tr>
<td>Figure 8. <em>Difference in Topic Knowledge Scores across Time and Group</em></td>
<td>162</td>
</tr>
<tr>
<td>Figure 9. <em>Difference in Cognitive &amp; Behavioral Engagement across Time and Group</em></td>
<td>163</td>
</tr>
<tr>
<td>Figure 10. <em>Difference in Value/Interest across Time and Group</em></td>
<td>164</td>
</tr>
<tr>
<td>Figure 11. <em>Difference in Anxiety across Time and Group</em></td>
<td>165</td>
</tr>
<tr>
<td>Figure 12. <em>Difference in Working Together across Time and Group</em></td>
<td>167</td>
</tr>
<tr>
<td>Figure 13. <em>An Example of Featured Snippets</em></td>
<td>179</td>
</tr>
</tbody>
</table>
CHAPTER 1
INTRODUCTION

Statement of the Problem

Today’s learners routinely turn to the Internet for academic, work-related, and personal reasons (Pew Research Center, 2014). Yet the emergence of digital media has transformed the concept of text and reading comprehension in ways that introduce new challenges for learners of any age. Comprehending information in digital texts, including electronic texts and multimedia documents, requires that readers navigate nonlinear hypertext (Rouet et al., 1996; Salmerón et al., 2005) while reading across multiple documents (Bråten, Britt et al., 2011; Stadtler & Bromme, 2007). In addition, digital texts require more complex levels of reading comprehension skills compared to those needed for conventional single text reading (Cho et al., 2017; Coiro & Dobler, 2007; Kiili et al., 2009). Thus, learners need to be aware of and use additional reading strategies in order to make sense of information they encounter on the Internet.

Unfortunately, research has shown that learners have difficulty making sense of and using multiple and diverse texts (Anmarkrud et al., 2014). They also have difficulty applying complex reading strategies to solve problems in academic settings (Cho et al., 2017). For example, readers experience disorientation and navigation problems because hypertext involves more complex nonlinear text structures compared to linear texts that are organized in more hierarchical structures (Foltz, 1996; Rouet & Levonen, 1996). In addition, readers are expected to have prior knowledge of how to locate information on websites and in search engine results,
while applying multilevel inferential reasoning and self-regulation strategies beyond those typically required to navigate print-based texts (Coiro & Dobler, 2007).

Some research suggests that opportunities for working together may help scaffold learners’ learning as they engage with increasingly complex texts and multilevel comprehension strategies. Collaboratively working with a partner can help learners solve problems and foster a deeper understanding of important content (Kirschner et al., 2009; Liu & Hmelo-Silver, 2010; Salomón & Perkins, 1998). In fact, some studies have found that working with a partner can improve an individual reader’s ability to construct meaning and formulate responses to an online inquiry task (Coiro et al., 2011; Coiro et al., 2014). Other researchers, however, have pointed out that beneficial effects are not guaranteed simply by working with a partner, particularly if the partners do not know each other (Mäkitalo et al., 2005) or if they use different ways of talking and thinking (Mercer, 1995).

Despite the potential of peer interaction in educational contexts, more work is needed to determine if and how collaborative work with a partner is more beneficial than working individually to solve academic problems. Moreover, few studies have sought to explore how working with a partner to solve problems influences specific literacy outcomes, such as gains in knowledge, strategic use of comprehension processes, or comprehension outcomes.

**Purpose of the Study**

The purpose of this study is to examine the effects of working jointly with a partner through peer interaction by comparing differences between individual readers and paired readers in terms of task-specific knowledge gains, strategic reading
processes, and comprehension outcomes as measured by a Question-Generation Task (QGT) at the end of their online inquiry activity. Another purpose of this study is to determine the factors that influence the online QGT results.

**Research Questions and Hypothesis**

More specifically, this study will involve a set of questions to compare performances of an online QGT between the individual and pair groups:

*Research Question 1a*: Are there significant differences in the frequencies of using four reading strategies (information location, source evaluation, meaning making, and self-monitoring) between individuals and pairs of college students completing an online QGT?

*Research Question 1b*: Is there a significant difference in the quality of reader-generated questions and justification between individuals and pairs of college students as an outcome of an online QGT?

*Research Question 2*: To what extent do paired students learn knowledge about the inquiry topic and change attitudes toward online inquiry, compared to individuals after completing an online QGT?

**Hypothesis (RQ 1-2)**: Previous work on collaborative learning suggested that, when students in a same group work together through collaborative interaction, they are more likely to construct joint knowledge and produce better joint outcomes (Hmelo-Silver, 2004) and, in turn, an individual student can improve knowledge acquisition and learning (Fawcett & Garton, 2005). Moreover, socio-constructivists have pointed out that, when students work together, high-level cognitive skills (Momtaz & Garner, 2010), comprehension skills (Palinscar & Brown, 1984), and
critical thinking skills (Chen et al., 2018) might be acquired or improved through the development of metacognitive skills such as regulation (Fleming & Alexander, 2001).

As a part of answering these research questions, statistical analyses were implemented to compare the process and the outcome of an online QGT between the groups of individual and paired readers. For RQ1, independent samples t-tests and the Mann-Whitney U tests were used to test differences of online reading strategy use and the outcome of an online QGT between the groups of individual and paired readers. To address RQ2, two-way mixed ANOVAs were used to verify both pre- and posttest changes in knowledge on the topic and the attitudes toward tasks, and the differences between individuals and pairs.

Another set of research questions was used to explore the relationships between the quality of student performance outcomes and types of reading strategy use and/or learning gains:

Research Question 3a: To what extent does performance of four reading strategies (information location, source evaluation, meaning-making, and self-monitoring) and learning gains predict the quality of reader-generated questions and justifications in an online QGT?

Research Question 3b: Do source evaluation and information location predict the quality of reader-generated questions and justifications in an online QGT over and above: (a) self-monitoring, (b) learning gains, and (c) meaning-making?

Research Question 3c: Does self-monitoring predict the quality of reader-generated questions and justifications in an online QGT over
and above: (a) learning gains, (b) meaning-making, (c) source evaluation, and (d) information location?

Hypothesis (RQ3): Previous work on online reading comprehension based on new literacies theory (Leu et al., 2013; 2017) have suggested that new adaptive skills are necessary to be a successful reader in a rapidly changing society. In addition, many studies of online reading have reported that readers used mainly four online reading strategies: information location, meaning-making, source evaluation, and self-monitoring (Cho et al., 2017; Coiro & Dobler, 2007).

The purpose of a set of regression analyses was to determine whether or not a reader’s use of the four reading strategies and learning gains significantly predict the outcome of an online QGT. Furthermore, this study hypothesizes that either new strategies emphasized in online reading (e.g., information location and source evaluation) or metacognitive strategy (e.g., self-monitoring) will predict the quality of outcome of an online QGT over and above learning gains and uses of other reading strategies.

In addition to these three quantitative research questions, this study also explored a qualitative question to explore and analyze how the specific reading strategies were used by participants while completing the assigned online QGT:

Research Question 4: What are the shared or unique characteristics of strategic reading processes employed by higher-performing individuals and pairs as they complete an online QGT?

The purpose of the qualitative analysis of this study was to examine the characteristics of online reading strategies more closely. A qualitative analysis of the
successful uses of online reading strategies may provide important examples and identify critical patterns to extend the interpretation of quantitative analyses. These examples may characterize similarities or differences in online reading strategy use between higher-performing individuals and pairs of readers while completing an online QGT.

**Methods**

**Participants**

Purposive sampling (Patton, 2015) was applied to explore how students work collaboratively with a partner to solve an online QGT. Purposive sampling differs from convenience sampling in that the sample is selected by the judgment of the researcher. The strength of purposive sampling is that it selects information-rich cases to perform in-depth studies (Patton, 2015).

Several criteria for selecting participants were considered during the sampling procedure. First, the researcher selected college-level students because an online QGT is a complex process that requires readers to use diverse reading strategies to locate, evaluate, synthesize, and communicate relevant information from Internet sources, reflecting higher-order thinking skills and critical thinking abilities. Second, students in their freshman year of college were recruited because the online QGT involved activities that are commonly assigned to first-year college students. Third, the researcher selected a class that consisted of mostly freshman college students (and a few upperclassman) who were already expected to do online research as part of their coursework to avoid creating artificial reading situations.
After asking for consent from instructors of several freshman-level liberal arts courses, I chose one particular course at a state university in the eastern United States. In 2020, the university enrolled 14,687 undergraduates, including 3,277 first-year students. Students’ participation in the study was not mandatory and a total of 68 out of the 75 students enrolled in the course consented to participate in the study (See Appendix A). The 68 students then were randomly assigned to either an individual reading session (n=22) or a paired reading session (n=46, 23 dyads).

**Instruments**

*Pre-post knowledge assessment.* A researcher-developed set of 24 questions related to the inquiry topic (adapted from Cho et al., 2017) was administered to measure the learners’ knowledge on the topic before and after they engaged in the online QGT (See Appendix B). Each assessment consisted of 24 items: ten multiple-choice literal questions (1 point each), ten true-false inferential questions (1 point each), and four analytical questions (3 points each), with points from each question type accumulated into a composite score (maximum = 32 points). To minimize any testing effect, the pretest was conducted five weeks earlier than the online reading and posttest session.

*Pre-post attitude survey.* Students’ attitudes toward the online inquiry task were measured by an 18-item survey with responses scored using a 6-point Likert scale ranging from strongly disagree (1) to strongly agree (6) (See Appendix C). The survey consisted of three subscales: cognitive and behavioral engagement (8 items), value/interest (6 items), and anxiety (4 items). It was administered twice, both in the
training session before participants complete an online QGT as a pre-survey and immediately after finishing the task as a post-survey in the task session.

**Online reading strategy performance measure.** All participant actions and think-aloud/dialogic interactions for each online inquiry session were captured by video and later transcribed to rate the frequency of online reading strategy use. The frequency of reading strategies that students engaged in, either individually or with a partner, were counted using a coding scheme consisting of four main processes: information location, meaning-making, source evaluation, and self-monitoring (see Table 4 in Chapter 3).

**Post-reading write-up.** Participants’ generated questions and their justifications were scored using Cho et al.’s (2017) rubric, which was organized by three criteria (relevance, validity, and significance) and four quality descriptions for each criterion (complete: 3, adequate: 2, partial: 1, lacking: 0), with a maximum of 9 points (see Appendix D).

**Procedures**

As students completed this task, both individuals and pairs of readers engaged in talking aloud about their thinking process. Many studies have used think-aloud protocols to identify participants’ reading processes and strategy use (Cho et al., 2017; Coiro et al., 2011; Coiro & Dobler, 2007; Pressley & Afflerbach, 1995; Zhang & Duke, 2008). Among them, several studies have used interaction protocols (Miyake, 1986) to capture the process of co-constructing meaning or strategies used in paired reading situations (Coiro et al., 2011; Kiili et al., 2012). Based on social constructivist theory, which posits that knowledge is co-constructed within a social interaction,
observing paired reading is thought to be a more natural way of eliciting an individual reader’s thinking and how knowledge is co-constructed during online inquiry (Kiili et al., 2012; Palincsar, 1998).

Consequently, the first part of the procedure introduced students to think-aloud interaction practices. In a single two-hour training session, participants received training on verbal reporting and how to construct a high quality question. Students who were assigned to the individual reading session were taught how to talk out loud about what they are thinking and doing as they engaged in the online reading task. Students who were assigned to the paired session received training on how to talk about what they are thinking when engaging in conversation with their partner. All students were also asked to complete a pre-test measure of their prior knowledge about the inquiry topic and their attitudes toward the inquiry task.

In the task session, students engaged in a 60-minute online inquiry task about the assigned controversial topic in order to generate a question that would stimulate discussion and increase rich understanding among a hypothetical audience of their peers (see Cho et al, 2017). After completing the online inquiry task, participants individually or jointly (i.e., under paired reading conditions) wrote one question and an associated rationale for the importance of that question. Students were then asked to complete a post-test measure of topic knowledge and attitudes toward the inquiry task.

**Data Analysis**

To answer Research Question 1, I conducted independent samples t-test (the Mann Whitney U test) to compare group differences in reading strategy use and the
quality of generated questions and justifications. In each case, the independent variable was the difference between groups (individual and paired reading conditions) and the dependent variables were the frequencies of each of the four reading strategies and the quality of generated questions and justification (scored by a rubric, 0-9 points).

For Research Question 2, I employed two sets of two-way mixed analyses of variance (ANOVAs) to determine pre-post differences in knowledge and attitudes between individuals and pairs. To determine pre-post differences between the two groups on the knowledge measure (scored between 0-32 points), I conducted one two-way mixed ANOVA with one between-subjects independent variable with two levels (individuals vs. pairs) and one within-subjects independent variable with two levels (pretest and posttest). Another set of two-way mixed ANOVA with one between-subjects independent variable with two levels (individuals vs. pairs) and one within-subjects independent variable with two levels (pretest and posttest) was conducted to determine pre-post differences between the two groups on the survey of attitudes toward online inquiry (6-point Likert scale).

To address Research Question 3, a set of regression analyses (multiple regression analysis and hierarchical multiple regression analysis) were conducted to investigate which reading strategies and knowledge gains significantly contributed to the quality of generated questions and justifications. Based on findings from Cho and colleagues (2017), the hypothesis was that reading strategies in the regression model will predict the quality of students’ generated questions in this sequence: meaning-making, self-monitoring, source evaluation, and information location. In Cho’s study, self-monitoring, meaning making, and source evaluation jointly predicted the quality
of the generated question significantly, but only meaning-making predicted the quality of the generated question directly, albeit with marginal significance.

Finally, for Research Question 4, follow-up qualitative analyses of a small subset of participants compared the similarities and differences in how individuals and pairs of readers who received high scores on QGT outcomes engaged in the online inquiry process.

**Significance of the Study**

Today’s digital world is inherently collaborative (Verbeek-Cowart, 2016). Therefore, efforts to understand the nature of collaboration in the context of online inquiry are timely and important. Working with peers may help students work through the complexities of online inquiry across multiple sources (see Chen et al., 2018). Further, generating questions as a product of online inquiry has the potential to activate metacognitive and critical comprehension strategy use in ways that foster understanding of challenging content (Cho et al., 2017).

Findings from this study shed new light on how peer interaction may influence students’ comprehension processes and learning outcomes as part of online inquiry. In addition, this study contributes to emerging work that examines the role of question generation, which has been relatively ignored in earlier work as a crucial factor influencing the overall inquiry process and the quality of learning outcomes.
CHAPTER 2
REVIEW OF LITERATURE

The majority of this chapter provides a review of the relevant literature pertaining to online inquiry-based question generation tasks (QGTs), online reading strategies, and peer interaction.

The first section of this chapter reviews the literature on online inquiry tasks and question generation to describe a particular feature of online QGTs. Specifically, this section reviews the instructional value of online inquiry tasks in content learning and the development of reading skills as well as the importance of question generation as an outcome of the inquiry task. The second section reviews the existing literature on online reading strategies, focusing on four main reading strategies: information location, meaning-making, source evaluation, and self-monitoring. Finally, the third section of this chapter discusses the available literature on peer interaction. This section reviews the value of peer interaction in collaborative learning tasks and the transferability of reading strategies through peer interaction. Throughout this review, it becomes evident that there is a need for further work exploring the instructional value of peer interaction in online QGTs for content learning and the development of cognitive reading skills.

Theoretical Perspectives

Two interconnected sets of theories inform my interest in whether working with a partner during an online inquiry fosters individual strategic comprehension and learning and, if so, what mechanisms facilitate this process. First, I draw on a new literacies perspective of online research and comprehension that suggests that online
inquiry involves a process of asking questions, then locating, evaluating, synthesizing, and communicating information to answer those questions (Leu et al., 2013; 2017). This study extends these ideas in two ways. First, given some evidence that proficient readers engage in online reading strategies, such as information location, meaning-making, source evaluation, and self-monitoring as they use the Internet to answer their questions (Afflerbach & Cho, 2009), I examine readers’ online research and comprehension processes through reading strategies uses while they engage in the online inquiry task. Second, since generating questions can activate critical thinking and metacognitive skills for learning from online sources and is considered to be an important strategy in text comprehension (Cho et al., 2017), I used online QGTs as a task to develop and capture readers’ cognitive comprehension skills at the same time.

Secondly, I draw on Vygotsky’s (1978) social constructivist theory, which posits that the nature of all learning is inherently social, context-based, and interactive, even when initially socially acquired strategies become internalized. Wertsch (1979) applied Vygotsky’s zone of proximal development to explain how social interaction plays an important role in the development of higher mental functions. By Wertsch’s account, learners acquire independent problem-solving abilities by transitioning from methods of other-regulation to those of self-regulation; that is, learners first solve problems by watching and interacting with others who model useful meta-cognitive and strategic behaviors then gradually self-regulate their own problem-solving behaviors over time.

Wertsch’s theory suggests there is the potential for paired individuals to adopt both independent problem-solving regulation abilities and online reading strategies as
they interact with each other during online inquiry. Working collaboratively can also increase students’ conceptual understanding of the subject matter (Liu & Hmelo-Silver, 2010) and their ability to construct new ideas (Salomon & Perkins, 1998). Consequently, when learners collaboratively engage in online inquiry, it seems they can absorb more from their reading and use the gained knowledge to generate higher-quality questions that reflect a deeper understanding of the subject at hand.

**The Online Inquiry-based Question Generation Task (Online QGT)**

**Inquiry Tasks**

According to American educational philosopher John Dewey (1938b), humans learn from a series of experiences, which require reflective thinking and cognitive reconstruction to take place between experiences to result in true learning. Reflective thinking entails a set of psychological processes that solve the problems that people face in their natural and social environments. When undertaken deliberately it has been called ‘inquiry’ (Dewey, 1938b; Schön, 1992; Rodgers, 2002), as “it begins with an indeterminate situation (i.e., confusing, obscure, or conflictual) and goes on to make that situation determinate.” (Schön, 1992, p. 122). The inquiry process is transactional, open-ended, and inherently social. Because the inquirer’s perspective is from inside the problematic situation(s), Dewey believed that true learning begins with the innately human quality of curiosity, which is activated according to the situation or problem of the learner (Dewey, 1938a; Savery, 2006).

In the course of the 20th century and into the present, his ideas prompted extensive discussion around learner-centered education that is socially relevant, giving more attention than previously to the autonomy of the learner in shared social
concerns. As a result, educators began to pay more attention to the learning methods in which students solve problems related to their lives and society at large. These methods were collectively labeled in various ways, including inquiry-based learning, project-based learning, and problem-based learning, largely depending on the various academic disciplines and political associations of the time. For example, ‘inquiry-based learning’ was the term commonly used in the field of science education. Meanwhile, ‘problem-based learning’ originated in medical education, but was later adopted by researchers in several other educational disciplines.

Although there are still some remaining differences among today’s researchers, these terms generally have the following features in common (Savery, 2006; Aditomo et al., 2013). Students are considered to learn best when they are challenged to assume an appropriate degree of autonomy and responsibility over their own learning, wherein the role of educator is that of a more knowledgeable guide, facilitator, or coach. Students should be able to redefine the problem and to identify both the resources they need and the knowledge they need to possess in order to successfully complete a given activity. In addition, they should be challenged to articulate and apply their learning to new situations.

For all the variety and debates around what broadly has gone under the label of “progressive education,” contemporary Deweyan’s overwhelmingly agree that the purpose of inquiry learning is to collaboratively solve real-world problems centered around people (e.g., Schön, 1992; Feinberg, 2016). In most situations, such problems are unstructured and open-ended in a way that encourages free inquiry. However, sometimes a problem is more specific, depending on the purpose of the activity. Coiro
et al. (2019) divided the level of learner autonomy into ‘modeled,’ ‘structured,’ ‘guided,’ and ‘open inquiry,’ according to the responsibilities assigned to the learner, with open inquiry denoting when learners are free to make all decisions based on their interests. For younger students, it is more difficult for them to decide everything themselves (Edelson et al., 1999). For example, they may feel difficulty in deciding the inquiry topic, locating potential sources, evaluating information from texts, and synthesizing information they find, as these activities require high levels of metacognitive skills.

Next, to solve problems, learners conduct investigative research on topics or information related to the assigned task. As a result, learners produce a tangible output. Therefore, ‘inquiry’ is the activity of acquiring and applying new knowledge throughout the process of problem solving and, ultimately, its application. Inquiry is associated with continuous and reflective reasoning (Linn & Slotta 2006), information gathering skills, and problem-solving methods. During the inquiry process, learners use various cognitive strategies, refine ideas as they gather additional information, and compare results with solutions generated by others to work towards problem solving (Castek et al., 2012).

Researchers point to the following primary advantages of inquiry learning: concept/knowledge learning and the development of inquiry skills (e.g., problem-solving skills). Inquiry-based learning has the advantage of deepening the learner’s understanding of the given topic of inquiry. For example, students may acquire science-related knowledge and/or an understanding of scientific concepts during
inquiry activities via methods such as problematization, demand, discovery and refinement, and application (Edelson et al., 1999).

‘Problematizing’ means that learners discover gaps in their domain knowledge and this process motivates learners to become more curious about a topic. ‘Demand’ refers to the awareness that learners need certain additional relevant content knowledge to have an inquiry activity be successful. ‘Discovery and refinement’ refers to when learners actually learn new facts or deepen their previous knowledge while finding the answers to questions during inquiry activities. Finally, ‘application’ refers to the idea that the inquiry activity gives the learner the opportunity to apply what they know, thereby strengthening the learner's connection with the learned content knowledge.

Beyond concept learning, inquiry activities can facilitate the development of general inquiry skills (Edelson et al., 1999; Kuhn & Pease, 2008). Through finding research topics according to open-ended questions, students hone their inquiry skills to eventually conduct research more efficiently. In other words, general inquiry skills are necessary for students to complete independent activities related to inquiry, including posing and refining research questions, planning and managing an investigation, and analyzing and communicating results. According to Kuhn and Pease (2008), as a result of conducting inquiry-based learning at a sequence of progressively more demanding level, students showed substantial progress in understanding the objectives of inquiry, identifying questions, attending to evidence, identifying patterns, making controlled comparisons, interpreting increasingly complex data, supporting claims, and drawing justified conclusions over the course of three years. However, the results also
maintained that the students had difficulty realizing the purpose of the inquiry and synthesizing information to infer the results (Kuhn & Pease, 2008).

**Online Inquiry Tasks and Online Reading Comprehension**

In the broad field of reading comprehension, there have been many studies with an interest in the similarities between the process of inquiry activities and the process of reading comprehension (c.f. Castek et al., 2012; Coiro et al., 2016). Furthermore, because the amount and scope of information that learners can access on the Internet is virtually infinite, learners need various levels of complex cognitive skills to use resources efficiently and these skills are very similar to the inquiry skills required for success in more general inquiry activities.

Researchers who take a new literacies perspective of online research and comprehension define inquiry on the Internet as “a problem-based process involving the additional skills, strategies, dispositions, and social practices that are important as we use the Internet to solve problems and answer questions” (Kiili et al., 2012, p. 450). From this perspective, at least five processing elements occur during online research and comprehension: reading to define important questions, reading to locate online information, reading to critically evaluate online information, reading to synthesize online information, and reading and writing to communicate online information (Leu et al., 2004).

Similarly, researchers studying multiple-source comprehension argue that multi-text reading and online inquiry are inherently similar. Wiley et al. (2009) examined the pattern of learners' reading comprehension in a science inquiry task using a multiple-source comprehension framework. They viewed online inquiry as a
type of learning task that provides an opportunity to explore the process of evaluation, analysis, synthesis, and integration of multiple sources. According to Wiley et al. (2009), in general, an inquiry contains five essential functions: (a) engaging students in scientifically oriented questions, (b) using evidence to respond to questions, (c) formulating explanations on the basis of evidence, (d) connecting explanations to scientific knowledge, and (e) communicating and justifying explanations.

Meanwhile, several researchers have made attempts to apply online inquiry as an actual teaching and learning method for online reading comprehension (Coiro et al., 2016; Dwyer, 2013; Hoch et al., 2019; Wiley et al., 2009). These studies claim that online inquiry activities can help learners develop the skills and strategies necessary to properly absorb content read from online sources. First, Hoch et al. (2019) introduced guided inquiry as a teaching method for proficiency of multimodal text comprehension skills in a digital environment and introduced five key principles necessary for effective instruction: (a) attending to motivation and engagement, (b) thoughtfully selecting sources, (c) framing instruction as inquiry, (d) supporting student synthesis, and (e) writing for an authentic audience and purpose. In addition, they viewed the inquiry task as a natural way to teach online reading because learners engage in online reading activities such as finding, evaluating, and synthesizing information during online inquiries.

Dwyer (2013) suggested the online inquiry activity be used as a practical teaching activity for the development of online reading strategies in struggling readers. She viewed online reading comprehension development in the context of the information-seeking cycle: (a) goal formation, planning, and constructing meaningful
question, (b) generating and revising search terms and investigating search results with a critical eye, (c) locating and critically evaluating online information, and (d) synthesizing and communicating information to others. She further argued that self-regulating reading skills such as planning and questioning, reasoning, building prior knowledge connections, monitoring, and clarifying could be developed through online inquiry activities, especially in a collaborative environment.

According to Wiley et al. (2009), the skills related to inquiries include searching, evaluating, and understanding information sources, which are essential in online reading as well. Beyond an individual’s skill set, individual argumentation skills and the epistemological stance of a learner can influence the inquiry process. In addition, the fulfillment of self-regulatory and metacognitive processes like planning, monitoring, and implementing strategies is required for effective inquiry learning.

Coiro et al. (2016) introduced a framework of Personal Digital Inquiry that involves “a set of practices in which students actively (a) inquire, (b) collaborate and discuss, (c) participate and create, and (d) reflect” (p. 484) based on principles of inquiry-based learning. They note the importance of learners learning problem-solving skills (i.e., “learning how to learn”) through inquiry activities and, in particular, they emphasize the importance of learners’ ability to find and integrate information from many texts of various perspectives and to use appropriate digital tools when constructing social meaning through cooperation. They also characterize the importance of learner reflections that “... consider content learned, metacognitively examine the processes used, and mull over choices they made to improve the process for future action” (p. 486), while also noting that reflection can be the start of a new
inquiry. The ideal result of any inquiry activity is for participants to create a new or modified question through comprehensive learning. Reflection “enables students to reframe problems, identify gaps in their knowledge, and decide what additional inquiries may be necessary” (p. 486).

In summary, online inquiry is a student-centered teaching and learning method that can develop students' online reading skills. During inquiry activities, students develop a repertoire of reading strategies and improve their reading skills. Clearly, the ability to understand an initial question and to learn more about various elements related to the problem is a central aspect of online inquiry for readers (Leu et al., 2013). For the purposes of the present study, the online inquiry task begins with a problem in the form of a question and ends when participants communicate the question’s answer to others.

Typically, to study how readers engage in online inquiry, the researcher generates a guiding question. Moreover, all students begin with this same question, which makes it easier to compare different readers’ online inquiry performance. To complete the problem-based inquiry task, readers are then asked to locate, critically evaluate, and synthesize answers to the question; however, learners are also asked to generate new questions as a result of their inquiry activities. This serves as a reflection process in the inquiry activity, helping learners to immerse themselves in the task and to check their personal knowledge gaps. Ultimately, it should provide a good opportunity for individuals to understand the results of a given inquiry activity cycle before the start of a subsequent inquiry activity.
Question Generation as Part of Reading Comprehension

Question generation has been recognized as an important reading strategy that can be used before, during, and/or after text reading (Palincsar & Brown, 1984). Many studies (c.f. Palincsar & Brown, 1984; Rosenshine et al., 1996; Wong, 1985) have explained that the positive factors that question generation has on the reading comprehension process unfold primarily as follows.

First, question generation helps the reader understand a text on a deep level. During questioning, students focus on the main ideas and details of the text as they immerse themselves in various cognitive processes that require a more in-depth interaction with the text (Taboada & Guthrie, 2006). According to Palincsar and Brown (1984), self-directed questioning leads students to more actively monitor their reading process. In other words, by asking questions, students can better grasp the important information described in the text and self-verify their own understanding.

Second, question generation can activate a learner’s reading process. Rather than looking for answers to questions presented by teachers or researchers, the activity of finding answers to questions they have generated on their own helps learners to immerse them in reading comprehension activities more actively. In this regard, Wong (1985) found that when readers generate higher-order questions, readers are assumed to induce more thorough processing of given materials (Rickards & Di Vesta, 1974), which further fuels the reading process.

Third, question generation contributes to activating prior domain knowledge that can help readers read associated text (Taboada & Guthrie, 2006). According to schema theory, if the reader lacks adequate prior knowledge, the reader may struggle
with reading comprehension. However, readers can have difficulties with reading comprehension not only when prior knowledge is insufficient, but also when prior knowledge is not properly activated (Bransford & Johnson, 1972). Generating appropriate questions is therefore meaningful in that it helps activate the reader's appropriate prior knowledge of the content of a given text.

**Question Generation in Online Inquiry Tasks**

Many existing studies on online inquiry activities have recognized that generating a question on a research topic is an important activity for starting an online inquiry activity (Castek et al., 2012; Henry, 2006). Also, research has demonstrated that “how one understands a given question” or “what kinds of questions about a topic are generated” has a large influence on the remainder of the inquiry activity (Leu et al., 2011). According to the degree of learner autonomy, inquiry activities exist on a spectrum from guided inquiry to open inquiry. Ideally, inquiry learning aims to explore fully-autonomous or open inquiry; however, if students bear virtually all inquiry responsibilities, this requires a high level of cognitive demand (burden) and can ultimately lower students’ task performance.

In the context of teaching and learning, the questions of inquiry activities are generally provided by the researchers or instructors to reduce the burden on learners. This is called structured inquiry or guided inquiry. In this case, students engage in activities such as finding answers or results by investigating a pre-determined prompt or question. This type of inquiry activity, in which questions are given by professors or researchers, acts as an intermediary step toward open-ended inquiry. There are several advantages of this set-up to specific aspects of teaching and learning.
First, when inquiry learning is used for the purpose of developing cognitive reading comprehension skills and strategies, it is effective to have students perform inquiry activities using the same topic and prompt question(s) to practice reading comprehension strategies. Next, when learning content about a specific topic covered in an academic course, such as social studies or science, specific questions are often asked by a professor. Further, performing an inquiry activity on a topic commonly assigned by teachers is mainly used when learning the target content or reinforcement of learned content is required.

This, however, can result in limited engagement for readers, as researcher-designed questions are less apt to be connected to each readers’ own personal wonderings about the world (Coiro et al., 2019). For example, because questions posed by researchers or instructors guarantee less autonomy for learners, learners may feel less responsible for inquiry activities and may not participate as actively because they are not intrinsically motivated. If this occurs, effective learning or reading comprehension skill development may not occur.

Ultimately, the ideal purpose of inquiry learning is to allow learners to perform independent inquiry activities using questions generated from their own curiosity or open-ended inquiry. In this case, learners can participate in the inquiry task more autonomously and actively because they designate all processes of the inquiry ranging from question generation, process, and solution (Banchi & Bell, 2008).

Activities that invite readers to generate their own inquiry questions can reinforce individuals’ intrinsic motivation in ways that help them persist and devote more effort to completing challenging tasks (Ciardiello, 2006), especially tasks that
involve strategic meaning-making for the purposes of gaining knowledge (Guthrie et al., 2004). Beyond motivational purposes, question generation is an important tool for improving text understanding and can help readers engage in critical thinking. Question-generating activities can also promote meta-cognitive strategies that allow readers to continuously monitor their own processes as the goal of online reading (Cho, 2014; Cho et al., 2017). Consequently, if readers perform an online inquiry task that involves generating their own question, they may make more strategic reading decisions while engaging in solving the inquiry-related problem at hand (Cho et al., 2017; Leu et al., 2011).

However, when it is difficult to guarantee the full autonomy of learners, using an inquiry task that asks students to generate an inquiry question based on a given topic at the end of the task can be a supplement that can relieve the cognitive burden on learners but still encourage their active interest and participation. In addition, by moving the act of generating questions from the beginning of inquiry to the end of the task, learners are likely to have more knowledge about the problem and can compose thoughtful questions that reflect newly gained understanding.

Adding question generation as a final component of an online inquiry task offers several new avenues for research. First, activities that incorporate self-generated questions more closely align with authentic inquiries as they allow students to have a sense of ownership. This likely promotes increased autonomy, which may also stimulate intrinsic motivation during the inquiry process (Chu et al., 2011). Second, while generating their own questions, students will put forth more effort into using reading strategies effectively for successful comprehension (Cho et al., 2017), which
may allow students to learn additional reading strategies or to practice applying existing reading strategies in their repertoire. Finally, the opportunity to generate questions allows students to learn new knowledge by constructing meaning from multiple sources. This reflects students’ learning based on their curiosity and interest, two prerequisite elements of any generative and authentic inquiry process (Dewey, 1923; Rodgers, 2002).

Overall, many studies of online inquiry have focused on how to characterize readers’ in-process use of comprehension strategies as they engage in online inquiry with given questions (Coiro & Dobler, 2007; Goldman et al., 2012). In addition, student-generated questions can be used as outcomes to demonstrate how cohesively readers construct new meaning through multiple sources.

**Online Reading Comprehension Strategies**

Newly developed information and communication technologies centered around the Internet are changing the aspect of literacy performance. Accordingly, many researchers have studied the application of reading strategies on the Internet. Several studies have defined and modeled Internet reading or online inquiry activities as continuous and complex strategic activities (Afflerbach & Cho, 2009; Brand-Gruwel & Wopereis, 2006; Leu et al., 2013; 2017).

From the perspective of the new literacies of online research and comprehension, many researchers have framed online reading comprehension as a process of problem-based inquiry, involving the additional skills, strategies, dispositions, and social practices that individuals employ when they collect information from the Internet to solve problems and to answer questions. (Leu et al.,
Five major processing practices have been identified to encompass all components of online reading comprehension: (a) reading to identify important questions, (b) reading to locate information, (c) reading to critically evaluate information, (d) reading to synthesize information, and (e) reading to communicate information.

Other researchers that have conducted thorough reviews of studies investigating multiple document reading in both print-based and Internet-based settings from the model of constructively responsive reading comprehension strategies used during Internet hypertext reading, divide the strategic process of Internet reading into four categories: (a) information location, (b) meaning-making, (c) source evaluation, and (d) self-monitoring (Afflerbach & Cho, 2009; Cho et al., 2017).

Still others named the activity of searching for information on the Internet as “information-problem solving,” a process consisting of five major activities: (a) defining and understanding an information problem, (b) using a search engine and keywords to search for information, (c) scanning, evaluating, and selecting a subset of webpages (d) scanning, evaluating, and selecting information from the webpages, and (e) processing and integrating the information from different webpages to construct the answer to a particular question (Brand-Gruwel & Wopereis, 2006; Hinostroza et al., 2018; Walraven et al., 2008).

To summarize, readers generally use four types of reading strategies in inquiry-based reading activities when using the Internet: information location, meaning-making, source evaluation, and self-monitoring. Below, I will describe the
characteristics and significance of each strategy and what challenges students face in applying them.

**Information Location**

*Importance.* Many studies have lauded information location as an important strategy that demonstrates the core characteristics of online reading (Bilal, 2000; Coiro & Dobler, 2007; Henry, 2006; Hinostroza et al., 2018; Leu et al., 2007). The main reasons for this are related to the open and uncertain nature of browsing the Internet.

Since its creation, the Internet has changed a lot in the way people locate desired information. It provides an opportunity to access an almost infinite amount of information in a short amount of time compared to conventional print-based media. However, because of the open-source nature of the Internet, reading from web-based browsers involves sifting through more uncertain information than does print-based reading. Because anyone can freely publish content on the Internet, Internet space is prone to include incomplete information, false information, and/or biased information for commercial or advertising purposes. When readers seek information on the Internet, they often must navigate through many undesired results to find reliable information.

In addition, readers must take an active role in obtaining desired information from the Internet. When reading from traditional paper-based materials, text is generally presented in a linear sequence or structure that is easily predictable to the reader (Cho, 2014). In this environment, readers usually read content according to the order or structure constructed by the writer (Cho, 2011). In contrast, the haphazard presentation of online content pushes readers to navigate the informational space of
the Internet more freely. In jumping back and forth within and between active texts, readers construe their own search paths and are not bound by any particular reading procedure (Goldman et al., 2012; Salmerón & Garcia, 2011).

Broadly, information location in online reading means setting up one or more search terms to limit the range of potentially useful sources and selecting the most useful source with the least amount of information in the search results. When searching for information, the relevance and reliability of information and sources listed on the results page generate important concerns (Kiili et al., 2009). Since Internet readers complete the rest of the reading process based on the findings of their initial search, the initial stage of an online inquiry can substantially influence subsequent reading processes and outcomes. (Coiro, 2007; Kiili et al., 2009).

**Difficulties.** Many readers face various difficulties with information location when performing Internet reading. First, when tasked with Internet reading assignments, readers find it difficult to recognize or define the problem at hand. Readers often struggle to determine what kind of information to seek and how to find such information if they do not fully understand the problem they are trying to solve or if there is a lack of prior knowledge on a given subject (Walraven et al., 2008). Studies show that most teenage readers often start searching immediately without exploring a topic or planning how to conduct a proper online search (Fidel et al., 1999).

Readers also have a hard time producing useful search terms (Bilal, 2000). For example, readers often get less relevant search results due to problems such as asking questions in complete sentences or using search criteria that are too broad (Hinostroza et al., 2018; Walraven et al., 2008). Using broad concepts is associated with the
reader's lack of domain knowledge on the subject. Readers tend to use generic keywords when they cannot produce useful or domain-specific keywords due to a lack of domain knowledge. As a result, their generated search results tend to be too broad. In addition, searches performed by simply adding and subtracting keywords produce less efficient results compared to strategies that modify keywords using various synonyms or related words (Monchaux et al. 2015).

Third, readers find it difficult to effectively judge or evaluate online search results. In internet-based reading tasks, readers should evaluate and select sources from the results page that are likely to provide the most relevant information for their needs. One major factor that makes it difficult to assess the quality of search results is a lack of domain knowledge. Unsuccessful readers do not want to rate their search results and readers that access information purely from the top of the search results list often fail to successfully complete the assigned task. According to Salmerón and colleagues (2013), readers implement two primary methods of processing Internet search results. One is to systematically evaluate the hyperlinks of the search results page by taking into account the relevance and reliability of the minimum information from the source (e.g., the reputation of the webpage domain, their prior familiarity with the source, etc.). However, since this process requires an additional cognitive burden with each search entry and depends heavily on prior domain knowledge, as a second way, readers tend to choose from the results at the top of the page as a heuristic device. In this way, readers may be routinely exposed to inaccurate or commercially-biased information.
**Required Skills.** To effectively search for information on the Internet, various types of prior knowledge are required, including knowledge of the topic and familiarity with printed text structures, common website structures, and web-based search engines (Coiro & Dobler, 2007). First, many studies have emphasized prior domain knowledge as an essential prerequisite for successful information searching (Brand-Gruwel et al., 2005; Coiro & Dobler, 2007; Monchaux et al., 2015; Walraven et al., 2008). Domain knowledge may facilitate the generation of additional relevant search terms and/or help to evaluate the relevance or reliability of information or of its source. However, when completing online inquiry tasks, student readers are likely to have no or very little prior domain knowledge about the topic of the task. Therefore, conducting a general search on a given topic to gain preliminary domain knowledge prior to a full-scale information search may be helpful in achieving the goals of the online inquiry task (Rouet et al., 2011).

In addition to sufficiently general prior knowledge of a topic, familiarity with the structure of printed texts is necessary for effective online searching. This includes knowledge of the conventional characteristics of printed text, such as signal words, boldfaced or italicized typography, and the format of paragraph headings, indices, and table of contents. It has been demonstrated that skilled readers apply this knowledge when reading from online sources as well (Coiro & Dobler, 2007) as many websites adopt conventional formatting schemes.

Finally, general knowledge about common website structure and how to use search engines is important in Internet reading (Coiro & Dobler, 2007). Knowledge of website structure includes how to navigate nonlinear hypertext and how to use a
browser’s home button, forward button, and back button (Bilal, 2000; Coiro & Dobler, 2007; Guinee et al., 2003). Search engine knowledge includes understanding how to select search engines and how to generate search terms (Bilal, 2000; Coiro & Dobler, 2007; Guinee et al., 2003; Henry, 2006). Readers apply this knowledge when they demonstrate awareness of the use of algorithms to display search results by visiting only pages listed at the top of result pages accordingly (Salmerón et al., 2013).

**Information Location Strategies.** Information location strategy is largely composed of two parts. One is to apply search terms and the other is to select hyperlinks that are likely to be useful on the search results page based on various inferences. First, strategies related to search terms include generating search keywords and phrases, modifying keywords, and selecting an appropriate search engine for an inquiry. Creating and using search terms means limiting and managing the number of inputs used to access results information relevant to the task goals. When evaluating sources from the Internet, which is characterized by high informational uncertainty, strategic readers focus on recognizing potentially useful links (Cho, 2014). The ability to generate effective search terms is highly related to the level of domain knowledge. For example, using domain-specific keywords as search inputs is more efficient than using search terms in the form of complete sentences or using ambiguous or general terminology (Bilal, 2001; Brand-Gruwel et al., 2005; Walraven et al., 2008).

If the preliminary search results do not yield useful hyperlinks, readers often will modify their search terms accordingly. According to Cho (2014), readers will specify the type of publication (e.g., blogs, websites, news articles, etc.), the type and quality of information according to their subject-related knowledge and information
needs (e.g., factual, scientific, opinionative, etc.), or specific authorships (e.g.,
government, interest group, professional group, etc.) by modifying their search inputs.

Second, the hyperlink selection strategy involves readers predicting and
selecting links based on clues to locate potentially useful information on a search
engine’s results pages. Various cues related to the hyperlink, such as the URL address,
website title, and short content description are used as the basis of the judgement. In
the often amorphous context of Internet browsing, readers are required to use forward
predictive evaluation strategies of short texts more frequently (Coiro & Dobler, 2007).
This is an alternative way of evaluating the relevance and reliability of the full text
content of a web page. In other words, based on the minimal information provided in
the search results, readers have to conclude whether the hyperlink is relevant or
reliable for their needs. According to Salmerón and García (2011), the ability to
choose an appropriate hyperlink positively correlates with reading comprehension
scores. Researchers speculate that cohesive hyperlink selections maximize readers’
likelihood of accessing relevant information, which in turn contributes to an overall
higher reading comprehension.

Readers tend to implement this kind of forward inferential reasoning based on
minimal clues about relevance and reliability primarily during the search stage (Coiro
& Dobler, 2007; Fidel et al., 1999). Even after selecting a link using forward
inferential reasoning, readers perform a quick secondary check using visual and
semantic cues to determine whether the information on the selected webpage is
relevant to the reader's goals (Rouet et al., 2011).
Activating prior knowledge can be an important strategy in any information location process (Coiro & Dobler, 2007). As mentioned, domain knowledge can influence the generation of search keywords and the selection of appropriate links. In addition, more efficient search is possible when the reader has background knowledge related to the structure of websites or search engines (Coiro & Dobler, 2007).

The information location strategy can be implemented in combination with other reading strategies. For example, successful information location can positively affect meaning-making and learning processes. Conversely, inefficient information location can have negative consequences on the quality of learning as well as on the overall reading process (Kiili et al., 2009). Other work has found that readers can perform Internet reading more effectively when they implement source evaluation strategies alongside information location (Hoffman et al., 2003). The ability to continuously remind the goal of the task and to monitor one's metacognitive performance is essential to the process of information location (Bilal, 2000; Brand-Gruwel et al., 2005; Rouet et al., 2011). Metacognitively competent readers recognize the patterns of unsuccessful searches and, in response, generate new or modified keywords and use multiple different search engines to change the search results in a more successful direction (Guinee et al., 2003).

**Meaning-making**

*Importance.* Many studies have demonstrated the importance of the meaning-making strategy in Internet reading (Afflerbach & Cho, 2009; Anmarkrud et al., 2014; Cho, 2014; Hinostroza et al., 2018). Meaning-making refers to a series of activities intended to construct meaning, ranging from identification of important information to
information synthesis of, and includes the following, more detailed activities: prior knowledge use, paraphrasing, tackling word meanings, making inferences, interpretation, analysis and synthesis, use of text structure or website structure, identifying main ideas, comparing and contrasting different information, questioning, etc. (Cho, 2014).

Meaning-making is the most basic reading strategy and is central to both online and offline reading processes, yet many studies have instead focused on information location and source evaluation in relation to Internet readings (Walraven et al., 2008). However, existing research has emphasized meaning-making as an important strategy in Internet reading activities. For example, Cho and his colleagues (2017) argued that in New Literacies perspective several researchers have focused on the inherent characteristics of the Internet environment that have encouraged the public to underestimate the process of constructing meaning, which is fundamental to reading comprehension. For example, Hoffman and colleagues (2003) found that many students had difficulty retaining accurate information from reading during online inquiry tasks and most demonstrated only partial understanding.

Similar to conventional reading environments, the activity of constructing accurate meaning through reading is equally important when reading text from online sources, although both cases can be difficult for student readers. Even in reading comprehension tasks using print source materials, synthesizing information and constructing new meanings has been regarded as one of the most difficult reading strategies (Coiro, 2007; Dole et al., 1991). However, synthesizing information from
multiple texts into one comprehensive and cohesive meaning has also been cited as the most essential part of reading through the Internet (Wolfe & Goldman, 2005).

**Difficulties.** Students seem to have difficulties identifying and storing important information and constructing meaning in their own words. Many students can identify important information but they do not retain it (Walraven et al., 2008). When storing textual information in note-taking activities, most seemed to have difficulty synthesizing the information through paraphrasing or through comparing and contrasting information from different sources (Hinostroza et al., 2018). Many students showed a lot of copy-paste patterns when they wanted to keep pieces of information they found while reading from Internet sources. Even when more explicit writing tasks are required, students tend to demonstrate copy-paste patterns (Hinostroza et al., 2018).

Reading multiple texts and constructing meaning through processes such as comparison, contrast, analysis, and synthesis, is difficult for readers of both online and print content (Kiili, 2013). However, since online readers, in particular, have to synthesize information from various web sources, flexibility across various text structures, genres, and various modes of information is critical (Kiili, 2013). Also, online readers have to consider how the text from different resources inform and/or contradict that of others (Kiili, 2013) by linking information contained in other texts.

**Meaning-making Strategies.** There are three major strategies for making meaning in Internet reading: (a) making sense of hyperlinks, (b) comprehending webpage content, and (c) building linkages across multiple texts (Cho, 2014). The
latter two strategies are not unique to online contexts and are also emphasized as important strategies in reading text from print sources.

Constructing meaning from hyperlinks primarily involves reading a minimum amount of information on the search results page, including the webpage’s name and URL. From the hyperlinks on the results page, the reader decides whether or not to use the hyperlinked source. For example, if readers search for the phrase “PV solar panels” to find the specific characteristics of photovoltaic solar panels, but there are mostly more general “solar panel” or “solar thermal panel” related links in the search results, then readers will use deductive meaning-making and will decide to refine their search terms. In a similar way, readers can further link meanings between hyperlinks within a specific website.

Next, readers often use the following comprehension strategies when reading webpage content: general content skimming, identifying and retaining important information, inferring missing information or the relevance of a text, and comparing, contrasting, analyzing, and synthesizing the content of a single text. Skimming the text has the purpose of ensuring the relevance and reliability the reader initially inferred from the search results page and usually occurs before full-scale text processing. Skimming also provides general prediction of what information the text will provide. However, many young readers struggle to skim information effectively, often making decisions based on expected information, not in terms of validity, authority, and recency (Walraven et al., 2008).

Note-taking plays an important role when identifying and keeping important information (DeSchryver, 2017). In addition to note-taking, creating an argument
graph that can visually express readers' thoughts can help to synthesize information and construct meaning when performing argumentative essay tasks based on an online inquiry (Kiili, 2013).

Inferring missing content and the appropriateness of the text means that the reader not only infers intentionally omitted content in the literal sense, but also infers what the text means to convey latently (e.g., the author's intention, commercial intention, etc.). Analyzing and synthesizing different elements of a text is based on the relationship and logical coherence of argument and evidence, and readers use linking strategies to bridge gaps between the content from multiple texts. Online readers can identify supportive or conflicting thoughts and viewpoints between texts by linking and analyzing information between various web sources, which can help deepen understanding of the subject (Cho 2014; Coiro & Dobler, 2007). The more strategies students use to build links between documents corresponds to a more integrated level of controversial reasoning in their essays (Anmarkrud et al., 2014). Backward linking appears to be the dominant strategy to connect various sources and explicit reference to information that conflicts with previously read content plays an important role in linking multiple documents (Anmarkrud et al., 2014).

The strategy of meaning-making works in conjunction with other reading strategies such as information location, evaluating sources, and self-monitoring. For example, Cho and colleagues (2017) demonstrated that source evaluation plays a mediating role for meaning construction by using path analysis of four reading strategies for the quality of question-generating tasks. Results aligned with those of previous researchers, namely, that source evaluation plays an important role in higher
learning processes. Moreover, the more effectively readers participated in the reading process using these strategies, the better the quality of the learning results produced by the readers (Cho et al., 2017). Students who continuously checked the task goals (self-monitoring) were better at synthesizing information and meaning-making (DeSchryver, 2017).

Source Evaluation

**Importance.** Although the Internet has given people virtually unlimited access to vast amounts of information in the world, the Internet has blurred the lines between the producers and consumers of published information and content. For example, unrestricted public access to social media outlets makes it easy for anyone to produce information, so there is a lot of unverified information that is not based on fact or peer-reviewed expertise. Burbules (2001) described this phenomenon as the decentered nature of the Internet, meaning that the reference guides and organizational systems traditionally used by libraries, news publishers, and other literary institutions to regulate print-based media cannot function systematically to filter Internet content. In other words, the Internet is a space that does not provide wholly value-neutral information. Readers are not provided with balanced information, which can be exacerbated by the use of algorithms to filter opinions they agree with from those that they disagree with. Also, biased and/or fake information is often distributed to represent the interests of certain groups. In fact, a lot of information is likely to be biased information produced for commercial purposes.

Therefore, today’s online readers are expected to think critically about the information found on the Internet. They should be able to decipher whether
information on the Internet is true or false and if it is a fact or an opinion. When browsing search results, readers should be wary about any information that strikes them as unbelievable or unlikely, as web-based news sources can be unreliable. Furthermore, readers should be able to discern which interest group objectives contain biased arguments.

Evaluating sources from a critical point of view has a positive effect on the comprehension of multiple documents and learning quality, including in online reading settings (Bråten et al., 2009; Goldman et al., 2012). For example, Goldman and colleagues (2012) compared the performance of high quality learners and poor quality learners on an online inquiry task, revealing that higher quality learners used more self-assessment strategies and source assessment strategies.

**Difficulties.** Readers occasionally have difficulty evaluating the relevance and reliability of online information. Readers can experience a cognitive overload because of the large amount of information that is common to Internet search result pages. Therefore, readers tend to choose the first-listed hyperlink because it is located at the top of the search result page rather than spending time to critically evaluate the source based on the included source details. This pattern is more often observed in younger students (Rouet et al., 2011; Salmerón et al., 2013).

Selecting the first hyperlink at the top of a search results page may act as a heuristic action, as many people generally trust the algorithms used by today’s primary search engines, but this choice is actually more likely to result in a selection of biased or commercial information (Lewandowski, 2011; Mansell & Read, 2009; Salmerón et al., 2013). For example, regardless of the relevance or reliability of a top source’s
information, hyperlinks that users select most frequently will maintain a spot at the top of the search results page. Therefore, highly-ranked hyperlinks are repeatedly selected by users and, as a result, continue to be placed at the top of search results (Salmerón et al., 2013).

One reason readers use heuristics is that it takes a lot of time and cognitive effort to scrutinize the contents of individual search results (Salmerón et al., 2013). In addition, if a user’s domain-specific prior knowledge is insufficient, it becomes more difficult for them to devote cognitive resources to the critical evaluation of multiple sources (Baildon & Damico, 2009), so readers frequently opt to select the hyperlink located at the top without explicit evaluation of the anticipated content (Salmerón et al., 2013). Readers predict relevance and reliability by using minimal results in listed information such as source title, URL address, and the brief excerpt provided by the search engine. Younger readers tend to rely more on visual or superficial clues (e.g., capitalization, underlining, and boldface) than on semantic elements (Rouet et al., 2011).

In general, readers have a hard time separating facts from advertisements disguised as objective content. For example, students who lack domain knowledge tend to believe the content of report documents regardless of their original source, but students with a priori domain knowledge weigh report sources more heavily and consider documents from special-interest groups to be less reliable (Brand-Gruwel et al., 2017; Bråten, Strømsø et al., 2011). In addition, readers who lack domain knowledge tend to evaluate content at a more superficial level (e.g., “I don't like this”), while readers with a lot of domain knowledge provide more elaborate and detailed
evaluations (Brand-Gruwel et al., 2017). According to Baildon and Damico (2009), readers face three challenges when evaluating sources: (a) lack of domain knowledge, (b) overload of information, and (c) internal and external reliability assessment.

**Required Skills.** There are several important factors that influence source evaluation. First, having a lot of prior knowledge about a given topic has a positive effect on source evaluation (Brand-Gruwel et al. 2017; Hinostroza et al., 2018; Salmerón et al., 2013). Without adequate background knowledge, readers cannot determine the credibility of claims and evidence in context (Damico & Baildon, 2007). Additionally, the more prior knowledge a reader has, the more thorough he or she will be able to evaluate a source (Brand-Gruwel et al., 2017). Other forms of knowledge, including metatextual knowledge, knowledge about the functions of structural features of a text, such as headings, paragraphs, etc., help readers quickly and efficiently scan a text to determine its appropriateness for their purposes (Brand-Gruwel & Stadtler, 2011).

In contrast, epistemic beliefs, or the beliefs an individual holds about the nature of knowledge and how one comes to know something, are additional factors that influence source evaluation (Brand-Gruwel & Stadtler, 2011). Cho and colleagues (2018) have shown that by comparing successful and unsuccessful online readers, readers with better epistemological processing can more efficiently access and collect relevant and reliable information, which, in turn, results in a positive effect on quality.

Next, online readers need critical thinking skills to evaluate biasness of sources. From the perspective of critical literacy, texts do not have a neutral value in themselves (Garcia et al., 2015). A text reflects the intention of its author and it has a
value-biased appearance that advocates for a specific individual or group. Therefore, readers should always be skeptical of questioning the authenticity of text. Following a comprehensive review of various fields of work, including critical thinking, critical reading, and critical literacy, Coiro (2007) summarizes the concept of critical source evaluation as “readers read[ing] to evaluate the relevancy, accuracy, reliability, and commercial bias of information they encountered on the Internet” (p. 51).

**Source Evaluation Strategies.** Source evaluation relates to how students evaluate the credibility and relevance of information (Kiili et al., 2009). While credibility refers to distinguishing reliable information from unreliable information, relevance refers to distinguishing essential from non-essential information (Kiili et al., 2009). Cho (2014) categorizes source evaluation strategies into three broad subcategories: (a) examining the usefulness of hyperlinks, (b) judging the informational value of web sources, and (c) assessing the quality of web sources.

First, examining the usefulness of hyperlinks involves activating relevant a priori knowledge to predict the overall goodness-of-fit of a series of hyperlinks and generating forward inferential reasoning (Cho, 2014; Coiro & Dobler, 2007). The evaluation of hyperlinks’ usefulness is primarily conducted on search result pages, and the following criteria can be used: (a) relevance of the content (given by title and description), (b) the type of source (e.g., pdf, Word doc, etc.), (c) reputation (given by the URL domain—e.g., .com, .org, .net, etc.), (d) rank on hit list, (e) familiarity (knowledge of the URL or organization hosting the site page) and (f) familiarity with the content language (based on the title and description) (Walraven et al., 2013).
Second, the reader judges the value of information contained in the web source by evaluating both the internal and external features of the text, such as its relevance, importance, and general usefulness, as well as the content’s validity, credibility, and trustworthiness. (Cho, 2014). Walraven and colleagues (2013) suggested usability, verifiability, and reliability as criteria for evaluating information in web pages. Usability includes language (grammatical errors, domain specific language), connection to task/relevance, audience (target group), currency (up-to-dateness), and amount of information (full or partial). Verifiability includes the author, references (references on the page or links to more websites on the same subject), information agrees with more sites, information agrees with prior knowledge, and organization (governmental or organization). Reliability includes the type of information (e.g., newspaper, research paper, opinion piece, etc.) objectivity (objective or advertisement), source type (primary or secondary), and the goal or objective of the author or publisher.

Finally, evaluating the quality of web sources involves evaluating the usefulness of an information space and evaluating the relevance, credibility, and trustworthiness of a website (Cho, 2014). More detailed standards consist of technical, usability, verifiability, and reliability (Walraven et al., 2013). Technical considerations include appearance (design) and speed (time to load the page). Besides technical, usability, verifiability, and reliability are almost identical to the criteria for evaluating the information value of the above web sources. Usability includes language (grammatical errors, domain specific language), connection to task/relevance, audience (target group), and currency (up-to-dateness). Verifiability is comprised of
reputation (famous or good reputation), reliability had kind (site/PDF), and source type (primary or secondary).

When judging the relevance and reliability of hyperlink information, web page content information, or the website itself, several evaluation methods rely on textual surface information and textual content information. Text superficial information is often used when selecting hyperlinks from search results pages to predetermine useful web pages. For example, the URL of the hyperlink (e.g., .gov, .org, .com, etc.), up-to-dateness, or the reputation of the organization may be used to assess site credibility (Walraven et al., 2008). In addition, the relevance of hyperlinks is judged based on textual content information, such as site title, URL address, and the short description listed on the search results page. The reader’s domain knowledge also greatly influences this evaluation process of textual content information.

Younger readers tend to rely on visual and superficial cues such as typographical cues like underlining, boldface, or capitalization rather than semantic elements in search results (Rouet et al., 2011). However, it is not typically enough to evaluate the relevance and credibility of the text relying solely on surface-level features and ignoring semantic aspects. For example, if readers search for “The French revolution”, they would be likely to open links to irrelevant titles such as “FRENCH cuisine: A REVOLUTION” if they are only relying on superficial textual cues (Rouet et al., 2011).

Researchers argue that when evaluating texts, both internal and external aspects of the text should be evaluated together (Baildon & Damico, 2009; Cho, 2014; Damico & Baildon, 2007). Evaluating text internal information means evaluating the
internal consistency of a text on a webpage, such as the adequacy of the arguments. However, since some texts may be incomplete or contain false information, simply evaluating based on internal information of a text is an insufficient evaluation method on its own. In other words, it is necessary to re-evaluate not only internal logical consistency but also external intertextuality—i.e., cross-validation by comparing content with that of other texts. However, readers are often unwilling to judge whether the information they find is true or biased and tend to be less concerned about the quality of the information they find (Hinostroza et al., 2018). In other words, they do not perform external intertextuality checks using additional sites. Novice readers, in particular, do not seem to employ a variety of sources to verify the accuracy of the information found online (Hoffman et al., 2003).

**Self-monitoring**

*Importance.* The self-monitoring strategy is “knowing and adjusting one’s knowing, thinking, and performance” (Cho et al., 2017, p. 697). The self-monitoring strategy is a very important strategy not only in Internet reading but also in traditional reading contexts (Afflerbach & Cho, 2009; Pressley & Afflerbach, 1995). Throughout reading comprehension, metacognitive thinking can help readers recognize and cope with difficulties encountered in the reading process (Cho, 2014; El-Koumy, 2004; Schunk & Zimmerman, 1997). Self-monitoring helps readers select, apply, and evaluate their strategic activities throughout the duration of the reading activity (Cho et al., 2017). According to Zimmerman (1995), self-monitoring has a positive effect on reading comprehension because it increases selective attention, helps readers to
know the effectiveness of their performance and learning strategies, and provides an opportunity for readers to identify better strategies when their goal is not achieved.

Because the Internet is a space where readers can easily be distracted, it is important for readers to self-monitor the purpose of the assignment and the reading process when completing online inquiry activities. Readers may have to cycle through several texts to construct meaning from the content they find on the Internet. In particular, because of the overabundance of information, readers can have a difficult time figuring out what to read and how to derive meaning, which becomes a cognitive burden and contributes to feelings of hopelessness (Bilal, 2000; Cho et al., 2017; Coiro & Dobler, 2007). In addition, the non-linear characteristics of hyperlinks and the inherent horizontal and vertical connection characteristics of the Internet space increase the cognitive burden on the reader, and in this case, the reader may more easily lose track of the purpose of his or her reading. In addition, the large amount of irrelevant or commercial advertisements and biased information on the Internet can also make the reader forget the original purpose of reading.

**Difficulties.** Many students experience difficulties clarifying the objectives of online inquiry tasks and determining the necessary information via self-monitoring before starting the online task (Walraven et al., 2008). Most teenagers have been shown to initiate online inquiry tasks without thinking or planning for the assignment (Fidel et al., 1999). In addition, most high school aged readers have a harder time regulating their reading process while more successful and mature readers and experts are to monitor their reading process (Brand-Gruwel et al., 2005).
**Self-monitoring Strategies.** Successful readers are metacognitively competent and they use a self-monitoring strategy to monitor how much they know and the way they learn (Brand-Gruwel et al., 2005; Cho et al., 2017). The self-monitoring strategy consists of managing the determination of reading paths, regulating the construction of meaning, and perceiving one’s self (Cho, 2014).

Managing the determination of reading paths includes the determination of whether an Internet hypertext reading requires attention while locating relevant search result information. As part of this procedure, readers additionally consider the sequence of reading order, manage the process of information searching and the determination of reading order, and detect possible sources of processing issues while exploring search result content (Cho, 2014). Since readers can become easily distracted when searching for information, some students have used strategies to set landmarks, comfort zones, or starting points that are easy for them to remember to prevent disorientation (Fidel et al., 1999).

Regulating the construction of meaning process includes planning and adjusting cognitive efforts (e.g., to overview, to identify important ideas, to take a look at additional details), recognizing unknown words or conceptual terms and activating the process of finding their meaning, determining the importance of information and adjusting cognitive efforts according to search results (e.g., reading aloud, rereading, slowing down reading speed, pausing, and skipping), detecting cognitive problems in reading comprehension (e.g., a lack of prior knowledge, inappropriate association of prior knowledge with text information, inaccurate predictions, inferences, understanding of text information), and changing the focus of reading and reading
progress and allocating reading attention (Cho, 2014). Recognizing the self includes understanding the strengths and limitations of one's own cognitive abilities, and recognizing one’s personal stance toward knowledge and truth (Cho, 2014).

Self-monitoring reading can be viewed as a metacognitive process occurring on two levels. One is during the online search and evaluation process, which occurs primarily when a reader quickly clicks back and forth through tons of short Internet texts available on the search results page. The other is a more traditional self-monitoring that occurs when reading longer texts over time in webpages (Coiro & Dobler, 2007).

According to Coiro and Dobler (2007), Internet reading uses independent fix-up strategies similar to those of traditional reading, such as goal-setting, rereading, monitoring, and comprehension repair. In addition, the information location step in self-regulated online reading follows the recursive process to plan (to set a goal), predict (to predict the result of link selection), monitor (to monitor the link selection), and evaluate (evaluate the relevance of the selection). These processes are performed simultaneously and repeatedly.

Self-monitoring strategies also have a positive effect on other reading strategies. Periodically checking the objectives of a task or prompt helps individuals construct meaning through information synthesis (DeSchryver, 2017). For example, in order to judge the importance or relevance of information, the reader needs to know exactly what a particular task requires (Rouet et al., 2011). According to a study by Rouet et al. (2011) to assess the relevance of text, “the reader must have in mind a ‘task model,’ that is, a mental representation of the goals and demands of the task” (p.
This task model can include clues to questions or instructions and pragmatic constraints, such as time.

In addition, the self-monitoring strategy can have a positive effect when combined with the meaning-making strategy. The more carefully a reader monitors their understanding and the more actively the reader regulates their approach, the more successful that reader is at linking different perspectives, absorbing content, and establishing an integrated understanding (Anmarkrud et al., 2014). It has also been found that readers who evenly allocate cognitive resources to both micro-level metacognitive strategies (e.g., monitoring their understanding of the text and thinking about what to do next) and macro-level metacognitive strategies (e.g., monitoring or planning task goals and checking their performance) can construct more elaborated meaning from the text (Kiili et al., 2009).

Finally, self-monitoring strategies also have a positive influence on the information location process. Employing self-monitoring methods during information location often manifests as readers recognizing the patterns of unsuccessful searches and trying new search keywords or different search engines to change the search results in more effective ways (Guinee et al., 2003). In a similar case, readers tend to be increasingly elaborate in their searching methods when conducting repetitive trials of searching. One reason for this may be that self-monitoring strategies help students deepen their understanding of the subject and improve their search results with each search iteration (Hinostroza et al., 2018).

In summary, the applied reading strategies used in Internet spaces, such as in online reading or search inquiries, can be largely divided into information location,
meaning-making, source evaluation, and self-monitoring. Each strategy has its own important role, but interacts with other strategies as part of a more complex and holistic reading process.

**Peer Interaction and Reading Comprehension**

This section aims to show how peer interaction can play a positive role in the development of personal cognitive abilities, such as in the mastery of reading comprehension strategies and learning content knowledge. I will explore what peer interaction is, what role it plays in a collaborative learning environment, and, more specifically, what role it plays in the collaborative reading comprehension process.

**Peer Interaction from a Constructivist Perspective**

In educational settings, social interaction involves “teachers, learners, and others acting upon each other and consciously or unconsciously interpreting those actions” (Oxford, 1997, p. 444). Among these, peer interaction has been heavily emphasized as an important component to individual cognitive development and learning from a constructivist perspective. This constructivism-based view of cognitive development is largely composed of the socio-cognitive approach based on Piagetian achievements and the socio-cultural approach based on Vygotskian achievements (Johnson & Johnson, 2002; O’Donnell & O’Kelly, 1994).

According to Piaget (1950), an individual’s socio-cognitive conflict caused by social interactions stimulates conceptual growth and the development of perspective-taking abilities and cognitive development. In this perspective, a small group of students with relatively similar abilities was considered as a condition for ideal interaction. Vygotsky (1978) saw that the collaborative efforts of individuals to learn,
understand, and solve problems are essential processes for constructing knowledge and internalizing joint processes. Researchers in this field have observed that cognitive development and learning take place through social interactions, and that the most ideal interactions occur between the student and the more competent partner.

Whatever their differences, studies of Piagetian and Vygotskian models have emphasized the role of social interaction in cognitive development and learning. From the perspective of peer learning, cognitive activities affect students’ learning, and these cognitive activities are affected by peer interactions between learners (Cohen, 1994; O’Donnell & King, 1999; Webb & Palincsar, 1996).

Collaboration and Collaborative Learning

For a long time, researchers have referred to social interaction-based learning using various terms, including ‘cooperative learning’ and ‘collaborative learning’ (Dillenbourg, 1999; O’Donnell & O’Kelly, 1994). Some researchers understand cooperative learning as a concept under the broader umbrella of collaborative learning (Bridge, 2014), while others understand that although both terms are based on constructivist epistemology, cooperative learning focuses more on specific classroom techniques, whereas collaborative learning is more closely related to personal philosophy (Oxford, 1997; Panitz, 1996). Although there are some disagreements in interpretation, in general, many studies have used the two terms interchangeably. Under both definitions, learning through peer interaction is considered to be a process of knowledge construction, with importance placed on the active role of learners.

When searching with Google Scholar, my recent search results for ‘collaborative learning’ yielded about 871,000 results while results for ‘cooperative
learning’ yielded about 640,000 results (May 2021). Because collaborative learning appears to be more commonly used than cooperative learning in the literature, I use the term collaborative learning in this study to indicate learning based on peer interaction.

**Collaboration.** Learning about the features of collaborative learning is closely related to the nature of peer interaction. But before that, in this part, I will first deal with what collaboration is before dealing with the features of collaborative learning. Collaboration refers to a specific type of productive way of reading or working together. Dillenbourg (1999) previously described the characteristics of collaboration according to four criteria: the situation, interactions, processes, and effects.

To begin, “if peers are more or less at the same level, [they] can perform the same actions, have a common goal and work together” (Dillenbourg, 1999, p. 7), then a given situation is collaborative. When this is the case, maintaining symmetry in the interaction becomes an important problem. Symmetry can be subdivided into symmetry of action, symmetry of knowledge, and symmetry of status. “Symmetry of action is the extent to which the same range of actions is allowed to each agent, symmetry of knowledge is the extent to which agents possess the same level of knowledge and symmetry of status is the extent to which agents have a similar status with respect to their community.” (Dillenbourg, 1999, p. 7). Next, paired participants should share a common goal. The process of setting common goals involves identifying constructing discrepancies between individual goals, which are often revealed through disagreements when making a decision or taking an action. The process can be further classified as either collaboration or cooperation, according to
the difference in the degree of the division of labor. In cooperation, participants generally receive tasks and perform their individual work in each stage of the process. Individual partial results are then combined to yield the final result. In contrast, collaboration means that participants work together simultaneously to complete tasks.

Regarding the interactions criterion, interactivity, synchronicity, and negotiability are considered the primary characteristics of collaboration. According to Dillenbourg (1999), interactivity is not simply defined by the frequency of how many peers interact with an individual learner, but by the extent to which these peer interactions influence the individual’s cognitive processes. Another feature of collaboration is that it is synchronous, which differentiates it from cooperation, which is mainly related to asynchronous communication. Negotiability is another key element of collaboration and requires a process of asserting, justifying, and negotiating the point of view of each participant in a peer interaction, rather than being forced from one’s point of view in a hierarchical situation.

Processes such as internalization or appropriation are considered to be the primary components of social interaction; however, collaboration can also include other, more personal processes such as induction and cognitive load. Internalization refers to the transfer of another person’s cognitive process to oneself through interpersonal interaction. Appropriation refers to the reinterpretation of one’s own actions and utterances based on a partner’s actions and words. Finally, the effect of the collaboration was mainly measured as a gain through the comparison of pre- and post-tests related to task performance. More specifically, they refer to the effects of conceptual change, increased self-regulation, etc.
Collaborative Learning. ‘Collaborative learning’ is a collective term used to describe several specific types of learning that adhere to the aforementioned characteristics of collaboration. O’Donnell and Hmelo-Silver (2013) refined the definition of collaborative learning. Collaborative learning emphasizes an equal relationship and mutual influence among group members. The purpose of collaborative learning is convergence, or the construction of shared meanings for conversations, concepts, and processes (Brown et al., 1993; O’Donnell & Hmelo-Silver, 2013; Roschelle, 1992).

Peer interactions play large roles in the outcome of joint assignments, individual learning, and individual cognitive growth when individuals complete tasks in a collaborative environment. There are two major theoretical perspectives that explain the nature and role of social interaction in collaborative learning: social-behavioral theory and a cognitive elaboration perspective (Bridge, 2014; Johnson & Johnson, 2002; O’Donnell & Hmelo-Silver, 2013; O’Donnell & O’Kelly, 1994; Staarman et al., 2005).

First, according to the perspective of social-behavioral theory, there exists the concept of social interdependence and the way in which it is structured determines the way individuals interact with each other. There are three main types of social interdependence: positive interdependence, negative interdependence, and no interdependence (Deutsch, 1949; Johnson & Johnson, 2002; O’Donnell & O’Kelly, 1994). Positive interdependence is a promotive interaction, in which the goals of group members are connected with each other and the achievement of individual goals is positively correlated. In other words, in order to achieve one’s goals, other members
must also achieve their goals. Next, negative interdependence is an oppositional interaction in which individuals’ goal achievement is negatively correlated. In this case, the individual’s achievement of a goal is related to the failure of others to achieve other goal(s). No interdependence means that the achievement of an individual’s goal is entirely separate from the achievement of other members’ objectives and is not a result of any interactions.

In collaborative learning, positive interdependence is a fundamental principle of peer interaction. The goals and achievements of group members are inherently and necessarily interconnected. Therefore, in order for one person to achieve a goal successfully, someone else in the same group must achieve their own goals as well.

Next, from a cognitive elaboration perspective, peer interaction aids in cognitive elaboration during information processing via processes such as encoding, activation of schemas, rehearsal, metacognition, and retrieval (O’Donnell & Hmelo-Silver, 2013). First, during the process of encoding information, peer interactions remind learners of prior knowledge and contribute to the activation of the schema. In addition, peer interaction allows students to practice making information retrieval, resulting in deeper processing and more active engagement. Moreover, giving and receiving feedback throughout the peer interaction process helps students decide when to check their own understanding of the content.

In addition, individuals expand their cognitive structure and achieve cognitive growth through cooperation with another individual. Elaboration refers to the specific explanations that arise when students provide examples, use different representations, explain a concept, or supply specific argumentation to explain an idea (Staarman et al.,
The elaboration process involves at least one explicit comparison of different perspectives or concepts, the development of shared meaning, the co-construction of new knowledge, and/or a collaborative resolution of the conflicting points of view. Verbalization plays an important role in the cognitive elaboration process because it leads to a sophisticated cognitive process (O’Donnell & O’Kelly, 1994; Staarman et al., 2005).

In summary, during collaborative learning activities, members share common goals and strive to achieve them through peer interactions based on positive interdependence. Individuals also have opportunities for cognitive elaboration and growth through their interactions with peers.

**Peer Interaction in Reading Comprehension**

Peer interaction has been widely used in reading classes to improve students’ reading comprehension and learning skills (Heckelman, 1969; Henry et al., 2012). Peer interaction in reading comprehension activities includes all behaviors that students use to interact with each other throughout the entire reading process. Peer interaction in this domain largely consists of paired reading and paired thinking processes (Topping & Bryce, 2004). Paired reading is a method used to support or assist struggling readers with reading activities (Henry et al., 2012; Topping, 2001). In the early days of research on paired reading, the term ‘paired reading’ referred to a process to help younger students to read aloud fluently—e.g., a tutor and tutee reading books together that are above the independent readability level of the tutored student. However, it was soon used extensively to include paired thinking and even the interaction of thoughts that occur while two people read a text together (Topping &
According to Topping’s studies, which have consistently used the term paired reading, paired thinking aims to develop reading comprehension skills and higher-level thinking skills (Topping, 2001; Topping & Bryce, 2004).

Peer interaction in reading comprehension is similar to the interaction observed in collaborative problem-solving (e.g., problem-based learning) because it involves both paired reading and paired thinking. Problem-based learning includes activities in which students work in small cooperative groups and learn the knowledge they need to solve problems (Hmelo-Silver, 2004). During collaborative problem-solving process, such as problem-based learning, students select and read a variety of information to solve a problem, think together, and construct the necessary knowledge through a process of integrating information, which includes elements of both paired reading and paired thinking. A key feature of collaborative problem-based learning is that it distributes the cognitive load of a task among members of a group, allowing individuals to successfully navigate problems that would normally be difficult to solve on their own (Pea, 1993; Salomon, 1993). Moreover, peer interaction aids in the development of individual problem-solving skills and higher-order thinking skills and facilitates the construction of common knowledge (Blumenfeld et al., 1996; Brown, 1994).

In summary, peer interaction in reading comprehension including pair reading and pair thinking, is similar to peer interaction in a collaborative problem-solving process such as problem-based learning or inquiry learning. Students can develop problem-solving skills such as reasoning strategies and metacognitive strategies.
Collaborative Peer Interaction in Reading Comprehension

Many studies have emphasized the effect of peer interactions in reading activities (Fuchs & Fuchs, 2005; Henry et al., 2012; Leu et al., 2007; Palincsar et al., 1987). However, not all peer interactions are effective (Dillenbourg, 1999; O’Donnell & O’Kelly, 1994). When an interaction occurs collaboratively, it is capable of producing positive results for all involved individuals. In this part, I will weigh the advantages of collaborative peer interaction in reading comprehension and investigate the conditions of collaborative situations necessary to promote collaborative peer interaction.

Much of the existing literature in reading comprehension, describes three main advantages of collaborative peer interaction in the context of reading comprehension: improving reading comprehension skills, learning content knowledge, and positive motivation (Coiro et al., 2014; Henry et al., 2012; Kiili et al., 2012).

**Improving Reading Comprehension Skills.** First, collaborative peer interaction in reading comprehension can help students improve their reading comprehension skills. Development of reading comprehension skills such as the cognitive processes individuals need to select, organize, connect, and evaluate what they read are primarily related to the overall growth of cognitive higher-order thinking skills and critical thinking abilities (Coiro, 2007; Coiro et al., 2011). According to cognitive-developmental theory, collaboration is an essential component of cognitive growth, resulting from coordinating perspectives while individuals work together towards a common goal (Johnson & Johnson, 2002). Additionally, working in partnership with more capable peers can result in cognitive development and
intellectual growth (Johnson & Johnson, 2002). When working together, several cognitive and conceptual conflicts, including those related to perspective or uncertainty, may arise among learners, which can stimulate growth in an individual’s perspective-taking ability and cognitive development (Piaget, 1950). Conflict also helps learners reconceptualize what they know, which can make them more informed and result in a more refined and thoughtful conclusion (Johnson & Johnson, 1979; 2002). According to Momtaz and Garner (2010), who studied the impact of collaborative learning on reading comprehension improvement in EFL reading comprehension classes, students in collaborative settings, have the opportunity to correct their mistakes through peer interactions through activities such as “brainstorming, listening to one another, asking questions, eliciting self-disclosure, making reflexive comments, eliciting confirmation, asking for explanation, clarifying issues, collective summarizing of paragraphs, and collective paraphrasing of the utterances” (p. 31). They argue that in collaborative reading situations, students can further improve their higher-level cognitive skills, such as analyzing, explaining, synthesizing, and elaborating.

Researchers explaining improvement in reading comprehension skills through collaborative peer interaction often describe the mechanism as a transfer of metacognitive strategies. Metacognitive strategies are strategic actions to keep track of one’s task performance and to decide how to perform a given task while engaging in that task. A representative example of metacognitive strategy is the self-regulation strategy. Self-regulation refers to learners checking and adjusting their thoughts or processes in order to achieve the purpose of a task while simultaneously performing
that task (Zimmerman & Schunk, 2001). Through collaborative peer interaction, learners can observe and test each other’s cognitive skills and ultimately acquire their own self-checking skills (Boekaerts & Corno, 2005; Bridges, 2014; Wang & Lin, 2007; Wolters, 2011). In addition, interactive feedback provided to each other during peer interaction can improve both students’ skill levels, regardless of the difference in their initial skill level (Webb & Palinscar, 1996).

When applied to reading comprehension activities, self-regulation refers to a reader’s self-questioning and use of fix-up strategies to repair problems in the reading process, often referred to as comprehension monitoring (Coiro, 2007). Self-regulation ability indicates the reader examines his/her own reading process and determines when and how to use various cognitive reading strategies to solve problems encountered during the reading process (Cho et al., 2017). These self-regulation or self-monitoring abilities can be transferred through peer interaction.

Researchers report that the online problem-solving process (e.g., online reading, inquiry task) is a cognitive process similar to that of self-regulation (Hmelo-Silver, 2004). The problem-solving process usually includes the following: identifying and defining the problem, constructing a strategy to solve the problem, organizing information required to solve the problem, allocating resources, and monitoring and evaluating problem solutions (Bridges, 2014). In this way, performing online inquiry tasks that investigate specific topics can facilitate learners’ acquisition of self-regulatory skills (Schraw et al., 2006). While performing an inquiry task, students can more actively engage in the learning process by using cognitive strategies and
metacognitive strategies to check the understanding of themselves and their partners (Schraw et al., 2006).

Content Knowledge Learning. Researchers who emphasize the positive aspects of peer interactions that can contribute to content knowledge learning explain that content knowledge learning is also enhanced through the development of cognitive skills and the use of self-regulation strategies (Bridges, 2014; Hmelo-Silver, 2004). During peer interaction, active reasoning between partners plays a very important role in the process of cognitive change. In effective collaborative situations, students focus on responding to or refining the ideas previously proposed, and, through this process, they can construct their own knowledge (Hmelo-Silver, 2004). Furthermore, by learning about the progression of a partner’s cognitive processes or thoughts through peer interaction, learners can correct their own misconceptions, fill gaps between understandings, reinforce the connection between new information and previous learning, recognize and resolve inconsistencies, and develop new perspectives and more sophisticated conceptualizations (Bridges, 2014; Fawcett & Garton, 2005).

There have been several attempts to explore the types of interactions that are more effective in facilitating the learning of content knowledge. For example, Asterhan and Schwarz (2009) analyzed patterns of peer collaboration, focusing on specific types of discourse, such as argumentation and explanation, and their detailed functions. The analysis demonstrated that participation in dialectical argument predicts conceptual learning gains, whereas consensus explanatory development does not. The rebuttal among the skills of negotiating ideas had a larger impact on the outcome of
the collaborative problem solving than mere agreement or the repetition of ideas in the
dialectical argumentation category (Asterhan & Schwartz 2009).

In addition, peer interaction can improve the outcomes of reading tasks.
Lazonder (2005) explicitly compared the outcomes of individual and paired reading
tasks to explore this critical relationship. As a result, initial responses to multiple-
choice or short-answer questions appear to be rechecked more often when two
individuals are paired together than when individuals complete the task alone, and, as
a result, incorrect responses were corrected approximately twice as much in paired
groups (Lazonder, 2005). In addition, when creating written responses together,
student discourses often focus on responding to and improving a proposed idea, and,
in constructing a common explanation, students demonstrate the construction of new
knowledge (Hmelo-Silver, 2004).

Motivation. Collaboration (including cooperative learning) helps students
focus and immerse themselves in a reading task. When students work together, the
burden of the task is reduced and they are likely to have a more positive attitude
toward the task and view it as more solvable. Henry et al. (2012) found that struggling
readers were more involved in the task and more confident in their online reading
skills when completing the online reading tasks collaboratively. Schraw et al. (2006)
found that peer interaction during inquiries among students from diverse socio-cultural
backgrounds can additionally enhance student motivation and epistemological
awareness.

In addition, students are motivated to perform tasks by observing their
partner’s activities, which improves their own self-regulation skills. This mechanism
can be described by the concept of self-efficacy, or the degree to which an individual feels that he or she will be able to achieve a specific task or goal (Bandura, 1994). Therefore, with a higher level of self-efficacy, the better the student can engage in difficult or higher-level tasks. Students are the most motivated and learn most effectively when they observe peers similar to themselves with high self-efficacy. Peer interaction through, such as iterative detailed feedback, not only enhances students’ sense of self-efficacy, but also develops self-regulation skills (Butler & Winne, 1995). In fact, students with low self-efficacy on self-regulation skills can improve their self-regulation skills simply by observing students with high self-regulation skills (Schunk & Zimmerman, 2007).

**Situation that Promotes Collaboration.** The positive effects of peer interaction in reading comprehension act to improve students’ reading ability, learning of content knowledge, and positive motivation; however, technically speaking, these desired elements are not always guaranteed by peer reading situations. Furthermore, interactions may be related to the construction or transmission of meaning, but not to learning itself (Oxford, 1997). In other words, peer interaction during reading comprehension activities can encourage collaborative situations based on an assumption of positive interdependence, but not all interactions themselves necessarily indicate or ensure truly collaborative behavior throughout the duration of a task (Dillenbourg, 1999; O’Donnell & O’Kelly, 1994). For example, even in learning situations that emphasize peer interaction, there are cases where the effect of peer interaction is insignificant to the development of critical thinking or higher thinking.
Therefore, fostering a collaborative atmosphere, as conceptualized above, is critical to yield a positive effect of peer interaction.

There are many situations that promote collaborative actions, but studies have shown that such behaviors are promoted particularly when learners share a common goal, when tasks are difficult to perform alone, or when a group size is small. As mentioned, it is positive interdependence (Johnson & Johnson, 2002) that learners share a common goal and that achievement is positively correlated is the basic assumption of cooperative peer interaction. Meanwhile, a study by Chen and colleagues (2018) verified the effectiveness of collaboration through a meta analysis, finding that the learning efficiency of collaboration was higher when students are engaged in more complex tasks. However, large group size may rather interfere with the success of these kinds of learner interactions (O’Donnell & O’Kelly, 1994).

In order to maximize the benefits of peer interactions in collaborative learning, many researchers have also turned to pairing (c.f., Fawcett & Garton, 2005; O’Donnell & O’Kelly, 1994). There have been many discussions on how to form effective student pairs, but the leading methods can be summarized as follows.

First, peer interactions can be influenced by the similarities or differences in the cognitive skill and knowledge level between an individual and his/her partner. In this regard, some have argued that pairing should be done with partners with different cognitive levels or with different knowledge backgrounds as possible and that this mismatch is particularly necessary for the purpose of encouraging students to readjust their understanding (Fawcett & Garton, 2005). Arguments further suggest that both students are helpful when good and poor students are in the same pair (Fawcett &
Poor students can improve their learning and develop cognitive abilities by interacting with high-performing good students, and, at the same time, good students can practice verbalizing their ideas more clearly and more explicitly by explaining and clarifying their thoughts.

In contrast, assigning students of different performance levels to be in pairs together does not guarantee successful cognitive effects. According to Piaget (1950), paired learners are more likely to develop cognitively in contexts where they have equal cognitive power as their peer partner and each has equal opportunity to influence the other. More specifically, Piaget (1950) explained that intellectual growth through this process of so-called equilibration occurs when partners have an equal level of intellectual understanding, when partners can preserve their own opinions, and when there is a condition of mutuality between partners.

In summary, collaborative peer interactions in reading comprehension situations play a positive role in the development of learners’ cognitive abilities, learning content knowledge, and positive motivation. However, peer interactions are not always collaborative and are affected by the goal and difficulty of the task, differences in cognitive levels between learners, and group size.

**Teaching Methods Using Peer Interaction in Reading Comprehension**

Teaching methods related to reading comprehension that use peer interaction include reciprocal teaching (RT), internet reciprocal teaching (IRT), and peer-assisted learning strategies (PALS).

First, a representative example of using peer reading to improve reading ability is reciprocal teaching (RT). RT is a collaborative learning model, primarily targeting
struggling students, in which a small group of students read the same text (Palincsar & Brown, 1984). The teacher model of comprehension strategies focuses on predicting, questing, clarifying, and summarizing strategies. Students practice applying these techniques and, through a gradual ease of away from dependence on the teacher, students begin to develop a useful set of comprehension strategies on their own. Eventually, students can transfer the use of these strategies to new reading contexts (Leu et al., 2007; Palincsar & Brown, 1984).

Internet reciprocal teaching (IRT) is based on RT and was proposed to help students overcome the difficulties of reading in the newly-emerging Internet environment of the time (Leu et al., 2007). Unlike RT, which was meant for paper-based single texts, IRT focuses on both the common and the unique processes that occur in the Internet environment through skimming and jumping between multiple different texts (Leu et al., 2007). The IRT emphasizes student modeling of online comprehension strategies rather than on the teacher modeling like that of RT. There are two main reasons for this. One is that students can use newer and potentially powerful reading strategies as digital natives, and secondly, empowering students to recognize themselves as experts is positive for improving reading skills (Henry et al., 2012). In addition, researchers argue that observing and practicing reading strategies through collaborative work during IRT activities will greatly help in internalizing paired students’ reading strategies.

Peer-assisted learning strategies (PALS) are primarily targeted at elementary school students and consist of activities such as partner reading with retell, paragraph shrinking, and prediction replay. While performing these kinds of activities in a read-
aloud manner, students are provided with extensive opportunities to practice basic
skills in reading, receive immediate feedback, and social support from peers (Fuchs &
Fuchs, 2005; Lee, 2014). One feature of PALS is that it does not require students to
have a fixed role. For example, as in peer tutoring activities, one student does not
perform the role of the tutor indefinitely, but the students take turns playing the roles
of tutor and tutee.

The three instructional models using the peer interaction described above have
several important implications. Although teacher guidance is very important for lower-
grade students (e.g., elementary school students), for higher-grade students (e.g., high
school students and college students), peer interaction can have a positive effect on the
acquisition of reading strategies and learning content knowledge. Almasi (1995) found
that group members used peer interaction to resolve cognitive conflicts and that peer-
led discussions provided more opportunities for student verbalization than teacher-led
discussions.

Manion and Alexander (1997) described two advantages of peer collaboration,
which can positively influence students’ cognitive metacognitive functions without
direct teacher guidance. First, it is an efficient way to share valuable information
between or among students, and, second, there is no negative impact of role allocation.
Therefore, the peer interaction-led learning method has an advantage in that it can be
applied more practically and effectively in classroom instruction situations. For this
reason, college students were asked to complete an online QGT in this study under the
assumption that the development of reading strategies and learning of content
knowledge can be promoted through paired peer interactions.
Transferability of Reading Strategies through Collaborative Peer Interaction

As seen in the previous section, collaborative peer interaction during the reading comprehension process can improve the development of an individual’s cognitive abilities, especially in his/her reading comprehension skills. In this study, I focus on the transferability of reading strategies in peer interaction in reading comprehension as a way of improving one’s reading comprehension skills. In previous work, transferability of original reading strategies was considered a kind of side effect, and never the objective of collaborative learning research (Dillenbourg, 1999). However, it has been demonstrated by several researchers that peer interaction is a great opportunity to transfer and internalize each other’s cognitive functions (Palincsar & Brown, 1984).

A study by Palincsar and Brown (1984) revealed the effectiveness of the reciprocal teaching method, evaluating teacher modeling and peer interaction in 7th grade struggling readers compared to a control group. As a result, reciprocal teaching improved scores on standardized comprehension tests, demonstrating the successful transferal of summarizing, questioning, and clarifying strategies.

When learners verbalize their thinking about how to complete online inquiry through peer interaction, they occasionally adopt each other’s reading strategies (Henry et al., 2012). Working and talking with a partner also provides opportunities to enhance individual higher-order thinking skills (Dillenbourg, 1999; Mercer & Littleton, 2007; Palincsar, 1998) and the co-construction of both meaning and knowledge (Kiili et al., 2012). Coiro et al. (2011) compared the frequencies of various cognitive strategies used in individual reading and those used in paired reading based
on the coding scheme for constructively responsive online reading strategies suggested
by Afflerbach and Cho (2009). The coding scheme consists of planning, searching,
overviewing, determining important ideas, questioning, inferring, integrating,
evaluating, monitoring, repairing, confirming/clarifying, and reflecting according to
reading processes. Based on their findings, they suggested that opportunities to co-
construct meaning may foster more efficient and productive comprehension of online
informational texts.

This transferability of reading strategies enables a paired reading activity that
is initially designed to promote learning and problem solving to also serve as a means
for individuals to build their own repertoire of reading strategies during the activity.
As students engage with digital text on the Internet, some research has found that the
act of reading in pairs promotes the development of online reading strategies.
However, few studies have explored how detailed online reading strategies are
transferred through peer interaction.

**Information Location.** Collaborative peer interaction can promote information
location strategy. Lazonder (2005) found pairs of students located relevant information
more often and in less time than did unpaired students because pairs of students
employ a richer repertoire of search strategies and are more proficient in monitoring
and evaluating their search practice during inquiry tasks. As another example, Shah
and González-Ibáñez (2011) conducted an Internet information search activity which
asked college students to prepare a report on the Deepwater Horizon oil spill using
three randomized types of cooperative search situations (i.e., remote collaboration,
two computers direct collaboration, and one computer direct collaboration). Student
performances were then compared. They discover that when two people work collaboratively, there is a synergistic effect, such as finding more diverse information than an individual. This synergistic effect was especially strong when cooperating online remotely.

According to González-Ibáñez et al. (2015), it would be more effective if people who cooperate when searching for information harmonize their various skills and experiences. For example, when experts on a given topic and experts in online searching collaborate, their search for information is more fruitful and efficient and the collaboration improves their understanding of the information.

Meaning-making. Similarly, collaborative peer interaction can promote meaning-making strategies as partners expand or deepen their understanding of text by building their own ideas (Kiili et al., 2012).

Coiro et al. (2014) explored the collaborative online inquiry activities of elementary school students in terms of cognitive strategy use and social interaction. As a result, they found evidence that productive collaborative interactions may be closely related to higher-level reading processes such as inferring, integrating, evaluating, and interpreting what is read. Productive pairs demonstrate processes of organizing what they have read, linking read content with prior knowledge, and integrating what they read with what they know using making-meaning, while less productive pairs read the content with little discussion and the partners do not listen as actively to each other’s suggestions or thoughts (Coiro et al., 2014). As a result, it is difficult for them to integrate the contents of the text or discussion. Therefore, the more active peer
interaction is, the easier it is for a meaning making strategy to be activated and implemented.

In particular, the use of elaborated speech and partnered work helps readers understand concepts in more comprehensive ways (Van Boxtel et al., 2000) related to cognitive elaboration. Also, receiving reasoned explanations from a partner can correct misconceptions and fill gaps between understandings. An important part of meaning construction is an active reasoning strategy and many studies have shown that active peer interaction has a positive effect on this strategy (Fawcett & Garton, 2005; Teasley, 1995). The verbalization of thoughts during peer interaction requires interpretative processing to link information in an individual’s short-term memory to one’s own thoughts or previously heard information. This exposes individuals to different forms of logic and explanations from partners while improving their meaning-making performance.

The mastery of meaning-making strategies is related to the level of metacognitive competence. For example, a study by Manion and Alexander (1997) found that paired students with high metacognitive understanding use more information recall strategies than do paired students with low metacognitive understanding. Meanwhile, there are also findings that suggest that summarizing strategies may be more active in cooperative online reading. Passig and Maidel-Kravetsky (2016) compared the summarization results of a group that performed online reading together and a group that performed reading of a paper book together, and found that the group who performed online reading performed better on content summarization.
**Source Evaluation.** Collaborative peer interaction can contribute to the activation of source evaluation during online reading activities. Source evaluation refers to evaluating the relevance, validity, and significance of information, which is related to critical thinking or critical reading capabilities. Coiro (2007) defined critical evaluation of a source in Internet reading as using critical thinking skills to “(a) question, analyze, and compare the resources they located; (b) judge the quality of information on various characteristics; and (c) defend their opinions with evidence from multiple sources and their prior knowledge.” (p. 47). In addition, Coiro (2007) notes that “critical reading involves processes of determining the information’s level of relevancy, accuracy, reliability, and bias” (p. 48).

There are several examples of studies that show that peer interaction can play a positive role in critical thinking or critical reading abilities. First, according to Fennell (1992), university students participating in research projects in a cooperative learning environment felt that they were more often engaged in critical thinking activities, such as evaluating ideas and opinions, in cooperative learning than in lectures or classroom discussions.

Gokhale (1995) compared the level of “drill-and-practice” (knowledge, comprehension, and application classifications of Bloom’s Taxonomy) and “critical-thinking” (synthesis, analysis, and evaluation classifications of Bloom’s Taxonomy) of individuals and a collaborative group of college students. As a result, it was revealed that the collaborative group performed significantly better in the critical thinking test than the group of individual students. This indicates that, in a cooperative environment, students are given more opportunities to perform critical thinking.
Tiwari et al. (2006) explored problem-based and lecture-based forms of collaborative learning in nursing students using the California Critical Thinking Disposition Inventory (CCTDI) score. Among the seven dispositions of CCTDI, the degree of Open-Mindedness, Analyticity, and Truth-Seeking were the elements of critical thinking corresponding to evaluation. Open-mindedness means “a person’s tolerance toward divergent thoughts and the ability to note one’s own bias” (Goyak, 2009, p. 116). Analyticity is related to “the use of reasoning and evidence to resolve problems” (p. 116), and truth-seeking is related to “addresses the propensity to search out the best and most honest knowledge even if it contradicts the self-interests of a person” (p. 116). Scores were significantly higher for students that participated in problem-based collaborative learning.

**Self-monitoring.** Researchers have also turned their attention toward how learners demonstrate their use of self-monitoring strategies when they work with a partner. While self-monitoring is one of the sub-functions of self-regulation (Bandura, 1991), in the field of reading comprehension research, the term self-monitoring is used to mean self-regulation (Coiro, 2007). Self-monitoring strategies enable readers to metacognitively focus on the goal of reading with the flexibility to explore alternative strategies when they confront difficulties in achieving that goal (Cho et al., 2017).

Self-regulated strategy use contributes to successful problem-solving (Bielaczyc et al., 1995). Furthermore, self-regulation skills, such as the ability to set goals and determine which reading strategies will be most effective, are particularly important in online inquiry contexts. That is, reading to solve problems on the Internet requires readers to navigate, evaluate, and make sense of a diverse range of non-linear
information sources represented as text, graphics, animation, audio, and video (Azevedo & Cromley, 2004).

These self-regulation skills can be further developed when readers engage in collaborative learning activities such as paired reading and discussion (Bridges, 2014). According to Wertsch (1979), during social interaction such as collaborative learning, learners acquire independent problem-solving abilities by transitioning from other-regulation to self-regulation. In addition, during paired activities, productive learners distribute and share responsibilities for thinking and problem solving, which, in turn, fosters the improvement of self-regulatory skills (Bridges, 2014).

Overall, self-regulatory skills contribute positively to individual problem-solving processes and these self-regulating skills can be improved when students engage in collaborative processes. Therefore, collaboration can promote students’ performance in problem-solving and online inquiry at both the individual and group levels (Castek et al., 2012; Coiro et al., 2014; Fawcett & Garton, 2005).

In summary, peer interaction additionally plays a very important role in collaborative learning from a constructivist perspective. Peer interaction has a positive effect on learners’ cognitive development, content knowledge learning, and positive motivation when the interaction occurs in a situation that facilitates true collaboration. In particular, peer interaction in reading comprehension has the advantage of improving reading ability, which is also explained by the transferability of reading strategies such as information location, meaning-making, source evaluation, and self-monitoring through the interactions between and among learners.
CHAPTER 3
METHODS AND PROCEDURES

This study used a mixed-method approach (Creswell, 2014) and this chapter describes both qualitative and quantitative methodologies to address the three main research questions. The chapter presents information about participants, tasks, procedures, data sources, and data analyses.

This study used a quantitative-based qualitative approach (Chi, 1997) to examine the value of working together through the comparison of strategies used by individual and paired students during an online QGT (e.g., the frequency of using reading strategies) and their corresponding outcomes (e.g., the quality of generated questions/justifications and learning gain). To compare two groups of participants, this study employed a quasi-experimental research design with one individual group and one pair group. Specifically the matching-only pretest-posttest control group design was used because participants were already in intact group (Fraenkel et al., 2011).

Additionally, this approach was implemented to determine the factors that influence the online QGT results. Verbal analysis was conducted to evaluate the processes used during the online QGT with verbal reports as the primary data source. Verbal analysis has been used to capture ones’ cognitive process such as what they learn and how they use that knowledge to reason or solve the problem (Afflerbach, 2000; Chi, 1997). As qualitative data, verbal reports can provide a deeper understanding of students’ process of the online QGT. However, comparing the process of individuals and pairs with a qualitative approach may result in subjective interpretation.
A quantitative-based qualitative approach with verbal data can complement the shortcomings of qualitative studies that only include verbal analysis (e.g., subjectivity and non-replicability). This mixed approach allows for the quantification and analysis of the impressions or trends to be revealed through the qualitative coding of verbal data and a quantitative comparison of the frequency of the code (Chi, 1997).

For the first step, qualitative data representing students’ processes and outcomes of the online QGT, such as verbal reports, screen interactions, written materials, and survey responses, were collected from both individual and paired student groups that completed the online QGT.

Quantitative analyses were used to compare the process and the outcome of the online QGT between the individual and pair groups and to determine the factors that influence the online QGT results. After students’ verbal reports were coded and quantified based on robust procedures, statistical analyses, including an independent samples t-test and a two-way mixed ANOVA, were used to compare the process and the outcomes of the online QGT between the individual and pair groups. Multiple regression and hierarchical multiple regression were used to determine the factors (e.g., reading strategy frequencies and learning gains) that predict the quality of generated questions and justifications as outcomes of the online QGT.

Participants

This study applied purposeful sampling (Patton, 2015) to explore the way students work with partners to complete the online QGT. Purposeful sampling differs from convenience sampling in that the samples are selected according to some criteria
established by the researcher. The strength of purposeful sampling is that it selects information-rich cases and allows for more in-depth research (Patton, 2015).

Several criteria were used to purposefully recruit and select participants. First, college-level students were selected because the online QGT involves a complex process that requires the diverse use of strategies that reflect high-order thinking processes and critical thinking skills in order to locate, evaluate, synthesize, and communicate relevant information from online sources (Leu et al., 2013). Most previous studies of complex online reading tasks primarily focus on students in Advanced Placement high school classes or college-level classes, due to the difficulty of such activities (see for example Bilal, 2001; Cho et al., 2017; Cho et al. 2018; Goldman et al., 2012).

Students in their freshman year of college were mainly recruited because the online QGT involved activities that are commonly assigned to first-year college students. According to a study by Ford and Perry (1982), for example, instructors in about 80% of writing classes assigned research-based tasks for first-year college students. For freshman students new to university-level academic course loads, research-based assignments can be unfamiliar and difficult. Therefore, I selected university freshmen as main participants.

Finally, the present study sought to avoid artificial reading situations by selecting a class of freshman college students who were already expected to conduct online research as part of their coursework without restricting students based on their reading ability. Previous studies that have students verbally report their strategy use have mainly targeted proficient readers in order to capture the diversity in their
conscious use of reading strategies (c.f. Coiro & Dobler, 2007; Cho et al., 2017). However, skilled readers only constitute a part of the student community. Research involving students with moderate or poor reading skills is still limited, even though the need for expanding research focus to include them has been highlighted several times (Afflerbach, 2000).

Therefore, in this study, potential research participants were freshman university students with no prerequisite reading ability enrolled in a liberal arts class that was likely to involve online research as part of its typical coursework. Students were recruited from the freshman class at a state university in eastern United States with a student population of about 14,500 students, of which roughly 22% are first-year undergraduates. I asked for cooperation from instructors of several freshman level liberal arts courses by explaining the purpose and procedure of the study. Ultimately, I chose one particular course in which the instructor had already planned an assignment involving Internet research with a format similar to that of the online QGT. The instructor agreed to substitute the online QGT into the syllabus in place of the original course assignment.

However, student participation in the study was not mandatory. Although all students were expected to complete the online QGT as a class assignment, they were also free to choose whether or not they were willing to allow the researcher to include their work in the data for this study. Moreover, the results of the online QGT were not reflected in the students’ grade— the instructor scored students based only on the contents of a reflective essay about what they learned from the task that was requested later in the class. Further, students were free to withdraw their participation from the
study at any time. While introducing the opportunity to participate in the research to the students, I repeatedly emphasized the voluntary participation. This ensured that their participation was not compulsory. Following this process, a total of 68 out of the 75 college students consented to participate in the study (See Table 1).

Table 1. Demographics of Participants

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<tr>
<th>Case Number</th>
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Note. See more information about creating groups in Procedures at Chapter 3.

There were 22 students in individual group and 46 students (23 pairs) in pair group. The participants’ ages ranged from 18 to 22 years old, with a mean age of 18.87 years old (standard deviation = 0.929 years). The participants were 21 males and 47 females and they were mainly freshmen (about 72%) and have various majors, such as business, computer science, education, history, nursing, psychology, etc.

**Instruments**

Several instruments were developed or adapted to capture participants’ topical knowledge, to identify students’ use of four online reading strategies, and to evaluate
the quality of the question and justification generated at the end of the online QGT

(See Table 2).

Table 2. Instruments

<table>
<thead>
<tr>
<th>Instruments</th>
<th>Descriptions of instruments</th>
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<tr>
<td>Pre-post knowledge survey</td>
<td>A 24-question survey was used to measure the participants’ knowledge of PV solar panels</td>
</tr>
<tr>
<td>Pre-post attitude survey</td>
<td>An 18-item survey was used to measure the participants’ attitude toward the online inquiry task</td>
</tr>
<tr>
<td>Online reading strategies performance measure</td>
<td>Think-aloud, interaction, and reader-computer interaction protocols were used to capture the participants’ performance in online reading strategies</td>
</tr>
<tr>
<td>Written question and justification</td>
<td>Participants’ outcome of the online QGT, which consisted of questions and justifications, was scored by a 9-point rubric</td>
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</table>

Pre-post Knowledge Assessments

A researcher-developed set of 24 questions related to the inquiry topic, photovoltaic (PV) solar panels, was administered to measure learners’ topical knowledge before and after they engaged in the online QGT. Each assessment consisted of 24 items in three sections (adapted from Cho et al., 2017): ten multiple-choice literal questions (1 point each), ten true–false inferential questions (1 point each), and four analytical questions (3 points each); points from each section were aggregated into a composite score (maximum = 32 points). Basically, the questions of pre and post knowledge tests were identical, but the post test was given with additional blank spaces following each question for students to explain the reasoning behind their
answers. This was designed to determine whether students had solved these questions using information learned during the online inquiry task.

To create the knowledge test, I used the Internet to learn more about PV solar panels and to locate relevant information that students were likely to encounter during the Internet search portion of their own online QGT. As a result, I gathered a lot of basic information about PV solar panels as well as details about four important issues related to their cost and efficiency, affordability, impact on the environment, and impact on public health. Then, I drafted a test sheet to include four perspectives and a similar number of questions. Feedback on this draft was provided from two researchers with Ph.D. degrees and two doctoral candidates in the field of literacy research. For example, since there is a limit to the amount of knowledge that students who have less prior knowledge can acquire during an hour-long inquiry task, questions were modified to be less detailed. The final version of the knowledge assessment (see Appendix B) consisted of ten multiple-choice questions, ten true-false questions, and four short-answer questions. Most of the multiple-choice questions (Items 1-8) focused mainly on factual information on PV solar panels, such as the basic concept of renewable energy sources and components of a PV solar system. To construct each of the multiple-choice questions, I applied Zimmaro’s (2004) recommendations: follow the best answer or the correct answer format, focus on a single problem or idea for each test item, avoid cueing one item with another, and keep the items independent of one another. Several multiple-choice questions focused on the perspectives surrounding PV solar panels (i.e., impact on the environment, impact on public health, the cost and efficiency, and affordability). Questions regarding impact on public health
considered environmental pollution and its effects on human well-being (e.g., “Which of the following is a toxic chemical in PV solar panels?”). Cost efficiency questions inquired about retail pricing and consumers’ perception of tradeoffs (e.g., “Which of the following is the estimated cost of PV solar panels for an average-sized home in the US before a tax credit is applied?”). Finally, questions regarding the affordability of PV solar panels covered equal access to energy sources (e.g., “What percentage of the total cost of installing PV solar panels in your home can be claimed as a credit on your federal tax return in the U.S.”).

The second part of the assessment included 10 true–false questions that were related to answering inferential information. Compared to the multiple-choice questions, these questions required more advanced reasoning skills beyond basic fact-checking. These questions were distributed among the four perspectives: impact on the environment (questions 11, 12, 13), impact on public health (questions 14, 15), the cost and efficiency of PV solar panels (questions 16, 17, 18), and affordability (questions 19, 20). For example, students were asked to judge whether the following sentences were true or false: “Replacing fossil fuel power plants with PV solar power plants may help reduce the number of people suffering from respiratory diseases” and “After the warranty period ends, PV solar panels should be replaced.”

The last four questions were analytical questions in a short answer format. These questions scored three points each, which was higher than the other question formats. These questions asked students to address their point of view or position on the four perspectives: environmental issues, human health issues, cost/efficiency
issues, and affordability. To minimize any testing effect, the pretest was conducted five weeks before the online reading and posttest session.

**Pre-post Attitude Survey**

The students’ attitude toward an online QGT was measured by an 18-item survey with a six-point Likert scale ranging from strongly disagree (1) to strongly agree (6) (See Appendix C). This survey was made by implementing several items from Putman (2014) and National Assessment of Educational Progress, Survey Assessments Innovations ([NAEP SAIL], 2016). The survey took three subscales from Putman, 2014: cognitive and behavioral engagement (8 items), value/interest (6 items), and anxiety (4 items), which explained 9.8%, 9.1%, and 5.4% of the variance, respectively (α = .88, α = .83, and α = .84). The survey used in the present study also used items on the use of the Internet (4 items) and attitudes toward working together (4 items) from NAEP SAIL (2016). Participants completed the attitude survey twice; once in the training session and again immediately after finishing the online QGT task in the task session.

Eight items related to cognitive and behavioral engagement asked about participants’ confidence on their completion of the online QGT, such as formulating questions, selecting the hyperlink of the best source, evaluating source information, combining information, etc. Six items regarding value/interest asked about the students’ perceived value of the online inquiry activities (e.g. “I believe the Internet makes it easier to get useful information” and “I believe using the Internet for research and reading has made learning more interesting”). Four items were about any anxiety that students may feel when they do online inquiries (e.g. “I cannot relax when I am
reading/researching on the Internet” and “I believe it is easy to get lost when I am using the Internet for research”).

Four items asked about the frequency of using the Internet in both academic and recreational settings (e.g. “I search for information for my homework on school assignments” and “In my free time, I search for information on the internet about issues that interest me”). Four items asked students about their attitudes toward working together (e.g. “I prefer working with a partner more than working by myself to solve a problem” and “I am more confident when I work with a partner than when working by myself to solve a problem”). A comprehensive list of questions can be found in Appendix C.

**Online QGT**

*Instrument development.* I selected the online QGT as the task of this study to explore how students perform online reading activities. This activity is informed by the new literacies of online research and comprehension (Leu et al. 2013). This theoretical framework regards online research and comprehension as “a process of problem-based inquiry” that consists of five procedural activities: (a) identifying a problem, (b) locating information, (c) evaluating information, (d) synthesizing information, and (e) communicating information.

For the present study I adapted the critical Internet reading tasks from Cho and colleagues (Cho, 2011, 2014; Cho et al., 2017). Cho (2011) designed a critical Internet reading task that consisted of an online inquiry component and a question generation component. For the online inquiry portion of the task, students were asked to find, evaluate, and synthesize information using Internet sources to learn about a specific
topic—i.e., Mountaintop mining. Immediately after they finished their inquiry, students generated a critical question on the topic they learned and made a rationale why the question they made was important based on what they learned from the online inquiry component. Cho (2011) assumed that question generation regarding controversial topics has two roles in the Internet reading. First, question generation would help participants read Internet texts more critically and second, it would be used to assess participants’ meaning construction results and learning (Cho, 2011).

The online QGT used in this study has similarities and differences with the critical Internet reading task from Cho et al. (2017). First, both tasks shared a common goal, which was to create compelling questions that promote a deeper understanding and develop readers’ critical perspectives on a topic after they search for, evaluate, and synthesize information on that topic.

Unlike other research studies that encourage readers to freely choose topics that inspire or motivate them, in the present study, students performed tasks on the same topic designated by the researcher in order to ensure comparability between the individual and pair groups’ processes and results of the online QGT. An internet search was conducted to find topics that satisfied four criteria: (a) students should not be very familiar with the topic, (b) students’ responses can be interpreted from diverse perspectives, (c) specific details about the topic are available on the Internet, and (d) the topic is not particularly politically or culturally sensitive. Through a quick informal survey conducted among the researcher’s inner circle, photovoltaic (PV) solar panels was selected as a topic for the online inquiry task over other options such as animal testing, the colonization of Mars, and electronic vaping. Since vaping was the second-
favorite topic on the quick survey, I decided to use vaping as a topic for the training session.

To study the value of working together, the present study expanded the design of the online QGT used by Cho et al. (2017) to involve pairs of readers in addition to individual readers. I decided to observe both individual students and pairs of students since a series of previous studies have emphasized the value of working together in learning (Bridges, 2014; Liu & Hmelo-Silver, 2010). I therefore hypothesized that when students work together in the online QGT, they will generate better outcomes. Therefore, because all students completed the same online QGT about PV solar panels, I was able to compare the processes and the outcomes of the online QGT between the individual and pair groups with only several changes made to the scoring of the paired QGT setting.

The paired students were asked to perform the same tasks as the individual students, but they worked together. Originally, student pairs were supposed to meet in person and work together by sharing one laptop for the task; however due to the COVID-19 pandemic, the QGT was modified slightly so that paired students could work together from their own homes using the desktop application, Zoom. Each person in the pair would be asked to lead the task, alternating screen sharing every 10 minutes. This was designed to encourage pair collaboration by dividing the labor of two participants equally. Paired students were asked to use the same Google documents to share their thoughts while they completed the task together.

Importantly, even though some students completed the online inquiry task with a partner, all participants were asked to complete the pre and post knowledge and
attitude surveys individually. This enabled me to examine whether or not working together would have a positive impact on not only the outcome of the online QGT but also on individual learning gains and student attitude toward the online QGT task.

Prior to the actual data collection, I conducted a pilot study with two individuals and one pair of students. Of the two individuals, only one was a university student and the other three students were PhD students in Education. Based on their feedback, the items of the overall instruments were revised. In particular, the items in the knowledge assessment survey underwent significant revisions. As mentioned above, the items on the knowledge assessment survey that ask for too detailed facts were modified to ask for more general information.

**Developing training materials.** The think-aloud protocol is an effective way to examine the readers’ reading process and the strategies they use during the process (Cho et al., 2017; Coiro et al., 2011; Coiro & Dobler, 2007; Pressley & Afflerbach, 1995; Zhang & Duke, 2008). My major professor, Dr. Julie Coiro, and a doctoral student in Education helped to develop these training materials. I first prepared two types of training materials for thinking aloud. One was a sample video of how to think aloud while solving a tangram puzzle that makes a robot shape with diverse-shaped blocks. I video-recorded the doctoral student solving the tangram puzzle and demonstrating how to speak aloud during the process. I then prepared two simple paper-and-pencil puzzles (See Appendix E) for students to solve while practicing thinking aloud in the training session; one puzzle required students to draw four straight lines that passed through all nine dots on the paper without removing their pen from the paper and a second puzzle required students to draw the shape of a house.
without removing the pen from the paper. All three puzzle-solving tasks were unrelated to the online QGT task to prevent students from learning and practicing reading strategies that might influence their performance on the actual reading task.

Second, for training purposes, I prepared a slideshow explaining three criteria for generating good questions and justifications and three examples of questions and justifications for vaping. I designed the slideshow to show the three criteria first and three examples sequentially. In order to clearly demonstrate how each example met or did not meet the three criteria, I color coded each criterion and its evidence in the same color.

After creating all of the training materials, I piloted them with my major professor and another doctoral student. Based on their feedback, all materials were revised for clarity, understanding, and readability. I decided to include one example of a lengthy question and justification that was not of good quality to demonstrate to students that simply writing long responses does not guarantee good quality of the question and justification.

**Making a prompt of the online QGT.** A prompt was given to explain the purpose of the online QGT with directions and tips for how to complete the task. Students were asked to read aloud directions and, in the case of pairs, they read aloud the directions in turns. I shared a screen when providing the prompt, but students could access the prompt anytime if they wanted since the document including the prompt was in the Google Docs folder. I made both an individual version and a pair version for the task instruction using Google Docs (Appendix F&G). Generally, the two versions were almost the same but the pair version included some phrases or
The goal of your assignment is to work with your partner to use the Internet to create a compelling question that stimulates rich classroom discussion about photovoltaic (PV) solar panels. To do this, you will navigate the Internet to find multiple useful sources, read them carefully, and create a compelling question and justification based on your reading.

**Directions for completing the Internet research task**

- Speak as loudly and clearly as possible.
- Stay close to the laptop so that the microphone can record your voice.
- Please use your cursor to follow along while you are reading.
- Use your mouse cursor when you want to point out a certain part on the screen.
- Use the Google Docs file you are given to type your notes.
- Focus on the process of locating relevant sources and learning as much as possible about the topic.

Two additional prompts were provided at the beginning of the task. One prompt was designed to provide basic information about PV solar panels and to introduce multiple perspectives surrounding PV solar panels, such as the impact on the environment, impact on public health, cost and efficiency of PV solar panels, and affordability. These perspectives reflected the contents of the knowledge assessment survey about PV solar panels, which were based on what I learned through my own preliminary online research about PV solar panels. The prompt read as follows:

*Due to ever increasing energy demands, maintaining safe and sustainable energy sources continues to be an important issue. As an alternative to fossil fuels, and other alternative energy sources that do not naturally replenish themselves, solar energy has become an important provider of naturally renewable energy. One technique for using solar energy uses photovoltaic (PV) solar panels to convert sunlight directly into electricity. Although this technology has developed and gained popularity over the last several decades, there is increasing discussion among some*
groups about its relative benefits and drawbacks, including its impact on the environment, impact on public health, the cost and efficiency of PV solar panels, and affordability.

A second prompt (see Appendix F&G) provided more details about the goal of the online QGT and called attention to the steps to be taken as part of creating a compelling question and related justification.

Your assignment is to create a compelling question that guides classroom discussion about photovoltaic systems using the Internet. To do this, you will navigate the Internet to find different web sources deemed useful, read the sources carefully, and create a compelling question and justification based on your reading. You will make ONE question and justification as an outcome of pair work. Talk with your partner to reach an agreement on what your compelling question and justification will be.

Your generated question should foster deeper thinking and discussion about your research topic, which will result in a richer and more complex understanding of the topic. A high-quality question and justification is relevant to the topic, is supported by a variety of information, and is of significant importance.

After they finished the online inquiry task, participants completed a 30-minute question generation activity based on what they had learned from the online inquiry task. As with the directions for the online inquiry task, I shared my screen while students were asked to read aloud the directions. For paired groups, students were asked to read aloud the directions by taking turns. Students could freely access the prompt anytime since the document that included the prompt was available in a Google Docs folder. Directions for the QGT were provided as follows:

Directions for generating a compelling question and justification
- Speak as loudly and clearly as possible.
- Stay close to the laptop so that the microphone can record your voice.
- Use the Google Docs file you are given to create your compelling question and justification.
Focus on the process of generating your compelling question and justification.
You can use your notes and briefly look back at the web pages you found to help with this process.
You will produce a joint outcome: Discuss with your partner to reach an agreement on what your compelling question and justification will be.

**Online reading strategy performance measure.** As individuals and pairs of students completed the online QGT, all actions and think-aloud/dialogic interactions for each online inquiry session were captured by video recording and later transcribed. These data were then analyzed in order to determine the type and frequency of online reading strategy use. I developed a coding scheme of online reading strategy for counting the frequency of using each reading strategy by adapting Cho et al., (2017). I assumed that if participants used more of each reading strategy, the quality of the process of the online QGT would be better because all of the reading strategies in the coding scheme were from proficient readers’ reading (Cho et al., 2017). Therefore, I used the frequency of reading strategy to determine the quality of students’ entire online QGT process.

**Rubric for Scoring the Quality of Written Questions and Justifications.** The scoring rubric created by Cho et al. (2017) was also adapted and used to rate the quality of students’ written questions and justifications that were generated at the end of the online QGT. The rubric was organized according to three criteria (relevance, validity, and significance), with four quality descriptions for each criterion (complete: 3, adequate: 2, partial: 1, lacking: 0), which could sum to a maximum of nine points (See Appendix D). *Relevance* referred to the extent to which the questions and
justifications generated by the students were related to PV solar panels. This category also considered the relevance of Internet sources students used to learn about PV solar panels. *Validity* was a criterion for evaluating how logically and coherently students constructed their questions and justifications in an argumentative relationship, as students were required to logically compose arguments and grounds for justification based on what they learned. Finally, *significance* was used to rate how deeply a question and justification could promote a complex understanding of the subject and critical thinking. Details for each criterion are depicted in Appendix D.

**Procedures**

As approved by IRB (See Appendix A), the data collection was conducted over two sessions for about two months (See Figure 1). In the training session, all students were trained on how to think aloud and how to create a compelling question and justification (See Appendix E) before they completed the pre-surveys. This took about three hours (2.5 hours for the training and 30 minutes for the surveys). In the task session, students performed the online QGT and post-surveys, which took about two hours; these were performed individually or in pairs about five weeks after the training session.
Prior to completing the online QGT, the entire class of students participated in a 2.5 hour training session. At the beginning of the class, students were told the purpose and process of the research. Then, the session provided training on how to think-aloud and how to generate compelling questions and justifications as well as time for students to complete two pre-tests and to learn more about the permission process before deciding if they would share data from the online QGT class assignment with the researcher.

**Think-aloud training.** For the first part of the training session, all participants were taught how to speak their thoughts out loud in a single whole group classroom setting. After watching the video of the researcher demonstrating how to think aloud
while solving a puzzle, the students practiced thinking-aloud with each other for approximately 20 minutes, taking turns to solve two simple puzzles in pairs. The think-aloud practices session provided students with a chance to think aloud to a partner and to help think aloud with each other prior to the completion of the online QGT. Students were instructed to focus on the process of thinking out loud rather than puzzle solving and to remind their partner if they did not think-aloud for more than ten seconds. While they were practicing thinking aloud by solving the puzzles, my assistant and I moved around the classroom and provided support when needed.

**Question generation training.** In the second part of the training session (which took approximately 40 minutes), participants were shown how to generate a compelling question and related justification. I first provided time for students to think and talk about what compelling questions are with their partner. Then, I asked students to create compelling questions (questions they thought might provoke classroom discussions by engaging other students’ interests) about the practice topic, vaping, and to create justifications for their questions (explanations or rationales about why those particular questions were important). After sharing a few questions and justifications made by the students with the whole group, I provided a definition and more explanation about the three criteria that would be used to judge the quality of their compelling question and its justification: relevance, validity, and significance (adapted by Cho et al., 2017). Relevance refers to how closely a question and justification were connected to the topic and the Internet sources. To fulfill this criterion, students’ questions and justifications had to contain topic-related sentences with evidence or notes from sources they searched and read. Validity refers to how logically a question
and justification are connected to each other. To fulfill this criterion, students’
questions were required to be supported by detailed evidence in the corresponding
justifications. Significance refers to how well a question and justification would
prove different perspectives on the topic based on critical thinking. To fulfill this
criterion, students’ questions and justifications had to deal with critical issues on the
topic with diverse perspectives. Detailed information about these three criteria (as
shown in Table 3) was shared with students in this part of the training session.

Table 3. Three Evaluation Criteria to Consider for Generating a Compelling Question
and Related Justification

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Descriptions</th>
</tr>
</thead>
</table>
| Relevance | - Is your compelling question and justification connected to the topic you were given and the Internet sources you read?  
- A *relevant* question and justification would have a strong connection to the topic and the Internet sources you read.  
- An *irrelevant* question and justification would not be related to the topic and the Internet sources you read. |
| Validity  | - Is there a strong and logical connection between your question and your justification? Does your justification include both a claim and related evidence (details)?  
- A *valid* question and justification would show a strong and logical connection between what you are asking and the claim and evidence you provide to justify it. |
An invalid question and justification would not provide sufficient evidence or would provide evidence that is unrelated to the claim or the question you are asking.

**Significance**

- Does your question produce thinking from different perspectives and provoke extended discussion related to the topic?
- A significant question and justification would encourage conversation about the topic from diverse perspectives connected to the real world.
- An insignificant question and justification would neither encourage diverse perspectives on the topic nor be connected to the real world.

Next, students were given three sets of example questions and justifications about vaping (See Appendix E) and asked to evaluate the quality of each. One set of materials served as an example of a high quality question and justification based on the three criteria; another set served as an example of a low quality question and justification, and a third set served as an example of a medium quality question and justification. Students were asked to evaluate the samples with a partner and to discuss the reason for their evaluations of each question and justification together. Then, I modeled for the class how to evaluate the quality of each example in line with the three criteria. Students had time for questions to clarify their understanding of the task.
Pre-tests. In the third part of the training session, students undertook pretests on prior knowledge about PV solar panels—the subject of the actual online QGT—and their attitude toward the online QGT. Student’s prior knowledge of PV solar panels was measured with a 24 item pre-test (See Appendix B) consisting of ten multiple-choice literal questions, ten true–false inferential questions, and four analytical questions (adapted from Cho et al., 2017 as described earlier). Students also completed an 18-item survey that used a six-point Likert scale for each question that assessed their attitudes toward the online QGT (See Appendix C) adapted from NAEP SAIL (2016) and Putman (2014).

Recruitment and permission process. Toward the end of the three-hour class, students were invited to decide whether or not to be a participant in the study by submitting their signed consent (See Appendix A). As was explained at the beginning of the class, students were reminded that although they were required to complete the online QGT as a class assignment, they were free to choose whether or not they would participate in the study since their participation was not related to their class grade. I repeatedly emphasized this point, taking care not to force students to participate in the study. A total of 68 out 75 students agreed to participate in the present study and to share their data.

Scheduling process and creating the pairs. Since one of the research objectives of this study was to compare the online QGT performance of individual students with that of student pairs, the participants were divided into two groups of individuals and pairs through a multi-step process. First, a table was created with 1.2 times more time blocks than the total number of participants using Google Docs, and
students were asked to choose their preferred time slot. This table consisted of two different sections; one meant for individuals and the other for student pairs, however, students were not informed of this in advance. As a result, 46 students self-selected into the section of the schedule that sorted them into pairs and 22 opted into the section that designated them as individuals in the online QGT. When forming the pairs, to control for external variables, I was careful not to match students who knew each other well into pairs. To do this, I asked the instructor to ensure that students who usually completed group activities together in the class or who knew each other well were not in the same pair. In addition, in the short practice session immediately preceding the online QGT, I checked to see if any of the paired readers knew each other well and there was no such case.

I took several steps to secure the internal validity of this study. First, participants were not informed in advance about whether they would complete the task individually or in pairs. They were only notified about this immediately before performing the online QGT. Moreover, I created and provided session packets for individual activities and pair activities separately. This was done to ensure that the participants were restricted from receiving information about the task environment of the alternative group’s format as much as possible.

There was concern if students already knew information about the topic, they would prepare and receive a better score in the post knowledge assessment. Therefore, to secure the internal validity, participants were asked if they had previously heard information about the assignment from other students who had already completed the
activity. I checked this with the students at the beginning of each task session, and it was confirmed that no students had previously heard about the task.

As a result of the scheduling process, 22 individuals and 23 pairs were scheduled (see Figure 2). Originally, I planned to have the task session with participants in person, but due to the mandatory social distancing and fully online classes caused by the COVID-19 pandemic, the task sessions were conducted online using the application Zoom. Through Zoom, participants and I could communicate with each other and they could share their own screen as they moved through the online QGT. All students who worked in pairs were asked to take turns sharing their screen to ensure the same amount of labor division and to promote collaboration. A colleague who has a Ph.D. degree in Literacy Education helped me to conduct the sessions when there were two individual sessions scheduled for the same time slot.

Figure 2. A Schedule for the Task Session

<table>
<thead>
<tr>
<th></th>
<th>3/30 (Mon)</th>
<th>3/31 (Tue)</th>
<th>4/1 (Wed)</th>
<th>4/2 (Thu)</th>
<th>4/3 (Fri)</th>
<th>4/4 (Sat)</th>
<th>4/5 (Sun)</th>
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<tbody>
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<td></td>
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<td>Pair</td>
<td>Pair</td>
<td>Individual</td>
<td>Individual</td>
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<tr>
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<td>Individual</td>
<td>Pair</td>
<td>Pair</td>
<td>Pair</td>
<td></td>
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<tr>
<td>5-8 pm</td>
<td>Pair</td>
<td>Pair</td>
<td>Pair</td>
<td>Individual</td>
<td>Individual</td>
<td></td>
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<tr>
<td>4/6 (Mon)</td>
<td>4/7 (Tue)</td>
<td>4/8 (Wed)</td>
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<td>4/10 (Fri)</td>
<td>4/11 (Sat)</td>
<td>4/12 (Sun)</td>
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<tr>
<td>1-4 pm</td>
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<td>5-8 pm</td>
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<tr>
<td>(Mon)</td>
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<td>4/16 (Thu)</td>
<td>4/17 (Fri)</td>
<td>4/18 (Sat)</td>
<td>4/19 (Sun)</td>
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<tr>
<td>9-12 pm</td>
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<td>5-8 pm</td>
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<td>4/23 (Thu)</td>
<td>4/24 (Fri)</td>
<td>4/27 (Mon)</td>
<td></td>
<td></td>
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<tr>
<td>9-12 pm</td>
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<tr>
<td>1-4 pm</td>
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<td>Individual</td>
<td>Individual</td>
<td>Pair</td>
<td>Individual</td>
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<tr>
<td>5-8 pm</td>
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<td>Individual</td>
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**The Task Session**

About five weeks after the training session, the students participated in the task session (lasting approximately two hours and twenty minutes), which consisted of the online QGT and post-surveys on prior knowledge about PV solar panels and their attitude toward the online QGT (See Figure 3). Unlike the training session, which was conducted with all participants in one large group, the task session was conducted with either each one student or each pair of students. Participants were encouraged to
participate in the task session in a place where they felt comfortable and undisturbed. To minimize the training effect of the pre-test on task performance or the post-test survey, sessions started about five weeks after the pre-surveys were conducted.

**Reinforcing think-aloud and question generation.** The task session started off by reminding students about how to think aloud and how to generate a compelling question, which is what they practiced in the original whole-class training session. For approximately 20 minutes, I guided students in recalling what they learned in the training session and explained the directions. Students briefly practiced thinking out loud again with the researcher by conducting a short (5-minute) online inquiry activity using electronic vaping again as an example topic. Additionally, I explained the evaluation criteria of a compelling question and justification one more time while looking at the example responses.
Figure 3. *The Procedure of the Online QGT in the Task Session*

Administering the Online QGT. Participants were introduced to the online QGT. I provided a brief instruction on how to use the Zoom application (e.g., sharing screen, stop sharing screen) and Google Docs (e.g., opening joint documents, finding task directions). I shared my screen to explain the goal of the task by letting them read prompts and directions. I checked whether they understood the task and let them ask questions about the task.
Participants were allotted up to 90 minutes to complete the entire online QGT; they were allowed up to 60 minutes to complete the online inquiry task about PV solar panels and then they were given up to 30 additional minutes to complete the question and justification portion of the task. For the first 60 minutes, participants worked either individually or with a partner to complete the assigned online inquiry activity on PV solar panels.

During the task, students were able to take notes using Google Docs (See Appendix H). Paired students shared one Google document for taking their notes together. The student who was leading the task was in charge of note taking. The researcher reminded them to switch screens every ten minutes. This meant that the students alternately were given power to execute decisions with the keyboard and mouse even though they worked together to complete the task. To capture students’ cognitive process (e.g., use of reading strategies) as they completed the online QGT, students were encouraged to speak out loud during the task about what they were thinking and doing. If the students did not think aloud for more than ten seconds, the researcher reminded them to do so. Students could freely use the Internet to conduct their inquiry activities if they so desired.

After finishing the online inquiry task, participants completed a question generation activity (See Appendix H). Students had up to 30 minutes to create a compelling question and the justification of why the question was important and compelling. Students could use the notes they made while creating the question. Briefly revisiting web pages was also allowed because it was not considered an activity in which participants could learn new information. However, to avoid students
gaining an unfair advantage by using additional information found after the one hour search period, entering a new website or searching for new information during the QGT was prohibited. To increase the collaboration in paired groups, students were given the same input opportunities by alternating which participant was screen-sharing every five minutes. The student who was sharing his/her screen executed the actions with the mouse and keyboard while they composed their question and justification together.

**Post-surveys.** At the end of the online reading session, students completed post-test items set up in a Google Form to demonstrate what they learned about PV solar panels and to complete Likert-scale items about their attitude toward the online inquiry activity. The surveys were identical to those conducted in the training session except for the knowledge survey. An additional blank space was given on the post-knowledge survey for students to explain their reasoning for answering each question. This was done to determine whether students had solved these questions based on the online inquiry task.

Since the task session was conducted online, the survey was collected using a Google form and all the participants responded. After finishing the online QGT, pair students completed the surveys individually without sharing their screens. It usually took less than 20 minutes for participants to finish the surveys.

**Data Analysis**

Data analysis was performed in three phases: (a) a qualitative phase that included the transcription and coding of verbal reports data; counting of the frequencies of each reading strategy; and scoring of knowledge test, attitude survey,
and generated question and justification; (b) a quantitative phase that included several statistical analyses of the frequencies of each reading strategy and scores of knowledge test, attitude survey, and student-generated questions and justifications; and (c) a qualitative phase to explore how commonly and differently successful readers in both individuals and pairs used online reading strategies.

**Qualitative Phase**

*Verbal reports data collection.* To determine the frequency of the online reading strategies used by students in real time, two types of data were used interchangeably: “think-aloud protocols” and “reader-computer interaction protocols” (Cho, 2011; Leander, 2008; Leu et al., 2008). First, think-aloud protocols and interaction protocols were used to capture verbal reports data for individuals and pairs, respectively (Kiili et al, 2012; Miyake, 1986). Since the verbal data reflects the thinking process taking place in the students' minds, these data provided evidence of what kinds of strategies were used by pairs and individuals as they read online and why they used certain strategies in specific conditions. Interaction protocols (or constructive interaction) are proxies for exploring the nature of reading strategies and processes used by participants who perform these types of tasks in pairs (see Kiili, 2013; Miyake, 1986). Interaction protocols methods are designed to avoid the unnatural situations that force participants to talk out loud in individual think-aloud practices, which have been cited as major drawbacks of individual-focused studies. Talking to a partner is a more natural way of studying participants to explain their thoughts without difficulty (Bainbridge, 1979; Miyake, 1986). To minimize the
researcher’s influence, students were encouraged to think aloud only when they did not speak out aloud for more than 10 seconds.

Two think-aloud training opportunities were given to the students before they completed the actual online reading and QGT task. First, all students practiced think-aloud with each other in pairs in the training session that involved the whole class. Next, before conducting the online inquiry activity in the task session, they practiced how to think-aloud while completing a five-minute demo version of the actual online inquiry activity about vaping.

Next, “reader-computer interaction protocols” were used to capture the students’ on-screen activities such as using the mouse, entering search terms, selecting links, etc. Using Zoom, students’ activities were videotaped. Students shared their computer screens with the researcher, and the process was recorded. Paired students were asked to switch screen-sharing responsibilities every 10 minutes, and I reminded the participants of this. In addition to the verbal data, video recorded data provided evidence of the web sources from which the students read and what actions they completed during the online inquiry activities.

**Data transcription.** I used Otter (otter.ai), an application for transcribing video materials, to complete a draft version of the transcription. I, then, cross checked the contents of the draft while watching the videos and corrected the parts that were ambiguously transcribed. I used a specific set of labels and symbols to capture comprehensive processing of participants by connecting their verbal reports with their reader-computer interactions. For example, when participants input a search term as they were reading online, I labeled it as [Search “search term”]. If participants
clicked a certain hyperlink, I labeled it as [Click “webpage name + URL”]. When they read the contents of webpages, I labeled it such as [Read aloud], [Read silently], and [Skimming]. When they took notes, [Typing] was used to label the students’ typing action when they directly input something, and [Copy & Paste] was used to label their action of copying and pasting the contents from web pages.

Verbal reports of 45 cases were collected. As shown in Table 4, transcripts of verbal reports ranged from 1,812 to 7,448 words, with an average of 4,364 spoken words. During the transcription process, I divided participants’ utterances into phrases or sentences that include the smallest unit of meaning. The average number of speech segments across all cases was 163, ranging between 80 to 266 speech segments per transcript. The average length of videos across all of the cases was 58 minutes 54 seconds, with a range from 50 minutes 12 seconds to 61 minutes 51 seconds. Then, I began the process of coding participant reading strategies based on the coding scheme described in the next section.

Table 4. Number of Spoken Words, Number of Speech Segments, and Length of Recorded Videos

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<th>Case Number</th>
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<th>Number of Words</th>
<th>Number of Speech Segments</th>
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<tr>
<td>2</td>
<td>Pair</td>
<td>4,328</td>
<td>181</td>
<td>57:12</td>
</tr>
<tr>
<td>3</td>
<td>Pair</td>
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<tr>
<td>4</td>
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<td>6,664</td>
<td>109</td>
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</tr>
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<td>5</td>
<td>Pair</td>
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<td>234</td>
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<td>14</td>
<td>Pair</td>
<td>7,448</td>
<td>189</td>
<td>60:18</td>
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</table>
Developing a coding scheme for reading strategy use. To compare the reading strategies that students used while performing the online QGT individually or in pairs, I developed a coding scheme by combining and integrating previous coding schemes of online reading strategies developed by Cho (2011; 2014) and Cho et al. (2017).

Cho (2011) and Cho (2014) summarized the reading strategies of adolescent students into four categories—information location, meaning making, source evaluation, and self-monitoring—and proposed the model of Constructively Responsive Reading that includes various detailed reading strategies (Afflerbach &
Cho, 2009; Cho, 2011; 2014). Cho et al. (2017) used a rubric to further specify descriptions of these four strategies into four sub-strategies. This coding process enabled Cho and colleagues to quantify the quality and frequency of strategy use so that data could be used as part of a quantitative analysis based on the model of Constructively Responsive Reading. Table 5 gives a brief description of the four strategies used during the online reading process and the criteria for determining the appropriate strategy code.

Table 5. *Brief Description of Four Reading Strategies Used in the Online Reading Process (Adapted from Cho (2014)).*

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
<th>Information Used in Determination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information location</td>
<td>The action of searching, accessing, and selecting various web sources and links to find useful text on the Internet that is relevant to the reading goal.</td>
<td>To be coded with this strategy, on-screen actions such as mouse movement, clicking, and typing were considered essential, and related verbal reports were optionally required.</td>
</tr>
<tr>
<td>Meaning making</td>
<td>Actions to construct meaning in various types of information sources, such as the search result page and webpages. This includes many activities related to text comprehension such as prior knowledge use, paraphrasing, generating inferences, analyzing, synthesizing, interpreting, reserving, and so on.</td>
<td>To be coded with this strategy, participants’ on-screen actions were optionally required, but verbal reports had to be included.</td>
</tr>
<tr>
<td>Source evaluation</td>
<td>Actions to evaluate sources or related information on the Internet in terms of relevance, validity (reliability), and significance. These include various forms of information (e.g., written texts, pictures and graphics, audio and video)</td>
<td>To be coded with this strategy, participants’ on-screen actions were optionally required, but verbal reports had to be included.</td>
</tr>
</tbody>
</table>
clips, websites, etc.) and hyperlinks (e.g., search entries, menus, buttons, image links, headings and subheadings, etc.).

| Self-monitoring | Actions to self-monitor reading processes, task-related factors, and the reader themselves. This information includes planning information location, monitoring task goals and processes, and regulating meaning making processes. | To be coded with this strategy, participants’ on-screen actions were optionally required, but verbal reports had to be included. |

Data for the present study were coded with this detailed coding scheme to characterize the nature of participants reading strategy use. Notably, 15% of the total data were coded deductively based on the existing coding scheme in Table 5, while additional types of strategy use observed in the data were coded inductively, described below. This two-step abductive coding process resulted in a comprehensive summary of online reading strategy use shown in Table 6.

Three new sub-strategy codes were added to the coding scheme. More specifically, “scrutinizing featured snippets in the search-results page” was added as an additional type of information location strategy; “reserving important information” was noted as an additional type of meaning-making strategy; and “monitoring the task” was added as an additional self-monitoring strategy.

First, the code “scrutinizing featured snippets in the search-results page” was used to describe a process of determining the most relevant information from search results, including header images, detailed descriptions, and graphs, provided by Google’s algorithm. I chose to make it a new strategy category because meaning-
making from featured snippets requires a different level of comprehension skills than simply examining the contents of a general search result page.

Next, the code “reserving important information” was defined as keeping information that the reader judged to be important as part of the note-taking process. According to Cho (2011), “reserving information” is a detailed type of “identifying important information” strategy. However, in the present study, the process of reserving important information suggested a more active level of strategy use compared to “identifying important information” and, therefore, they were separated into two strategies. Other sub-strategies in this coding category consisted of reserving useful websites, copying and pasting important information, paraphrasing text contents, and organizing note structure.

Finally, “monitoring the task” refers to all actions of the reader to monitor the goals and progress of the task. More detailed strategies included monitoring the reader’s progress toward goals of reading and revisiting the task prompt.

Beyond adding sub-strategy codes to the final coding scheme in the present study, strategies from Cho’s work that were rarely observed in the present data were removed. Across all coded data, the following reading strategies were observed less than 5 times, and were therefore judged to be unsuitable as important reading strategies in the quantitative analysis. In the information location strategy category, codes for “Using built-in search function on a promising website,” “Accessing goal-relevant websites,” “Accessing complementary sources,” and “Rejecting links” were removed. In the meaning-making strategy category, “Examining a group of links in the website and related meanings constructed from the reading of multiple hyperlinks”
was excluded. In the source evaluation category, “Assessing usefulness of websites by overviewing menus of the websites,” and “Assessing usefulness of websites by overviewing hyperlinks in the websites” were removed. Finally, in the self-monitoring category, “Perceiving repeated presences of hyperlinks presented in the multiple searches” and “Monitoring the reader’s self-confidence in choosing and using hyperlinks and web sources” were eliminated.

Table 6 presents the final coding scheme of reading strategies used in this study, related sub-strategies, and the definitions for determining the presence of each strategy in the data. The descriptions of detailed strategies included in the coding scheme of Cho (2011; 2014) and Cho et al. (2017) are based on the descriptions of Cho (2011) with some edits.

Table 6. Coding Scheme of the Reading Strategy with Detailed Strategic Actions and Their Explanations (Adapted from Cho (2011)).

<table>
<thead>
<tr>
<th>Information Location</th>
<th>Detailed strategic actions</th>
<th>Descriptions &amp; determination</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Generating and modifying search terms</td>
<td>1. Generating keywords and typing search terms</td>
<td>• Accessing a goal-relevant information space by generating keywords to type into the search engine</td>
</tr>
<tr>
<td></td>
<td>2. Modifying search terms</td>
<td>• Managing the range of available information by modifying search terms</td>
</tr>
<tr>
<td>B. Surveying the search result page and</td>
<td>1. (on the search engine) Scrutinizing website entries listed in the search-results page</td>
<td>• Scrutinizing website entries listed in the Internet search-results page (titles, URLs, short descriptions, etc.)</td>
</tr>
</tbody>
</table>
associated websites 2. (on the search engine) Scrutinizing featured snippets in the search-results page

- Scrutinizing featured snippets in the top of the search-results page
- Featured snippets: Featured snippets are in a special box at the top of your search results, often with a text description above the link (from Google)
- “People also ask”: another form of featured snippets

3. (on the website) Overviewing navigation menus within a website

- Testing relevant menus within a website and sequencing the order of reading

4. (on the website) Examining hyperlinks on the website for further information

- Examining hyperlinks that may lead to useful information outside of the site’s boundaries (e.g., citations, references)

C. Link selection 1. Selecting links

- (After scrutinizing a certain entry) Clicking the links as tentative references or main sources to consult further

<table>
<thead>
<tr>
<th>Meaning-making</th>
<th>Detailed strategic actions</th>
<th>Descriptions &amp; determination</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Making Meaning from Hyperlinks</td>
<td>1. Examining a group of entries on the search result page and relating meanings constructed from the reading of multiple entries</td>
<td>- Examining a group of entries to make an overall sense of common topics, themes, and characteristics across those hyperlinks in the search result page</td>
</tr>
<tr>
<td>B. Comprehending Information within a web page</td>
<td>1. Overviewing (skimming) a web source to gather an overall sense of the information</td>
<td>- Noting characteristics of web sources in relation to length, amount of information, embedded advertisements and banners, available menus and links, authorships and maintenance, and layout and design - Noting important parts, especially those covered in the web source,</td>
</tr>
</tbody>
</table>
by scanning content-related features with a special focus on headings, subheadings, and highlighted/bold words, the table of contents, and interactive overviews

- Determining what to read and in what order, what to read in detail, and what to ignore by rating the importance of content and conducting selective reading
- Summarizing what was gained from previewing and, based on this, generating an initial hypothesis about the context of the text

2. Identifying important information on a web source

- Using prior knowledge of the text topic, text structure, author, etc. to decide what is important to attend to while processing the text
- Repeating, restating, and paraphrasing text that was just read
- Reading aloud before taking notes
- Looking for keywords (e.g., concepts that are repeated in a text, domain-specific vocabularies, topic sentences, and topic paragraphs)

3. Generating inferences consciously to enhance the construction of meaning from a web source

- Inferring necessary but missing information to understand text content and filling in deleted information
- Generalizing text context by applying specific cases and examples described in the text into a broader context and situation
- Inferring plausibility of information in a text by checking and questioning (in)consistency between the reader’s prior knowledge and the text information currently being read
4. Analyzing parts of text on a web source

- Inferring intended or expected readers who may access, read, and benefit from a text and valuing the importance of the text’s content

- Comparing the degree of agreement between the perspectives presented in the text and those of the readers

- Comparing and contrasting different perspectives on the same issue presented within the webpage

- Comparing and connecting pictures, images, and graphics with written text to enhance understanding

- Analyzing the author’s claims, supporting details, and logical relationships between the claim and evidence

- Using complementary textual information attached to tables, charts, and maps to better understand the information (e.g., titles, descriptions, map legend, notes on the table)

5. Synthesizing different parts of text on a web source

- Synthesizing pieces of information from different parts of the text to make sense of what the text is about

C. Constructing Intertextual Meaning across Different Web Sources

1. Relating information from more than one text to develop understanding in an ongoing way

- Connecting and comparing different information gathered and learned from different web sources

- Categorizing, grouping, and classifying the information gathered and learned thus far to build a mental structure of meaning
2. Building an integrative mental model

- Using the meaning constructed in the course of navigating and reading multiple texts to build an integrative mental model (e.g., forming, developing, modifying, and confirming critical questions)

D. Reserving important information

1. Reserving useful websites

- Keeping useful websites in tabs, browser favorites, or bookmark folders
- Note-taking URLs

2. Copying and pasting important information

- Taking notes by copying and pasting important information into the designated note page

3. Paraphrasing text contents

- Taking notes by paraphrasing text contents including summarizing and synthesizing information
- Changing the wording

4. Organizing note structure

- Organizing note structure (e.g. using bullets, titles, sub-titles, etc.)
- Moving certain note content from one place to another
- Elaborating on the note contents

<table>
<thead>
<tr>
<th>Source Evaluation</th>
<th>Detailed strategic actions</th>
<th>Descriptions &amp; determination</th>
</tr>
</thead>
</table>
| A. Determining relevant sources | 1. Assessing relevance of the website entries on the search result page | - Assessing the relevance of hyperlinks by activating the reader’s prior knowledge
- Evaluating the topmost link on the search result page as the most relevant link |
| | 2. Assessing relevance of webpage contents | - Assessing the relevance of websites by examining the extent to which the sites’ contents are related to what is being sought |
B. Discerning reliable sources

1. Judging the credibility, reliability, and trustworthiness of hyperlinks
   - Judging the credibility, reliability, and trustworthiness of hyperlinks by inferring authorities from author information and source information (e.g., when and where did this information appear?), and URLs (e.g., .com, .org, .gov, .edu, .net, etc.)

2. Judging the credibility, reliability, and trustworthiness of the webpage contents
   - Identifying author/source information and inferring the author’s stance, purpose, and intent with a critical mindset
   - Distinguishing fact-oriented or opinionated sources and determining their information values
   - Judging the legitimacy of webpage content by checking citations and references

3. Judging the credibility, reliability, and trustworthiness of websites
   - Checking the credibility and reliability by identifying and examining reputation, authority, and reliability of information sources cited within the website
   - Checking the credibility and reliability by identifying and examining the current website’s authorship and sponsorship (e.g., institutions, sponsors, copyrights, contact information)
   - Examining maintenance and up-to-dateness by identifying when the articles and the website have been created and updated

C. Assessing each

1. Judging the significance of hyperlinks on the search result page
   - Judging the significance of hyperlinks by making meaning from minimal textual information with the links (e.g., link titles,
2. Judging the importance of the webpage contents

- Judging the importance of text information currently being read, with the evolving goals, questions, and foci of reading in mind, by comparing information that has been located and read so far

3. Judging the importance of the webpage contents on superficial level

- Any positive responses on anything they read (e.g., good, great, interesting, etc.)

<table>
<thead>
<tr>
<th>Self-Monitoring</th>
<th>Detailed strategic actions</th>
<th>Descriptions &amp; determination</th>
</tr>
</thead>
</table>
| A. Managing information searches | 1. Perceiving and determining that an Internet hypertext reading needs attention while locating relevant information, sequencing the reading order, and constructing the reading paths | - Noting multilayered relationships among web sources horizontally (e.g., numerous web sources are interconnected by hyperlinks) and hierarchically (e.g., needs to search for and locate relevant information among different articles posted within a webpage within a website using web search engines)  
- Noting possible information overload and disorientation and the resultant cognitive challenges  
- Noting the uncertainty of scope and the amount of information on the Internet |
| | 2. Detecting problems in searching for and navigating toward relevant and useful information | - Possible problems: ineffective generation and modification of topic-related keywords and incoherent selection of hyperlinks and web sources  
- Perceiving difficulties due to 1) ill-associated, inaccurate, and/or lacking topic-related prior knowledge; 2) ill-structured |
3. Perceiving the reader’s own goals in planning, directing, and redirecting the process of information searching, the determination of reading order, and the resultant path construction

- Planning information-seeking and the order of reading by 1) perceiving information being sought; 2) categories of information relevant to the goal; and 3) awareness of what is required to complete the reading task at hand
- Directing and redirecting information-seeking and the reading order by juxtaposing what information has been sought and located thus far with what information should be further/additionally sought, in relation to different aspects of information characteristics
- Redirecting information-seeking and the order of reading by mentally revisiting currently constructed reading paths and determining problems to be addressed and/or additional information
- Talking about the next steps or things to do next in information-seeking process

B. Regulating link selections

1. Perceiving previously selected hyperlinks and web sources

- Perceiving selected hyperlinks and web sources while examining the links and accessing the sources

C. Monitoring the task

1. Monitoring the reader’s progress toward the reading goals

- Monitoring the reader’s progress toward the reading goals by reflecting on the extent to which the reader learned and understood from searching and reading
- Monitoring their notes

2. Revisiting the task prompt

- Reading the task prompt, description, and criteria again

D. Monitoring the self

1. Monitoring the reader’s epistemological stance

- Monitoring the reader’s epistemological stance toward knowledge, truth, and source of knowledge and potential biases in choosing and interpreting web sources

2. Monitoring (or sharing) readers’ problem-solving strategies

- (For individuals) Monitoring one’s problem-solving strategies
- (For pairs) Monitoring and sharing readers’ problem-solving strategies

E. Deciding to stop or go further

1. Continuing (or quitting) meaning-making after source evaluation

- Deciding to stop reading or read further after evaluating the relevance and reliability of sources

2. Continuing (or quitting) meaning-making based on the degree of understanding toward the text

- Deciding to continue reading because readers feel their meaning-making is not sufficient
- Deciding to stop reading because readers feel their meaning-making is sufficient

3. Quitting meaning-making because of lack of understanding

- Quitting meaning-making because readers feel a lack of understanding

F. Adjusting meaning-making processes

1. Planning reading and adjusting cognitive efforts

- Planning reading and adjusting cognitive efforts by reflecting on and balancing short- and long-term foci of reading (e.g., to overview,
identify important ideas, take a detailed look)

2. Monitoring the stimulation of cognitive processing and activating processes to accommodate characteristics of the text

- Perceiving unknown and unfamiliar words, terminologies, concepts, and acronyms and activating processes to find or not find their meaning
- Judging the degree of importance of text information (e.g., keywords, main idea sentences, quotations, subheadings, highlighted references, repeated concepts) and adjusting cognitive efforts according to the importance rating results
- Detecting comprehension problems due to 1) a lack of prior knowledge related to text information; 2) inappropriate association of prior knowledge with text information; 3) inaccurate predictions, inferences, and understanding of text information; 4) cognitive conflicts due to conflicting sources on the same issue; and 5) superficial understanding of the text content due to over-focusing on searching rather than reading the content

3. Perceiving needs for controlling reading processes according to the task-related factors

- Perceiving needs for controlling reading processes according to the task-related factors, including task demands, time constraints, and cognitive overload, while reading on the Internet

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**Applying the coding scheme for reading strategy use.** All verbal utterances participants made were coded based on the coding scheme and then the frequency of each of the four reading strategies was counted. The unit of analysis for strategy
coding was a phrase or sentence containing the smallest semantic component that indicated participants’ strategy use. Therefore, I first performed the work of segmenting all verbal utterances to identify each unit of analysis. Whenever possible, only one strategy code was applied to each phrase or sentence; however, in some cases, more than one strategy code was applied.

Of particular concern was the coding strategy used among the paired reading performances. Because their verbal data was a form of dialogue, there was the possibility that both students in the pair could simply duplicate the same strategy. When one student’s speech indicated the use of a specific strategy, the coding decision was dependent on the partner student’s reaction. For example, if the partner was silent about a student’s comments that included strategies or simply gave meaningless reactions such as “yes,” “yeah,” and “uh huh,” or if they repeated the other’s words, it was not considered a separate strategy. However, if a different strategy was verbalized following the initial speech regarding the partner’s strategy, the speech was coded as having two separate strategies. For example, if in response to an utterance “I think this part is important,” the utterance “Yes, I think so, too. Let’s include this part in the note,” was added, it was coded as two strategies: determining importance and taking notes. Conversely, if the second person had simply said, “Yes, I think so, too,” it would have been coded as only one strategy (i.e., determining importance) in this case.

To verify my ability to appropriately and consistently code strategy scores, I initially discussed item characteristics and scoring procedures with a reading expert with a Ph.D. in Literacy. To establish inter-rater reliability, two raters, including the
expert in literacy research (co-encoder) and myself, coded a subset of about 17% from the 45 sets of videos. Subsequently, we scored data for each assessment together, calculated the percentage of agreement, and addressed any inconsistent ratings. To increase consistency, we completed a training session using six sets of videos. For those six videos, we coded the performance of reading strategies, and scored the questions and justifications together. When there was an inconsistency, we discussed it until reaching an agreement. After the training session, we coded two sets of videos independently. The average percentage of agreement was 97.2%. I coded the remaining videos independently.

Quantitative Data Analyses

As part of this project, I considered three main research questions (some with sub-questions) to explore the role of working together by comparing works between the individual and pair groups. In each case, IBM SPSS 18 was used for statistical analyses.

Research Question 1a: Are there significant differences in the frequencies of using four reading strategies (information location, source evaluation, meaning making, and self-monitoring) between individuals and pairs of college students completing an online QGT?

Research Question 1b: Is there a significant difference in the quality of reader-generated questions and justifications between individuals and pairs of college students as an outcome of an online QGT?

Research Question 1a sought to compare the frequencies of using the four reading strategies (information location, source evaluation, meaning making, and self-
monitoring) between individual and pair groups completing an online QGT. Research Question 1b refers to the comparison of online QGT outcomes between individual and pair groups by using the quality of generated questions and justifications.

Independent sample t-tests were conducted to compare both the frequencies of four reading strategies and the quality of generated questions and justifications. In each independent sample t-test, the independent variables were groups (individuals or pairs) and the dependent variables were one of the four reading strategies (information location, meaning making, source evaluation, and self-monitoring) and the quality of the questions and justifications generated by participants. For each of the four reading strategies, the frequency of strategy use was determined by counting the number of sub-strategies and adding them up based on the coding scheme. The quality of the generated questions and justifications was scored according to the rubric developed with three criteria: relevance, validity, and significance (complete: 3, adequate: 2, partial: 1, lacking: 0 for each criterion, see instruments part of chapter 3).

Research Question 2: To what extent do paired students learn knowledge about the inquiry topic and change attitudes toward online inquiry, compared to individuals after completing an online QGT?

To answer this question, two sets of two-way mixed analyses of variance (ANOVAs) were performed to analyze both pre- and post-test changes in knowledge on PV solar panels and the attitudes toward tasks and the differences between individuals and pairs. In this analysis, the within-subjects factor was the timing of the test (before or after of an intervention), the between-subjects factor was the group (individual or pair), and the dependent variables were level of knowledge with respect
to PV solar panels (as determined by scores on the pre and post knowledge tests) and attitude toward online inquiry tasks (as determined by responses to the pre and post attitude surveys). The pre and post knowledge tests consisted of the 24 items about PV solar panels: ten multiple-choice literal questions (1 point each), ten true–false inferential questions (1 point each), and four analytical questions (3 points each); points were aggregated into a composite score (maximum = 32 points). The attitude survey toward the online inquiry task was measured by an 18-item survey (cognitive & behavioral engagement, value/interest, anxiety, and attitude toward working together) with a six-point Likert scale ranging from strongly disagree (1) to strongly agree (6) (See Appendix C).

In addition, another set of questions was designed to investigate the relationship of reading strategies, learning gains, and the quality of task outcomes.

**Research Question 3a:** To what extent does performance of four reading strategies (information location, source evaluation, meaning making, and self-monitoring) and learning gains predict the quality of reader-generated questions and justifications in an online QGT?

A multiple regression analysis was used to determine whether or not a reader’s frequency of using the four reading strategies and the associated learning gain significantly predict the quality of his/her generated question and justification. The dependent variable was the quality of the generated questions and justifications, and the independent predictor variables included frequency counts of the four reading strategies (i.e., information location, meaning making, source evaluation, and self-
monitoring) and learning gain (as calculated by subtracting the knowledge pre-test score from the knowledge post-test score).

In this analysis, I entered all independent variables into the model at the same time to determine the overall predictive influence of four reading strategies and learning gain on the quality of generated questions and justifications. The composite score of generated questions and justifications, as determined by the rubric consisting of three criteria (relevance, validity, and significance) was used as the dependent variable.

It is important to recognize that the average value of the two students’ knowledge survey results was used for statistical analysis of pair performance. Many studies have pointed out an influence of domain knowledge of the topic on the quality of reading comprehension in both print-based and digital settings (Anmarkrud et al., 2014; Cho, 2014; Hinostroza et al., 2018). Although I recognize that averaging the scores of two people may not properly reflect an individual's learning gains, I decided to use averaged scores of the paired students in order to include pair learning gain as a variable in the regression analysis. I was cautious to use averaged scores because they did not represent the individual learning gains enough and it might result in inaccurate analysis results. I was aware of the possibility of misinterpretations of regression analysis as well. Despite these limitations, I decided to include this score as a variable to predict the quality of the outcome of an online QGT because topic knowledge was considered important for reading comprehension in previous studies (Coiro & Dobler, 2007).
Research Question 3b: Do source evaluation and information location predict the quality of reader-generated questions and justifications in an online QGT over and above: (a) self-monitoring, (b) learning gains, and (c) meaning-making?

A hierarchical multiple regression analysis (Tabachnick & Fidell, 2013) was employed to investigate the extent to which frequency of source evaluation and information location strategy uses correlated with the quality of the generated question and justification when the other variables (i.e., frequency of self-monitoring and meaning-making strategy uses and learning gain) were statistically controlled. Based on theoretical importance, the five independent variables were entered sequentially in the following order: self-monitoring strategy, learning gain, meaning-making strategy, source evaluation strategy, and information location strategy.

Among the four reading strategies, self-monitoring was considered the most influential because it has been regarded as an important metacognitive strategy that helps readers select, apply, and evaluate their strategies throughout reading activities in both Internet and traditional reading settings (Afflerbach & Cho, 2009; Coiro & Dobler, 2007; Pressley & Afflerbach, 1995). Self-monitoring strategy also has been shown to have a positive effect on other reading strategies (Cho et al., 2017), including meaning-making (Anmarkrud et al., 2014; DeSchryver, 2017) and information location (Guinee et al., 2003; Hinostroza et al., 2018).

Next, learning gain and meaning-making were entered into the model since the importance of domain knowledge and meaning-making has been emphasized in research of reading in offline settings (Afflerbach & Cho, 2009; Anmarkrud et al., 2014; Cho, 2014; Hinostroza et al., 2018). Learning gain was used to measure the
domain knowledge change about PV solar panels, and was obtained by subtracting the prior knowledge survey score from the post knowledge survey score.

Finally, source evaluation and information location were entered in the third phase. Many studies have emphasized source evaluation and information location as strategic activities that require new or more complex levels of cognitive skills in Internet reading or online inquiry activities (Bilal, 2000; Bråten et al., 2009; Coiro & Dobler, 2007; Goldman et al., 2012; Henry, 2006; Hinostroza et al., 2018; Leu et al., 2007).

Research Question 3c: Does self-monitoring predict the quality of reader-generated questions and justifications in an online QGT over and above: (a) learning gains, (b) meaning-making, (c) source evaluation, and (d) information location?

In addition to conducting a hierarchical multiple regression analysis to investigate the portion of two reading strategies (information location and source evaluation) emphasized in online reading that explain the variance of generated question and justification quality, I was interested in examining the extent to which self-monitoring explains a unique amount of the total variance. Another hierarchical multiple regression analysis (Tabachnick & Fidell, 2013) was employed to investigate the extent to which frequencies of self-monitoring use correlated with the quality of the generated question and justification, when controlling for the other variables (i.e., frequencies of information location, source evaluation, meaning making strategy uses, and learning gain). Based on theoretical importance, the five independent variables were entered sequentially in the following order: learning gain, meaning-making
strategy, source evaluation strategy, information location strategy, and self-monitoring strategy.

Self-monitoring strategy was entered in the last step since self-monitoring is a metacognitive strategy that regulates other cognitive skills and reading strategies in both Internet and print-based reading (Afflerbach & Cho, 2009; Coiro & Dobler, 2007; Pressley & Afflerbach, 1995).

**Qualitative Data Analysis**

*Research Question 4: What are the shared or unique characteristics of strategic reading processes employed by higher performing individuals and pairs as they complete an online QGT?*

I conducted a descriptive case analysis to answer Research Question 4. The purpose of this qualitative analysis was to check whether there were unique or shared characteristics between individual and paired participants in terms of their strategy use. I chose three individuals and three pairs who got high scores on the outcome of the online QGT (more than 8 out of 9) with the highest frequency of use of all four reading strategies as multiple cases of this analysis (Yin, 2006). Individuals numbered 13, 25, and 33 and pairs numbered 6, 22, and 30 were selected as multiple cases of this analysis. Table 7 shows cases’ frequencies of strategy uses and scores of the outcome of the online QGT.
Table 7. Average Frequencies of Reading Strategy Use and Average Scores of Questions and Justifications

<table>
<thead>
<tr>
<th></th>
<th>Information location</th>
<th>Meaning making</th>
<th>Source evaluation</th>
<th>Self-monitoring</th>
<th>Questions and justifications score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Individual</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>33.45</td>
<td>75.45</td>
<td>18.55</td>
<td>15.64</td>
<td>5.09</td>
</tr>
<tr>
<td>#13</td>
<td>40</td>
<td>81</td>
<td>27</td>
<td>23</td>
<td>8</td>
</tr>
<tr>
<td>#25</td>
<td>29</td>
<td>111</td>
<td>28</td>
<td>22</td>
<td>9</td>
</tr>
<tr>
<td>#33</td>
<td>18</td>
<td>83</td>
<td>26</td>
<td>21</td>
<td>8</td>
</tr>
<tr>
<td><strong>Paired</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>42.74</td>
<td>94.09</td>
<td>16.87</td>
<td>28.48</td>
<td>6.30</td>
</tr>
<tr>
<td>#6</td>
<td>65</td>
<td>123</td>
<td>40</td>
<td>38</td>
<td>8</td>
</tr>
<tr>
<td>#22</td>
<td>24</td>
<td>97</td>
<td>14</td>
<td>41</td>
<td>8</td>
</tr>
<tr>
<td>#30</td>
<td>79</td>
<td>72</td>
<td>19</td>
<td>39</td>
<td>8</td>
</tr>
</tbody>
</table>

Focusing on detailed reading strategies that were used most frequently in both individuals and pairs from the results of descriptive statistics (see Table 8), I examined whether there were any similar or different patterns of using strategies between the individual and pair groups. Coefficients that were not statistically different between individual and pair groups indicated strategies with similar frequency of use between the two reading groups.

To investigate the reason why the frequencies varied across group types, I focused on the strategies that showed significant differences between the individual and pair groups from the quantitative analysis results. I first sorted all excerpts of
transcripts that reflect corresponding strategy uses from the cases and then chose the best excerpt that represented shared or unique characteristics of strategy use between the two groups.

Table 8. Most Frequently Used and Unique Detailed Strategic Reading Actions Selected for Follow-up Qualitative Analysis

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Detailed strategic action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Most frequently used in both groups</td>
</tr>
<tr>
<td></td>
<td>Significantly different use frequency between groups</td>
</tr>
<tr>
<td>Information location</td>
<td>Scrutinizing website entries</td>
</tr>
<tr>
<td></td>
<td>Generating keywords and typing search terms</td>
</tr>
<tr>
<td></td>
<td>Scrutinizing featured snippets in the search results page</td>
</tr>
<tr>
<td>Meaning making</td>
<td>Identifying important information on a web source</td>
</tr>
<tr>
<td></td>
<td>Generating inferences consciously to enhance the construction of meaning from a web source</td>
</tr>
<tr>
<td></td>
<td>Reserve important information</td>
</tr>
<tr>
<td>Source evaluation</td>
<td>Determining relevant sources</td>
</tr>
<tr>
<td></td>
<td>Discerning reliable sources</td>
</tr>
<tr>
<td></td>
<td>Assessing each source’s significance</td>
</tr>
<tr>
<td>Self-monitoring</td>
<td>Managing information searches</td>
</tr>
<tr>
<td></td>
<td>Adjusting meaning making processes</td>
</tr>
<tr>
<td></td>
<td>Monitoring the task</td>
</tr>
</tbody>
</table>
Chapter Summary

This chapter described the participants, online QGT, procedures, data sources, and data analyses involved in this study. This study used a quantitative-based qualitative approach (Chi, 1997) to 1) examine the value of peer interaction by comparing the individual and pair’s online QGT performance and results and 2) determine the factors that influence the online QGT results.

The research procedure consisted of two sessions. The training session was conducted with all students prior to participating in the online QGT activities. Participants were trained on how to think aloud and how to generate a compelling question and justification. They were asked to complete a survey on PV solar panels and a second survey about their attitudes toward online inquiry tasks.

A survey of 24 questions (adapted from Cho et al., 2017) was used to measure the learners’ knowledge on PV solar panels before and after the students engaged in the online QGT. The students’ attitudes toward the online inquiry task were measured using an 18-item survey with a six-point Likert scale. To measure the frequency of the four reading strategies, I adapted a coding scheme from Cho (2011; 2014) and Cho et al. (2017). Written questions and justifications were scored using Cho et al.’s (2017) rubric, which is categorized by three criteria (relevance, validity, and significance).

In the task session, the students performed the online QGT and then participated in post-surveys on knowledge about PV solar panels and their attitudes toward the online inquiry task. Through an independent samples t-test, this study compared the quality of the questions generated by the students and the use of strategies by individuals and pairs during the online QGT. Two sets of two-way mixed
ANOVAs were used to analyze both pre–post and individual-pair differences in knowledge and the attitudes toward tasks. Multiple regression analyses were conducted to predict the quality of the outcome of the online QGT. Follow-up qualitative analysis was conducted to illuminate shared or unique patterns of frequent strategy use between individual and paired participants who performed well on the online QGT. Findings from these analyses are presented in Chapter 4.
CHAPTER 4

FINDINGS

This chapter first presents the results of descriptive statistics, independent samples t tests, Mann-Whitney U tests, two-way mixed ANOVAs, and hierarchical regression analyses used to address the three main quantitative research questions. The second part of the chapter presents qualitative findings to answer the fourth research question; illustrative examples of verbal protocol data reveal both shared and unique patterns of strategy use among high-performing individual and paired readers.

Quantitative Results

Research Question 1

Research Question 1a: Are there significant differences in the frequencies of using four reading strategies (information location, source evaluation, meaning making, and self-monitoring) between individuals and pairs of college students completing an online QGT?

Research Question 1b: Is there a significant difference in the quality of reader-generated questions and justification between individuals and pairs of college students as an outcome of an online QGT?

Initial Data Review

Prior to conducting either an independent samples t-test or the Mann-Whitney U-test, the relevant assumptions were tested. First, since the sample size of each group was smaller than 30, the central limit theorem assumption was not satisfied, so the normality of each distribution was tested by using the Shapiro-Wilk test. Results are
shown in Table 9. As a result, source evaluation and self-monitoring satisfied the normality assumption \((p > .05)\), but information location, meaning-making, and the scores of generated questions and justifications did not satisfy the normality assumption \((p = 0.038, p = 0.01, \text{and} \ p < 0.01, \text{respectively})\).

Table 9. Descriptive Statistics and the Result of Shapiro-Wilk’s test of Four Reading Strategies

<table>
<thead>
<tr>
<th>Reading strategy variables</th>
<th>Group</th>
<th>M</th>
<th>SD</th>
<th>W</th>
<th>df</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Location</td>
<td>Pair</td>
<td>42.74</td>
<td>16.043</td>
<td>.909</td>
<td>23</td>
<td>.038*</td>
</tr>
<tr>
<td></td>
<td>Individual</td>
<td>33.45</td>
<td>10.671</td>
<td>.939</td>
<td>22</td>
<td>.190</td>
</tr>
<tr>
<td>Meaning-making</td>
<td>Pair</td>
<td>94.09</td>
<td>34.016</td>
<td>.827</td>
<td>23</td>
<td>.001**</td>
</tr>
<tr>
<td></td>
<td>Individual</td>
<td>75.45</td>
<td>28.230</td>
<td>.927</td>
<td>22</td>
<td>.108</td>
</tr>
<tr>
<td>Source Evaluation</td>
<td>Pair</td>
<td>16.87</td>
<td>7.962</td>
<td>.938</td>
<td>23</td>
<td>.163</td>
</tr>
<tr>
<td></td>
<td>Individual</td>
<td>18.00</td>
<td>12.917</td>
<td>.923</td>
<td>22</td>
<td>.089</td>
</tr>
<tr>
<td>Self-Monitoring</td>
<td>Pair</td>
<td>28.48</td>
<td>11.591</td>
<td>.956</td>
<td>23</td>
<td>.381</td>
</tr>
<tr>
<td></td>
<td>Individual</td>
<td>15.64</td>
<td>8.398</td>
<td>.914</td>
<td>22</td>
<td>.058</td>
</tr>
<tr>
<td>Q&amp;J scores</td>
<td>Pair</td>
<td>6.30</td>
<td>1.063</td>
<td>.806</td>
<td>23</td>
<td>.000**</td>
</tr>
<tr>
<td></td>
<td>Individual</td>
<td>5.09</td>
<td>2.045</td>
<td>.948</td>
<td>22</td>
<td>.293</td>
</tr>
</tbody>
</table>

Q&J scores = the scores of generated questions and justifications.

* \(p < .05\), ** \(p < .01\).

An independent samples t-test was conducted to examine the difference that peer interaction may have caused between pairs and individuals with respect to their use of four reading strategies (information location, meaning-making, source evaluation, and self-monitoring), and the quality of questions and justifications generated as part of the online inquiry-based QGT.

Since information location, meaning-making, and the quality of generated questions and justifications didn’t satisfy the assumption of normality, the Mann-Whitney U test was used to compare the frequencies of information location and
meaning-making strategies and the scores of generated questions and justification between the individuals and the pairs. If the normality assumption that the variances in the two groups of the population are the same is not satisfied, the Mann-Whitney U test can be used to test the hypothesis (Diamantopoulos & Schlegelmilch, 2000).

Since source evaluation and self-monitoring satisfied the assumption of normality, an independent samples t-test was used to compare the frequencies of source evaluation and self-monitoring strategies between the individuals and the pairs. Other assumptions for using the independent samples t-test have also been considered. First, all dependent variables were measured on a continuous scale and the independent variable consisted of two categorical, independent groups. However, there were outliers in both source evaluation and self-monitoring as assessed by inspection of a boxplot. Reanalysis of the data for source evaluation and self-monitoring, without these outliers, did not change the significance for each variables, therefore the outliers were maintained in the final analysis. Next, although a Levene’s Test for Equality of Variances determined that the assumed homogeneity of variances was violated for the use of source evaluation and self-monitoring strategies (respectively, $p = .004$ and $p = .032$), SPSS corrected for this violation by adjusting the degrees of freedom using the Welch-Satterthwaite correction.

**Mann-Whitney U Tests**

In the case of information location, meaning-making, and the scores of generated questions and justifications, since the normality assumption was not satisfied, the Mann-Whitney U test was used to compare the performance of the
reading strategies (information location and meaning making) and the quality of generated questions and justifications of the individual and pair groups (see Table 10). The Mann-Whitney U test is the non-parametric equivalent of the independent samples t-test and is used for comparing two independently sampled distributions (Freund & Wilson, 1993).

Table 10. Results of Mann-Whitney U test of Information Location and Meaning-making Strategies and the Scores of Generated Questions and Justifications.

<table>
<thead>
<tr>
<th>Reading strategy variables</th>
<th>Group</th>
<th>Median</th>
<th>Rank average</th>
<th>Mann-Whitney U test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>U</td>
</tr>
<tr>
<td>Information Location</td>
<td>Pair</td>
<td>40.00</td>
<td>26.72</td>
<td>167.50</td>
</tr>
<tr>
<td></td>
<td>Individual</td>
<td>32.00</td>
<td>19.11</td>
<td></td>
</tr>
<tr>
<td>Meaning-making</td>
<td>Pair</td>
<td>86.00</td>
<td>27.11</td>
<td>158.50</td>
</tr>
<tr>
<td></td>
<td>Individual</td>
<td>68.00</td>
<td>18.70</td>
<td></td>
</tr>
<tr>
<td>Q&amp;J scores</td>
<td>Pair</td>
<td>6.00</td>
<td>27.78</td>
<td>143.00</td>
</tr>
<tr>
<td></td>
<td>Individual</td>
<td>5.00</td>
<td>18.00</td>
<td></td>
</tr>
</tbody>
</table>

Q&J scores = the scores of generated questions and justifications.
* p < .05, ** p < .01.

Results of the Mann-Whitney U-test showed, first, that there was no significant difference in the frequencies of using the “information location” strategy between the pair (Mean rank = 26.72) and the individual (Mean rank = 19.11) groups (U = 167.50, p = .052).

Frequencies of using the “meaning-making” strategy of the pair group (Mean rank = 27.11) were higher than those of the individual group (Mean rank = 18.70). A Mann-Whitney test indicated that this difference was statistically significant, U (N_pair = 23, N_individual = 22) = 158.50, z = -2.147, p = 0.32. The calculated effect size (r) was 0.320, indicating a medium effect, which means that the difference of frequencies of
using the “meaning-making” strategy between the pair and the individual group was moderate.

Scores for each “generated question and justification” of the pair group (Mean rank = 27.78) were higher than those of the individual group (Mean rank = 18.00). A Mann-Whitney test indicated that this difference was statistically significant, \( U (N_{\text{pair}} = 23, N_{\text{individual}} = 22) = 143.00, z = -2.554, p = 0.01 \). The calculated effect size (\( r \)) was 0.381, indicating a medium effect, which means that the difference of scores for the “generated question and justification” between the pair and the individual group was moderate.

**Independent Samples t-Tests**

An independent samples t-test was conducted to compare the frequencies of use for source evaluation and self-monitoring strategies between the individual and the pair group (see Table 8). For the frequencies of using the source evaluation strategy, there was no statistically significant difference between pair (\( M = 16.87, SD = 7.962 \)) and individual groups (\( M = 18.00, SD = 12.917 \)) with a statistically not significance mean difference of -1.130, 95% CI [-7.661, 5.400], \( t_{(34.666)} = -0.352, p = 727 \). Although there was no statistical difference, a comparison of the mean frequency showed that the individual group used a little more of the source evaluation strategy compared to the pair group. However, the standard deviation of the individual group was greater than that of the pair group, which implied that some students in the individual group used evaluation strategies a lot.
There was a statistically significant difference for the frequencies of using the **self-monitoring strategy** between the pair group ($M = 28.48$, $SD = 11.591$) and the individual group ($M = 15.64$, $SD = 8.398$), with a statistically significant mean difference of 12.842, 95% CI [6.763, 18.920], $t_{(40.116)} = 4.269$, $p < .001$. Results showed the pair group used more of the self-monitoring strategy than the individual group did. Self-monitoring strategy use involved the use of metacognitive activities to regulate and monitor one’s process of completing the task (e.g. monitoring strategy use, monitoring the task goal, etc.). This was a remarkable result that was consistent with results of previous studies in collaborative learning that have reported a positive relationship between development of self-regulation skills and pair interactions (Bridges, 2014; O’Donnell & Hmelo-Silver, 2013).

**Descriptive Comparison of Detailed Strategies**

In this section, I describe the results of descriptive statistical analysis, such as the frequency, mean, and percentage of use of the detailed strategic activities within the four reading strategies to compare individuals and pairs. Statistical analysis identified any statistically significant difference in the frequency of use of detailed strategic activities between the individual and the pair groups.

Each reading strategy consists of sub-strategies, which further consist of detailed strategic actions. Information location consists of 3 sub-strategies and 7 detailed strategic actions (Figure 4), and meaning-making consists of 4 sub-strategies and 12 detailed strategic actions (Figure 5). Source evaluation consists of 3 sub-
strategies and 8 detailed strategic actions (Figure 6), and self-monitoring consists of 6 sub-strategies and 14 detailed strategic actions (Figure 7).

Figure 4. Sub-strategies and Detailed Strategic Actions of Information Location Strategy
Figure 5. Sub-strategies and Detailed Strategic Actions of Meaning-making Strategy

- Making Meaning from Hyperlinks
  - Examining a group of entries on the search result page

- Comprehending Information within a web page
  - Overviewing (skimming) a web source
  - Identifying important information on a web source
  - Generating inferences
  - Analyzing parts of text on a web source
  - Synthesizing different parts of text on a web source

- Constructing Intertextual Meaning across Web Sources
  - Building an integrative mental model

- Reserving important information
  - Reserving useful websites
  - Copying and pasting important information
  - Paraphrasing text contents
  - Organizing note structure

Meaning making
Figure 6. Sub-strategies and Detailed Strategic Actions of Source Evaluation Strategy

Figure 7. Sub-strategies and Detailed Strategic Actions of Self-Monitoring Strategy
The normality assumptions of all the detailed strategic activities were tested, and the results indicated that only three out of the 41 strategic actions (“generating keywords and typing search terms,” “scrutinizing website entries conjoined in the internet search results page,” and “selecting links”) satisfied the normality assumption. Thus, the Mann-Whitney U test was used to compare individual and pair performance for all 41 strategies.

Table 11. Descriptive Statistics of the Four Reading Strategies

<table>
<thead>
<tr>
<th>Reading strategy variables</th>
<th>Individual (N=22)</th>
<th>Pair (N=23)</th>
<th>Total (N=45)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Location</td>
<td>736</td>
<td>33.45</td>
<td>983</td>
</tr>
<tr>
<td>Meaning-making</td>
<td>1660</td>
<td>75.45</td>
<td>2164</td>
</tr>
<tr>
<td>Source Evaluation</td>
<td>408</td>
<td>18.55</td>
<td>388</td>
</tr>
<tr>
<td>Self-Monitoring</td>
<td>344</td>
<td>15.64</td>
<td>655</td>
</tr>
<tr>
<td>Total</td>
<td>3148</td>
<td>143.09</td>
<td>4190</td>
</tr>
</tbody>
</table>

Before looking at the detailed strategic activities, the frequency and average of the four reading strategies are as follows (Table 11): Among the four reading strategies, individuals and pairs all used the “meaning-making” strategy the most (3,824 times, 52.11%). Pairs used three strategies (information location, meaning-making, and self-monitoring) more than individuals did, excluding the “source evaluation” strategy. Among the three strategies used more by pairs, there was a statistically significant difference in the frequency of using “meaning-making” and “self-monitoring” strategies between individuals and pairs.
Information Location. Descriptive statistics of the detailed strategic activities of the information location strategy are shown in Table 12. The most often used information location sub-strategy for both individuals and pairs was “link selection” (650 times, 37.81%). This strategy was used more by pairs. This is not a statistically significant difference, but the individual group used it 294 times, accounting for 39.95% of the total frequency of “information location” strategy used by the individual. The pair group used it 356 times, and it accounted for 36.22% of total frequency of “information location” strategy used by the pair.

Table 12. Descriptive Statistics of the Detailed Strategic Activities of the Information Location Strategy

<table>
<thead>
<tr>
<th>Information Location</th>
<th>Individual (N=22)</th>
<th>Pair (N=23)</th>
<th>Total (N=45)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL-A. Search terms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Generating search terms</td>
<td>182 8.27</td>
<td>305 13.26</td>
<td>487 10.82</td>
</tr>
<tr>
<td>2. Modifying search terms</td>
<td>39 1.77</td>
<td>40 1.74</td>
<td>79 1.76</td>
</tr>
<tr>
<td>IL-A total</td>
<td>221 10.05</td>
<td>345 15.00</td>
<td>566 12.58</td>
</tr>
<tr>
<td>IL-B. Search result page</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Scrutinizing website entries</td>
<td>129 5.86</td>
<td>116 5.04</td>
<td>245 5.44</td>
</tr>
<tr>
<td>2. Scrutinizing featured snippets</td>
<td>67 3.05</td>
<td>152 6.61</td>
<td>219 4.87</td>
</tr>
<tr>
<td>3. Overviewing menus</td>
<td>7 0.32</td>
<td>2 0.09</td>
<td>9 0.20</td>
</tr>
<tr>
<td>4. Examining hyperlinks</td>
<td>18 0.82</td>
<td>12 0.52</td>
<td>30 0.67</td>
</tr>
<tr>
<td>IL-B total</td>
<td>221 10.05</td>
<td>282 12.26</td>
<td>503 11.18</td>
</tr>
<tr>
<td>IL-C. Link selection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Selecting links</td>
<td>294 13.36</td>
<td>356 15.48</td>
<td>650 14.44</td>
</tr>
<tr>
<td>IL-C total</td>
<td>294 13.36</td>
<td>356 15.48</td>
<td>650 14.44</td>
</tr>
</tbody>
</table>
A statistically significant difference is evident in the use of the information location sub-strategies for “generating keywords and typing search terms” and “scrutinizing featured snippets in the search results page” strategies, with the pair group using the two strategies more than the individual group did. The frequency of using the “generating keywords and typing search terms” sub-strategy was higher in the pair group (mean rank = 28.52) than in the individual group (mean rank = 17.23). A Mann-Whitney U test indicated that this difference was statistically significant: $U (N_{\text{pair}} = 23, N_{\text{individual}} = 22) = 126.0, z = -2.895, p < 0.01$. The calculated effect size ($r$) was 0.432, indicating a medium effect, which means that the difference in frequency of using the “generating keywords and typing search terms” sub-strategy between the pair and the individual groups was moderate.

A statistically significant difference also occurred in the use of the sub-strategy labeled “scrutinizing featured snippets in the search results page.” The frequency of using the “scrutinizing featured snippets in the search results page” sub-strategy was higher in the pair group (mean rank = 26.98) than in the individual group (mean rank = 18.84). A Mann-Whitney test indicated that this difference was statistically significant: $U (N_{\text{pair}} = 23, N_{\text{individual}} = 22) = 161.5, z = -2.091, p < 0.05$. The calculated effect size ($r$) was 0.312, indicating a medium effect, which means that the difference in frequency of using the “scrutinizing featured snippets in the search results page” sub-strategy between the pair and the individual groups was moderate.
**Meaning-making.** With respect to the set of “meaning-making” strategies, “comprehending information within a web page” (2,054 times, 53.71%) and “reserving important information” (1,514 times, 39.59%) were the most used sub-strategies; this result was common to the individual group and the pair group. In the case of “comprehending information within a web page,” individuals used it 913 times (55%) and pairs 1,141 times (52.73%). Among the five specific strategies that represented aspects of “comprehending information within a web page,” the strategic action of “identifying important information on a web source” was used 1,201 times (31.41%), making it the most used detailed among all of the “meaning-making” strategies. Descriptive statistics of the detailed strategic activities of the meaning-making strategy are shown in Table 13.

Table 13. *Descriptive Statistics of the Detailed Strategic Activities of the Meaning-making Strategy*

<table>
<thead>
<tr>
<th>Meaning-making</th>
<th>Individual (N=22)</th>
<th>Pair (N=23)</th>
<th>Total (N=45)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MM-A. Making meaning from Hyperlinks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Examining a group of entries to make an overall sense of common topics</td>
<td>5 0.23</td>
<td>10 0.43</td>
<td>15 0.33</td>
</tr>
<tr>
<td>MM-A total</td>
<td>5 0.23</td>
<td>10 0.43</td>
<td>15 0.33</td>
</tr>
<tr>
<td>MM-B. Comprehending info. within a web page</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Overviewing</td>
<td>77 3.50</td>
<td>63 2.74</td>
<td>140 3.11</td>
</tr>
<tr>
<td>2. Identifying important info.</td>
<td>535 24.32</td>
<td>666 28.96</td>
<td>1201 26.69</td>
</tr>
<tr>
<td>3. Generating inferences</td>
<td>227 10.32</td>
<td>365 15.87</td>
<td>592 13.16</td>
</tr>
</tbody>
</table>
Among the five strategic actions of “comprehending information within a web page,” only “generating inferences consciously to enhance the construction of meaning from a web source” showed statistically significant differences in its use by individuals and pairs (227 times for individuals, 365 times for pairs). The frequency of using this strategy was higher in the pair group (mean rank = 27.63) than in the individual group (mean rank = 18.16). A Mann-Whitney test indicated that this difference was statistically significant: $U (N_{\text{pair}} = 23, N_{\text{individual}} = 22) = 146.5, z = -2.422, p < 0.05$. The calculated effect size ($r$) was 0.361, indicating a medium effect,
which means that the difference in frequency of using this strategy between the pair and the individual groups was moderate.

It is an interesting result that “generating inferences consciously to enhance the construction of meaning from a web source” was used more often in pair activities. Individuals’ inferring is basically an effective strategy for assisting with text comprehension (Coiro & Dobler, 2007). In a pair activity, inferring that is spoken aloud is not just an individual’s speech but also gives the partners an opportunity to think together. In other words, an inferring strategy can be used as an interaction in which participants ask each other questions that they either do not understand well or have not solved. In addition, the individual may have been more active in inferring for meaning-making in the pairing activity because there are partners who are likely to answer the question.

In the case of “reserving important information,” individuals used it 651 times (39.22%) and pairs 863 times (39.88%). Among the four strategic actions related to “reserving important information,” “copying and pasting important information” and “organizing note structure” showed marginally significant differences between the individual and the pair groups. The frequency of using the “copying and pasting important information” strategic action was higher in the pair group (mean rank = 26.35) than in the individual group (mean rank = 19.50). A Mann-Whitney test indicated that this difference was statistically significant: $U (N_{\text{pair}} = 23, N_{\text{individual}} = 22) = 176, z = -1.75, p = 0.08$. The calculated effect size ($r$) was 0.261, indicating a small
effect, which means that the difference in frequency of using this strategy between the pair and the individual groups was small.

The frequency of the pair group using the “organizing note structure” strategy (Mean rank = 26.09) was higher than that of the individual group (mean rank = 19.77). A Mann-Whitney test indicated that this difference was statistically significant, $U (N_{\text{pair}} = 23, N_{\text{individual}} = 22) = 182, z = -1.742, p = 0.082$. The calculated effect size ($r$) was 0.260, indicating a small effect, which means that the difference in frequency of using the “organizing note structure” strategy between the pair and the individual groups was small.

Using more of the “organizing note structure” strategy when reserving important information can be interpreted as increasing the likelihood of constructing meaning in an organized, coherent way. Although some participants organized their notes without a separate criterion, organization of the note structure was observed more often in the pairs. For example, participants organized or reorganized their notes based on criteria such as keywords, sites visited, and pros and cons.

“Constructing intertextual meaning across different web sources” evidenced no statistically significant difference, but the pairs used it 52 more times. This high-level meaning-making strategy allows readers to construct a common meaning, judge the authenticity of the contents of one text, or identify logical strengths and weaknesses through linking and comparing with the contents of other texts. The fact that the pairs used this strategy more often is meaningful: the pairs may have been able to construct a more elaborate meaning through intertextual meaning construction.
“Making meaning from hyperlinks” was rarely used among both individuals and pairs. There are two possible explanations. First, it can be interpreted as the participants rarely constructing meaning by tying up a collection of hyperlinks, whereas they actually engaged in a lot of activities to examine individual hyperlinks and evaluate their contents. A second interpretation is that this strategy was counted less than the actual frequency of use by the participants in the coding process. It may, for example, have been counted less because use of this strategy was not revealed through the verbal report and was made only silently, in the minds of the participants.

**Source Evaluation.** Unlike other reading strategies (information location, meaning-making, and self-monitoring), the “source evaluation” strategy was used a little more by individuals. However, there was no statistically significant difference between uses by the individual and the pair groups (408 times for individuals, 388 times for pairs). Descriptive statistics of the detailed strategic activities of the source evaluation strategy are shown in Table 14.

Table 14. *Descriptive Statistics of the Detailed Strategic Activities of the Source Evaluation Strategy*

<table>
<thead>
<tr>
<th>Source Evaluation</th>
<th>Individual (N=22)</th>
<th>Pair (N=23)</th>
<th>Total (N=45)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE-A. Determining relevant sources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Assessing relevance of the website entries</td>
<td>25</td>
<td>1.14</td>
<td>14</td>
</tr>
<tr>
<td>2. Assessing relevance of webpage contents</td>
<td>52</td>
<td>2.36</td>
<td>68</td>
</tr>
<tr>
<td>SE-A total</td>
<td>77</td>
<td>3.36</td>
<td>82</td>
</tr>
<tr>
<td>Source Evaluation Strategy</td>
<td>Activity Description</td>
<td>SE-B</td>
<td>SE-C</td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------------------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td><strong>SE-B. Discerning reliable sources</strong></td>
<td>1. Judging the credibility of hyperlinks</td>
<td>24</td>
<td>1.09</td>
</tr>
<tr>
<td></td>
<td>2. Judging the credibility of webpage contents</td>
<td>19</td>
<td>0.86</td>
</tr>
<tr>
<td></td>
<td>3. Judging the credibility of websites</td>
<td>23</td>
<td>1.05</td>
</tr>
<tr>
<td></td>
<td>SE-B total</td>
<td>66</td>
<td>3.00</td>
</tr>
<tr>
<td><strong>SE-C. Assessing sources’ significance</strong></td>
<td>1. Judging the significance of hyperlinks</td>
<td>5</td>
<td>0.23</td>
</tr>
<tr>
<td></td>
<td>2. Judging the importance of webpage contents</td>
<td>100</td>
<td>4.55</td>
</tr>
<tr>
<td></td>
<td>3. Judging the importance of webpage contents in superficial level</td>
<td>160</td>
<td>7.27</td>
</tr>
<tr>
<td></td>
<td>SE-C total</td>
<td>265</td>
<td>12.05</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>408</td>
<td>18.55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>796</td>
<td>17.69</td>
</tr>
</tbody>
</table>

Within the “source evaluation” strategy, the sub-strategy of “assessing each source’s significance” was frequently used both by individuals and pairs (501 times, 62.94%). As a detailed strategic action, “judging the importance of the webpage contents at a superficial level” was the most frequent, at 297 times (37.31%). This sub-strategy differs from that of “judging the importance of the webpage contents”, where the basis for judging the importance is clearly stated, and from the superficial level of positive or negative evaluation used by participants when reading the contents of a web page (for example, “It’s interesting” or “It’s good”). Considering that this
strategy was used a lot, it seems that participants in both the individual and paired reading situations tended not to use more advanced source evaluation.

Meanwhile, the “determining relevant sources” sub-strategy was used 159 times (19.97%) and the “discerning reliable sources” sub-strategy was used 135 times (17.09%), which are both lower than the “assessing each source’s significance” sub-strategy, mentioned above. When evaluating the relevance of the source, participants evaluated the contents of the web page (159 times) rather than evaluating the website entries of the search results page (39 times). When evaluating the reliability of the source, participants most often focused on hyperlinks on the search results page (64 out of 136). Participants’ use of the “determining relevant sources” strategy and “discerning reliable sources” strategy at relatively low frequency is related to the fact noted above, that “judging the importance of the web page contents at a superficial level” was frequently used. These facts can be regarded as further evidence that participants had difficulty evaluating sources or did not use source evaluation strategies effectively when they engaged in the online QGT.

**Self-monitoring.** With respect to the set of “self-monitoring” strategies, “managing information searches” (347 times, 34.73%), which included monitoring activities related to the information location process, was used most commonly by individuals and pairs. “Monitoring the task” (286 times, 28.63%) and “adjusting meaning-making processes” (211 times, 21.12%) were widely used by individuals and pairs. Descriptive statistics of the detailed strategic activities of the self-monitoring strategy are shown in Table 15.
Table 15. Descriptive Statistics of the Detailed Strategic Activities of the Self-monitoring Strategy

<table>
<thead>
<tr>
<th>Self-monitoring</th>
<th>Individual (N=22)</th>
<th>Pair (N=23)</th>
<th>Total (N=45)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM-A. Managing info. Searches</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Perceiving that Internet reading needs attention</td>
<td>3 0.14</td>
<td>9 0.39</td>
<td>12 0.27</td>
</tr>
<tr>
<td>2. Detecting problems in searching</td>
<td>20 0.91</td>
<td>14 0.61</td>
<td>34 0.76</td>
</tr>
<tr>
<td>3. Directing and redirecting the process of info. Searching</td>
<td>69 3.14</td>
<td>232 10.09</td>
<td>301 6.69</td>
</tr>
<tr>
<td>SM-A total</td>
<td>92 4.18</td>
<td>255 11.09</td>
<td>347 7.71</td>
</tr>
<tr>
<td>SM-B. Regulating link selections</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Perceiving previously selected links</td>
<td>16 0.73</td>
<td>39 1.70</td>
<td>55 1.22</td>
</tr>
<tr>
<td>SM-B total</td>
<td>16 0.73</td>
<td>39 1.70</td>
<td>55 1.22</td>
</tr>
<tr>
<td>SM-C. Monitoring the task</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Monitoring progress toward the goals</td>
<td>65 2.95</td>
<td>132 5.74</td>
<td>197 4.38</td>
</tr>
<tr>
<td>2. Revisiting the task prompt</td>
<td>43 1.95</td>
<td>46 2.00</td>
<td>89 1.98</td>
</tr>
<tr>
<td>SM-C total</td>
<td>108 4.91</td>
<td>178 7.74</td>
<td>286 6.36</td>
</tr>
<tr>
<td>SM-D. Monitoring the self</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Monitoring epistemological stance</td>
<td>10 0.45</td>
<td>5 0.22</td>
<td>15 0.33</td>
</tr>
<tr>
<td>2. Monitoring (or sharing) problem-solving strategies</td>
<td>3 0.14</td>
<td>6 0.26</td>
<td>9 0.20</td>
</tr>
<tr>
<td>SM-D total</td>
<td>13 0.59</td>
<td>11 0.48</td>
<td>24 0.53</td>
</tr>
<tr>
<td>SM-E. Deciding to stop or go further</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. Continuing (or quitting) meaning-making after source evaluation  
   - 20 0.91 27 1.17 47 1.04

2. Continuing (or quitting) meaning-making based on the degree of understanding  
   - 9 0.41 13 0.57 22 0.49

3. Quitting meaning-making b/c lack of understanding  
   - 3 0.14 4 0.17 7 0.16

SM-E total  
   - 32 1.45 44 1.91 76 1.69

SM-F. Adjusting meaning-making processes  

1. Planning reading and adjusting cognitive efforts  
   - 23 1.05 14 0.61 37 0.82

2. Monitoring cognitive processing  
   - 55 2.50 105 4.57 160 3.56

3. Perceiving needs for controlling reading processes  
   - 5 0.23 10 0.43 15 0.33

SM-F total  
   - 83 3.77 128 5.57 211 4.69

Total  
   - 344 15.64 655 28.48 999 22.20

Among the detailed strategic activities of the “managing information searches” sub-strategy, “directing and redirecting the process of information searching” was the most frequently used strategy (301 out of 347), and there were statistically significant differences between the individuals’ and the pairs’ use of this strategy. This strategy involved readers perceiving their own goals in planning, and then directing and redirecting the process of information searching, the determination of reading order, and the resultant path construction. Frequency of using this strategy was higher in the pairs group (mean rank = 32.54) than in the individuals group (mean rank = 13.02). A
Mann-Whitney test indicated that this difference was statistically significant: $U (N_{\text{pair}} = 23, N_{\text{individual}} = 22) = 33.5, z = -5.002, p < 0.01$. The calculated effect size ($r$) was 0.746, indicating a large effect, which means that the difference in frequency of using this strategy between the pair and the individual groups was large. The use of this strategy suggests readers were able to metacognitively monitor the process of searching for the information needed to achieve the task goals. It is interesting that the pair group used this strategy more frequently, since it is expected that the more it is used, the more the task performance and the quality of the outcome will improve.

Among the detailed strategic activities of “monitoring the task” sub-strategies, the act of “monitoring the reader’s progress toward the reading goals” was used most often (197 out of 286 times), and there was a marginally significant difference in the use of this strategy by individuals and pairs. The frequency of using this strategy was higher in the pair group (mean rank = 26.48) than in the individual group (mean rank = 19.50). A Mann-Whitney test indicated that this difference was statistically significant: $U (N_{\text{pair}} = 23, N_{\text{individual}} = 22) = 173, z = -1.906, p < 0.1$. The calculated effect size ($r$) was 0.284, indicating a small effect, which means that the difference in frequency of using the “monitoring the reader’s progress toward the reading goals” strategy between the pair and the individual groups was small. It is also interesting that the pair made more use of this strategy. This is because it is a strategy that monitors the overall progress of the task in light of the task goal at a macro level, so it is an essential strategy for successful task completion.
Among the detailed strategic activities of the “adjusting meaning-making processes” sub-strategy, “monitoring the stimulation of cognitive processing and activating processes to accommodate characteristics of the text” was used most often (160 out of 211), and the uses of this strategy among individuals and pairs were significantly different. The frequency of using this strategy was higher in the pair group (mean rank = 26.72) than in the individual group (mean rank = 19.11). A Mann-Whitney U test indicated that this difference was statistically significant: $U (N_{\text{pair}} = 23, N_{\text{individual}} = 22) = 167.5, z = -1.961, p < 0.05$. The calculated effect size ($r$) was 0.292, indicating a small effect, which means that the difference in frequency of using this strategy between the pair and the individual groups was small. This is a strategy that regulates the meaning-making process when participants read web page content. The strategy focuses on recognizing and solving problems in reading comprehension, from the word level to the text level; it is an important strategy for constructing coherent meanings (Cho, 2014; Rouet & Britt, 2011). The fact that pairs made more use of this strategy is an interesting result that accurately predicts the outcome of pair performance.

Meanwhile, use of the “perceiving previously selected hyperlinks and web sources” sub-strategy also differed at a marginally significant level. The frequency of using this strategy was higher in the pair group (mean rank = 26.48) than in the individual group (mean rank = 19.50). A Mann-Whitney test indicated that this difference was statistically significant: $U (N_{\text{pair}} = 23, N_{\text{individual}} = 22) = 173, z = -1.906, p = 0.057$. The calculated effect size ($r$) was 0.284, indicating a small effect, which
means that the difference in frequency of using this strategy between the pair and the individual groups was small. The strategy is meaningful because it improves the efficiency of the information location process and can be a clue to whether participants are focusing on the task.

**Research Question 2**

*To what extent do paired students learn knowledge about the inquiry topic and change attitudes toward online inquiry, compared to individuals after completing an online QGT?*

In order to evaluate the effect that working with a partner may have had on participants’ topic knowledge gain and attitude toward the online QGT, a two-way mixed ANOVA with independent variables of group (Pair Group and Individual Group) and time (Pre-survey and Post-survey) was conducted on the five dependent variables of topic knowledge, cognitive & behavioral engagement, value/interest, anxiety, and attitude toward working together to determine the effect of the online QGT. The means and standard deviations of each variable across time and group are provided in Table 16.

<p>| Table 16. Descriptive Statistics of Knowledge Assessment and Attitude Surveys |
|---------------------------------|------------------|------------------|
| <strong>Pair Group (n = 46)</strong>         | <strong>Pre-survey</strong>   | <strong>Post-survey</strong>  |
| <strong>M</strong>                           | <strong>SD</strong>           | <strong>M</strong>            | <strong>SD</strong>           |
| Topic knowledge                 | 11.74            | 2.265            | 17.61            | 3.356            |
| Cognitive &amp; behavioral          | 34.09            | 4.550            | 37.59            | 3.649            |
| engagement                      |                  |                  |                  |                  |
| Value/interest                  | 29.26            | 4.213            | 30.39            | 3.116            |
| Anxiety                         | 12.80            | 3.716            | 11.44            | 3.001            |
| Attitude toward working together| 14.96            | 4.676            | 14.70            | 4.580            |</p>
<table>
<thead>
<tr>
<th>Topic knowledge</th>
<th>Pre-survey</th>
<th>Post-survey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Topic knowledge</td>
<td>11.59</td>
<td>2.667</td>
</tr>
<tr>
<td>Cognitive &amp; behavioral engagement</td>
<td>33.68</td>
<td>6.686</td>
</tr>
<tr>
<td>Value/interest</td>
<td>28.82</td>
<td>3.850</td>
</tr>
<tr>
<td>Anxiety</td>
<td>13.86</td>
<td>3.060</td>
</tr>
<tr>
<td>Attitude toward working together</td>
<td>17.45</td>
<td>4.009</td>
</tr>
</tbody>
</table>
Table 17. Summary of Two-Way Mixed ANOVAs for Topic Knowledge, Cognitive & Behavioral Engagement, Value/Interest, Anxiety, and Attitude toward Working Together (N = 68)

<table>
<thead>
<tr>
<th>Sources</th>
<th>df</th>
<th>Group</th>
<th>Cognitive &amp; Behavioral engagement</th>
<th>Value/interest</th>
<th>Anxiety</th>
<th>Attitude toward working together</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>F</td>
<td>Partial η²</td>
<td>F</td>
<td>Partial η²</td>
</tr>
<tr>
<td>Topic knowledge</td>
<td>1</td>
<td>0.001</td>
<td>.000</td>
<td>0.178</td>
<td>.003</td>
<td>0.010</td>
</tr>
<tr>
<td>Cognitive &amp; Behavioral engagement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value/interest</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude toward working together</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group x Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between effects error</td>
<td>66</td>
<td>(207)</td>
<td>(33.909)</td>
<td>(21.225)</td>
<td>(18.558)</td>
<td>(34.390)</td>
</tr>
<tr>
<td>Time</td>
<td>1</td>
<td>149.06</td>
<td>.693***</td>
<td>31.706</td>
<td>.325***</td>
<td>12.641</td>
</tr>
<tr>
<td>Within effects error</td>
<td>66</td>
<td>(7.196)</td>
<td>(11.203)</td>
<td>(12)</td>
<td>(5.171)</td>
<td>(4.442)</td>
</tr>
</tbody>
</table>
**Topic Knowledge**

As depicted in Table 17, analysis of the main effects revealed that the main effect for group was not significant $F(1, 66) = 0.001, p = .979, \eta^2_p = .000$. Thus, there was no overall difference in the task scores of pairs ($M = 14.67$) compared to individuals ($M = 14.66$). A significant main effect for time was obtained, $F(1, 66) = 149.06, p < .001$, and this was a large effect ($\eta^2_p = .693$). Knowledge scores after the online QGT ($M = 17.67$) were significantly higher than before completing the task ($M = 11.67$). No significant interaction was reported between time and group for topic knowledge, $F(1, 66) = 0.074, p = .787, \eta^2_p = 0.01$ (Figure 9).

Figure 8. *Difference in Topic Knowledge Scores across Time and Group*
Cognitive & Behavioral Engagement

Analysis of the main effects revealed that the main effect for group was not significant $F(1, 66) = 0.178, p = .674, \eta_p^2 = .003$ (Table 17). Thus, there was no overall difference in cognitive & behavioral engagement of pairs ($M = 35.84$) compared to individuals ($M = 35.39$). A significant main effect for time was obtained, $F(1, 66) = 31.706, p < .001$, and this was a large effect ($\eta_p^2 = .325$). Cognitive & behavioral engagement after the online QGT ($M = 37.34$) were significantly higher than before completing the task ($M = 33.88$). No significant interaction was reported between time and group for cognitive & behavioral engagement, $F(1, 66) = 0.005, p = .941, \eta_p^2 = 0.00$ (Figure 10).

Figure 9. Difference in Cognitive & Behavioral Engagement across Time and Group
Value/interest

Analysis of the main effects revealed that the main effect for group was not significant $F (1, 66) = 0.010, p = .922, \eta^2_p = .000$ (Table 17). Thus, there was no overall difference in value/interest of pairs ($M = 29.83$) compared to individuals ($M = 29.91$). A significant main effect for time was obtained, $F (1, 66) = 12.641, p = .001$, and this was a medium effect ($\eta^2_p = .161$). Value/interest toward the online QGT after completing the online QGT ($M = 30.70$) was significantly higher than before completing the task ($M = 29.04$). No significant interaction was reported between time and group for value/interest, $F (1, 66) = 1.274, p = .263, \eta^2_p = 0.19$ (Figure 11).

Figure 10. Difference in Value/Interest across Time and Group
### Anxiety

Analysis of the main effects revealed that the main effect for group was not significant $F(1, 66) = 1.010, p = .321, \eta^2_p = .015$ (Table 17). Thus, there was no overall difference in anxiety of pairs ($M = 12.12$) compared to individuals ($M = 12.91$). A significant main effect for time was obtained, $F(1, 66) = 15.470, p < .001$, and this was a medium effect ($\eta^2_p = .190$). Anxiety toward the online QGT after completing the online QGT ($M = 13.33$) was significantly lower than before completing the task ($M = 11.70$). No significant interaction was reported between time and group for anxiety, $F(1, 66) = 0.419, p = .520, \eta^2_p = 0.06$ (Figure 12).

Figure 11. Difference in Anxiety across Time and Group
Attitude toward Working Together

Analysis of the main effects revealed that the main effect for group was not significant $F (1, 66) = 2.981, p = .089, \eta^2 = .043$ (Table 17). Thus, there was no overall difference in attitude toward working together of pairs ($M = 14.83$) compared to individuals ($M = 16.68$). A significant main effect for time was obtained, $F (1, 66) = 5.466, p = .022$, and this was a medium effect ($\eta^2 = .076$). Attitude toward working together after the online QGT ($M = 15.30$) was significantly lower than before completing the task ($M = 16.21$). No significant interaction was reported between time and group, $F (1, 66) = 2.764, p = .101, \eta^2 = 0.40$.

Although the attitude toward working together decreased after the online QGT for participants who worked individually and for those who worked in pairs, Figure 13 showed that the decrease of attitude toward working together of the pair group was less than that of the individual group (See survey questions at Appendix C). It is interesting that although the individual group didn’t actually conduct the task in pairs, their attitude toward working together decreased more than the pair group did after completing the task. It means the individuals liked the idea of working with a partner less than pairs. This suggests that individuals are more likely to have a negative attitude toward working together unless they don’t work actually together with a partner.
Research Question 3

**Research Question 3a:** To what extent does performance of four reading strategies (information location, source evaluation, meaning-making, and self-monitoring) and learning gains predict the quality of reader-generated questions and justifications in an online QGT?

**Research Question 3b:** Do source evaluation and information location predict the quality of reader-generated questions and justifications in an online QGT over and above: (a) self-monitoring, (b) learning gains, and (c) meaning-making?
**Research Question 3c:** Does self-monitoring predict the quality of reader-generated questions and justifications in an online QGT over and above: (a) learning gains, (b) meaning-making, (c) source evaluation, and (d) information location?

**Initial Data Review**

Prior to conducting this collection of multiple regression and hierarchical regression analyses, the relevant assumptions of these statistical analyses were tested. First, although a sample size of 45 is small in a regression model with five independent variables, the sample size was deemed appropriate using a formula of minimum sample size \( n \geq 20 + 5m \) (where \( m \) is the number of IVs) (Khamis & Kepler, 2010; Tabachnick & Fidell, 2013) and the results were statistically significant with the small sample size. The assumption of singularity was also met since the independent variables (self-monitoring, meaning-making, learning gain, source evaluation, and information location) were not a combination of other independent variables and none of the independent variables correlated highly with each other. Residual and scatter plots determined that variable distributions satisfied the assumptions of multivariate normality, linearity and homoscedasticity (Tabachnick & Fidell, 2013). In addition, the collinearity statistics (i.e., Tolerance and VIF) were all within accepted limits, which indicated no multicollinearity concerns. However an examination of the Mahalanobis distance scores indicated one multivariate outlier. This case represented a pair who had medium pre-post knowledge test scores and medium scores in generating their post-task question and justification, but a frequency of meaning-making strategy use was higher than other cases. The regression model was tested without this case,
but its removal did not affect any results of interest. As a result, the outlier case was retained in the data set.

Table 18 shows the means, standard deviations, ranges, and intercorrelations for all variables. Students’ scores for topic knowledge about PV solar panels ranged from 12 to 23, with possible scores ranging from 0 to 32. Frequencies of the four reading strategies ranged from 17 to 79 for information location, 36 to 214 for meaning-making, 0 to 43 for source evaluation, and 3 to 51 for self-monitoring. The quality of generated questions and justifications ranged from 0 to 9, with possible scores ranging from 0 to 9.

Bivariate correlation statistics in Table 18 show that two combinations of the independent variables were highly correlated: (a) information location and self-monitoring, $r_{(45)} = .498$, $p < .01$ and (b) meaning-making and self-monitoring, $r_{(45)} = .395$, $p < .01$. The dependent variable, the quality of generated questions and justifications correlated with almost independent variables, $r_{(45)} = .306$, $p < .05$ for meaning-making, $r_{(45)} = .410$, $p < .01$ for source evaluation, and $r_{(45)} = .541$, $p < .01$ for self-monitoring with the exception of learning gain and information location.


<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Learning gain</td>
<td>-</td>
<td>-.158</td>
<td>-.130</td>
<td>-.095</td>
<td>.034</td>
<td>.212</td>
</tr>
<tr>
<td>2. Information location</td>
<td>-</td>
<td>-.057</td>
<td>-.053</td>
<td>.498**</td>
<td>.202</td>
<td></td>
</tr>
<tr>
<td>3. Meaning-making</td>
<td></td>
<td>-.395**</td>
<td>-.088</td>
<td>.306*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Source evaluation</td>
<td></td>
<td></td>
<td>.101</td>
<td>.410**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Self-monitoring</td>
<td></td>
<td></td>
<td></td>
<td>.541**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Q&amp;J scores</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>M</em></td>
<td>17.67</td>
<td>38.20</td>
<td>84.98</td>
<td>17.42</td>
<td>22.20</td>
<td>6.00</td>
</tr>
</tbody>
</table>
As a result of performing a single regression analysis for all independent variables, meaning-making, source evaluation, and self-monitoring were significant while information location and learning were not significant. Meaning-making explained 9.4% of the variance in the quality of generated questions and justifications, which was significant, \( F (1, 43) = 4.453, p < .05 \). Source evaluation explained 16.8% of the variance in the quality of generated questions and justifications, which was significant, \( F (1, 43) = 8.675, p < .05 \). Self-monitoring explained 29.2% of the variance in the quality of generated questions and justifications, which was significant, \( F (1, 43) = 17.769, p < .001 \). Learning explained 4.5% of the variance in the quality of generated questions and justifications, which was not significant, \( F (1, 43) = 2.021, p = .162 \). Information location explained 4.1% of the variance in the quality of generated questions and justifications, which was not significant, \( F (1, 43) = 1.837, p = .182 \).

### Multiple Regression Analysis

As stated in Chapter 3, the purpose of this analysis was to determine whether or not a reader’s frequency of using the four reading strategies and the associated learning gain significantly predict the quality of generated question and justification as an outcome of the online QGT. Table 19 shows the results of multiple regression analysis with five predictors. The results of the regression indicated the five predictors explained 53.7% of the variance \( (R^2 = .537, F(5, 39) = 9.046, p < .001) \). Participants’ predicted score of their generated question and justification is equal to 1.154 +

<table>
<thead>
<tr>
<th></th>
<th>2.75</th>
<th>14.32</th>
<th>32.37</th>
<th>10.57</th>
<th>11.96</th>
<th>3.29</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>12</td>
<td>17</td>
<td>36</td>
<td>0</td>
<td>3</td>
<td>-2</td>
</tr>
<tr>
<td>Max</td>
<td>23</td>
<td>79</td>
<td>213</td>
<td>43</td>
<td>51</td>
<td>13</td>
</tr>
</tbody>
</table>

Q&J scores = the scores of generated questions and justifications.
* \( p < .05 \) (two-tailed). ** \( p < .01 \) (two-tailed).
.135(learning gain) + .015(meaning making) + .44(source evaluation) + .075(self-monitoring), where meaning-making, source evaluation, and self-monitoring were measured in frequency, and learning gain was measured in score. Participants’ score of their generated question and justification increased .135 point for each score of learning gain, .015 point for each frequency of meaning-making strategy use, .044 point for each frequency of source evaluation strategy use, and .075 point for each frequency of self-monitoring use.

Table 19. Summary of Multiple Regression Analysis for Variables Predicting the Quality of Generated Questions and Justifications (N = 45)

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
<th>sr²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning gain</td>
<td>.135</td>
<td>.016</td>
<td>.258</td>
<td>2.291</td>
<td>.027</td>
<td>.118</td>
</tr>
<tr>
<td>Information location</td>
<td>.002</td>
<td>.006</td>
<td>.013</td>
<td>1.04</td>
<td>.306</td>
<td>.000</td>
</tr>
<tr>
<td>Meaning-making</td>
<td>.015</td>
<td>.020</td>
<td>.279</td>
<td>2.32</td>
<td>.026</td>
<td>.121</td>
</tr>
<tr>
<td>Source evaluation</td>
<td>.044</td>
<td>.019</td>
<td>.272</td>
<td>2.24</td>
<td>.031</td>
<td>.114</td>
</tr>
<tr>
<td>Self-monitoring</td>
<td>.075</td>
<td>.059</td>
<td>.523</td>
<td>4.03</td>
<td>.000</td>
<td>.295</td>
</tr>
</tbody>
</table>

Note. Fit for model $R^2 = .537$, Adjusted $R^2 = .478$, $F(5, 39) = 9.046, p < .001$. The squared semi-partial ($sr^2$) correlation given is the squared Part correlation from SPSS. The r given is for the zero-order correlation from SPSS.

Except for information location, all independent variables (self-monitoring, learning gain, meaning-making, and source evaluation) significantly predicted the quality of generated question and justification. The influence of the four variables was shown in the order of self-monitoring ($\beta = .523$), meaning-making ($\beta = .279$), source evaluation ($\beta = .272$), and learning gain ($\beta = .258$). The frequency of information location strategy use didn’t contribute to the multiple regression model.
Hierarchical Multiple Regression Analyses

A hierarchical multiple regression analysis was conducted to investigate the extent to which both source evaluation and information location, reading strategies emphasized in the online environment, correlated with the quality of generated questions and justifications as an outcome of the online QGT when the other types of reading strategies and learning gains were statistically controlled. Table 20 depicts the results of the hierarchical multiple regression analysis with five predictors entered as separate steps in this order: self-monitoring, learning gain, meaning-making, source evaluation, and information location. Since many studies have emphasized the importance of source evaluation and information location strategies in Internet reading, this analysis examines how each of these two strategies explain the quality of the results from an online QGT.

First, the frequency of self-monitoring strategy use explained 29.2% of the variance in the quality of generated questions and justifications, which was significant, F change (1, 43) = 17.769, p < .01. The multiple R was .541, R² was .292, and the final beta for the frequency of self-monitoring strategy use in the model was .523, t (43) = 4.036, p < .01.

Table 20. Summary of Hierarchical Regression Analysis for Variables Predicting the Quality of Generated Questions and Justifications A (N = 45)

<table>
<thead>
<tr>
<th>Dependent and Independent Variables</th>
<th>R</th>
<th>R²</th>
<th>ΔR²</th>
<th>ΔF</th>
<th>Final β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of Q&amp;J</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-monitoring</td>
<td>.541</td>
<td>.292</td>
<td>.292</td>
<td>17.769**</td>
<td>.523**</td>
</tr>
<tr>
<td>Learning gain</td>
<td>.574</td>
<td>.330</td>
<td>.037</td>
<td>2.344 NS</td>
<td>.258*</td>
</tr>
</tbody>
</table>
After the frequency of self-monitoring strategy use was accounted for, learning gain explained an additional 3.7% of the variance in the quality of generated questions and justifications, which was not significant, F change (1, 42) = 2.344, p = .133. The multiple R was .574 and R² was .330. Interestingly, while learning gain didn’t explain a significant additional amount of the variance in the model, the final beta for learning gain was .258, t(42) = 2.291, p < .05.

After the frequency of self-monitoring strategy use and learning gain was accounted for, meaning-making explained an additional 14.7% of the variance in the quality of generated questions and justifications, which was significant, F change (1, 41) = 11.508, p < .05. The multiple R was .690 and R² was .477, and the final beta for meaning-making was .279, t(41) = 2.320, p < .05.

After the frequencies of self-monitoring strategy use and meaning-making strategy uses and learning gain was accounted for, source evaluation explained an additional 6% of the variance in the quality of generated questions and justifications, which was significant, F change (1, 40) = 5.196, p < .05. The multiple R was .733 and R² was .537, and the final beta for source evaluation was .272, t(40) = 2.244, p < .05. This suggested that the frequency of meaning-making strategy use is more associated with the quality of generated questions and justification than learning gain.

<table>
<thead>
<tr>
<th></th>
<th>R</th>
<th>R²</th>
<th>F</th>
<th>p</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meaning-making</td>
<td>.690</td>
<td>.477</td>
<td>11.508</td>
<td>&lt; .05</td>
<td>.279</td>
</tr>
<tr>
<td>Source evaluation</td>
<td>.733</td>
<td>.537</td>
<td>5.196</td>
<td>&lt; .05</td>
<td>.272</td>
</tr>
<tr>
<td>Information location</td>
<td>.733</td>
<td>.537</td>
<td>0.011</td>
<td>NS</td>
<td>.013</td>
</tr>
</tbody>
</table>

* p < .05 (two-tailed). ** p < .01 (two-tailed).
Finally, the addition of the frequencies of information location strategy use to the regression model explained an additional 1% of the remaining variance in the quality of generated questions and justifications, which was not significant, $F$ change $(1, 39) = .011, p = .918$. The multiple $R$ was .733 and $R^2$ was .537. The final beta for the frequency of information location strategy use was .013, $t_{(39)} = 0.104, p = 918$, which was not statistically significant. This suggested that information location strategy didn’t make either a joint or unique contribution to explaining the quality of generated questions and justifications.

When all five independent variables were included in stage five of the regression model, the frequency of using information location strategies use was not a significant predictor of the quality of generated questions and justifications. The most important predictor of the quality of generated questions and justifications was the frequency of using self-monitoring strategies, which uniquely explained 29.2% of the variation in the quality of generated questions and justifications. Together the five independent variables accounted for 53.7% of the variance in the quality of generated questions and justifications.

Another hierarchical multiple regression analysis was conducted to investigate the extent to which self-monitoring correlated with the quality of generated questions and justifications as an outcome of the online QGT when the other types of reading strategies and learning gains were statistically controlled. The reason why the self-monitoring strategy was put last in this analysis is because it was a metacognitive strategy that regulates other reading strategies, and I wanted to check how uniquely it explains the quality of the online QGT. Table 21 depicts the results of the hierarchical
regression with the following independent variables entered as separate steps in this order: learning gain, meaning-making, source evaluation, information location, and self-monitoring.

Table 21. Summary of Hierarchical Regression Analysis for Variables Predicting the Quality of Generated Questions and Justifications B (N = 45)

<table>
<thead>
<tr>
<th>Dependent and Independent Variables</th>
<th>R</th>
<th>$R^2$</th>
<th>$\Delta R^2$</th>
<th>$\Delta F$</th>
<th>Final $\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of Q&amp;J</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning gain</td>
<td>.212</td>
<td>.045</td>
<td>.045</td>
<td>2.021$^{NS}$</td>
<td>.258$^*$</td>
</tr>
<tr>
<td>Meaning-making</td>
<td>.398</td>
<td>.158</td>
<td>.113</td>
<td>5.653$^*$</td>
<td>.279$^*$</td>
</tr>
<tr>
<td>Source evaluation</td>
<td>.515</td>
<td>.265</td>
<td>.107</td>
<td>5.961$^*$</td>
<td>.272$^*$</td>
</tr>
<tr>
<td>Information location</td>
<td>.586</td>
<td>.344</td>
<td>.079</td>
<td>4.788$^*$</td>
<td>.013$^{NS}$</td>
</tr>
<tr>
<td>Self-monitoring</td>
<td>.733</td>
<td>.537</td>
<td>.193</td>
<td>16.286$^{**}$</td>
<td>.523$^{**}$</td>
</tr>
</tbody>
</table>

* $p < .05$ (two-tailed). ** $p < .01$ (two-tailed).

As seen in Table 19, the addition of each variable except learning gain added significantly to the amount of variance accounted for the quality of generated questions and justifications. First, learning gain explained 4.5% of the variance in the quality of generated questions and justifications, which was not significant, $F$ change $(1, 43) = 2.021, p = .162$. The multiple $R$ was .212, $R^2$ was .045. The frequency of meaning-making strategy use explained an additional 11% of the variance in the quality of generated questions and justifications, which was significant, $F$ change $(1, 42) = 5.653, p < .05$. The multiple $R$ was .398 and $R^2$ was .158. The frequency of source evaluation strategy use explained an additional 10% of the variance in the quality of generated questions and justifications, which was significant, $F$ change $(1,
41) = 5.961, \( p < .05 \). The multiple R was .515 and \( R^2 \) was .265. The frequency of information location strategy use explained an additional about 8% of the variance in the quality of generated questions and justifications, which was significant, F change \((1, 40) = 4.788, p < .05\). The multiple R was .586 and \( R^2 \) was .344.

Finally, after controlling all other variables, the addition of the frequencies of self-monitoring strategy use to the regression model explained an additional 19% of the remaining variance in the quality of generated questions and justifications, which was significant, F change \((1, 39) = 16.286, p < .001\). The multiple R was .733 and \( R^2 \) was .537.

Thus, altogether, the five independent variables accounted for 53.7% of the variance in the quality of generated questions and justifications. When all five independent variables were included in stage five of the regression model, the frequency of using information location strategies use was not a significant predictor of the quality of generated questions and justifications. The most important predictor of the quality of generated questions and justifications was the frequency of using self-monitoring strategies, which uniquely explained 19.3% of the variation in the quality of generated questions and justifications after controlling other variables.

There was no significant change in \( R^2 \) in learning gain in the model, which suggested that learning gain alone did not explain a significant amount of the variance of the quality of generated questions and justifications as the outcome variable among the participants in this study. Once again, it was interesting that self-monitoring still explained a large portion of the variance in the quality of generated questions and justification after controlling all other variables.
Qualitative Results

Research Question 4

What are the shared or unique characteristics of strategic reading processes employed by higher-performing individuals and pairs as they complete an online QGT?

In this section, I focus on the detailed strategic actions revealed by the descriptive statistics in the previous section in terms of strategies that were commonly used by higher performing individuals and pairs as well as patterns of significant differences among individuals and pairs. I explain the results of my qualitative analyses, focusing on examples of higher performing readers (three individuals and three pairs) who used the strategies well and achieved good scores on the outcome of the online QGT. Individuals numbered 13, 25, and 33 and pairs numbered 6, 22, and 30 were selected as multiple cases of this analysis. More detailed information on the subjects of qualitative analysis can be found in Chapter 3.

In the examples below, the participants are numbered in the order of the cases in which they completed the task, without distinguishing between individual performance and pair performance. In the case of individual student performance, only numbers are used to identify participants (e.g., Student 13), while the letters A or B are additionally used to identify participants that were members of a pair (e.g., Student 14A).

Information Location

Regarding information location strategies, “generating keywords and typing search terms” strategy was used most often by both higher performing participants; this strategy helped to narrow their down their search and make it more likely that they
would be able to access the most potentially useful information. Generating appropriate keywords was observed frequently in higher performing individuals and pairs, but pairs used this strategy more often than individuals did.

The strategic readers who worked individually explained how they used search terms such as “photovoltaic,” “photovoltaic solar panels,” or “PV solar panels” at the beginning of their search to build background knowledge on the topic.

13: I’m going to go to Google. And I am going to start, I think with like, a pros and cons. No, I'm not going to start there. I’m going to start on what is photovoltaic solar energy. [Searching "what is pv solar"] Okay. I’m going to click on this because they have pictures and diagrams that look like they can be of importance. [Click studentenergy.org]

After generating search keywords, students used the “scrutinizing website entries” strategy to evaluate the potential relevance and reliability of sources, based on the minimal information (short description, URL, title) visible in the search results. In the example above, 13 used the strategy of “scrutinizing featured snippets in the search results page” and featured snippets are a search assistant service provided by search engines such as Google and Bing and they are usually located at the top of search results (Figure 14). When participants searched information with keywords, the featured snippet showed the information judged to be most relevant by the algorithm at the top of the search results page, along with more detailed information and graphic elements such as pictures and tables. This is in contrast to the existing search results page, which provided only minimal information. In other words, 13 assessed the
relevance and importance of the source because the pictures and diagrams in the
Figure 13. *An Example of Featured Snippets*

After accessing basic information about “photovoltaic solar panels,” strategic
participants narrowed their search by creating search terms and combining different
words to find the information they were looking for.

13: Okay, so what I think I want to do is go back to Google and I want to look
up cost of solar photovoltaic energy. [Searching "costs of solar
photovoltaic energy"] Okay. So I'm going to click on this one because it
seems to give me a good, a chart. [Click news.energysage.com]
On the other hand, some participants also attempted to access specific websites to build basic background knowledge on the topic. In this case, participants used a search keyword combined with the topic keyword and the website name.

25: Let's google I don't really know much about PV solar panels? [Searching "pv solar panel quizlet"] So try to find a quizlet because I feel like they have a good view of what it is and like a language I can understand. [Click quizlet.com]

Participant 25 thought Quizlet was a good website to find basic knowledge on the topic in a language she could understand. So she combined the keywords “pv solar panel” and “quizlet” at the beginning of the search to create the keyword “pv solar panel quizlet.”

The higher performing pairs demonstrated similar searching patterns to those of individuals at the beginning of the task. However, in the case of one pair who worked together more collaboratively, the pair engaged in a process of negotiating which search terms to use before they conducted their keyword search.

22A: Okay. So 22_B basically, we have to talk about like, pros and cons, [Read aloud partially, description] "benefits and drawbacks and its impact on the environment." So, do you want to start by researching just like a basic like definition, like to get us started? Like, that'd be good?

22B: (Nodding)

22A: Okay. I'm gonna look up photo... Photovoltaic solar panels [Searching "Photovoltaic solar panels"] and just see what it says. Okay.
In the conversation above, 22A read the task description to set the direction of the search and then asked 22B’s opinion about searching from the basic concept of the topic. When 22B nodded in agreement, 22A created the search term “photovoltaic solar panels.”

In the next excerpt, participants discuss the process of refining search terms together. First, when Student 30B suggests that the pair search for the efficiency of solar panels, Student 30A agrees. 30B then generates the search term “how efficient are PV solar panels.” At some point while reviewing the search results, 30A remarks that perhaps the best way is to search how solar panels compare to other energy sources and suggests that they search using the phrase “PV solar panels versus others.” 30B listens and decides to follow that suggestion.

30B: Alright, so in terms of costs, we go like a start there. Maybe we should move on to like, efficiency.

30A: Yeah. How efficiently they run compared to...

30B: [Searching "how efficient are pv solar panels"]

30A: Yeah, solar PV panel specifically.

30A: [Read first result text] Finding a lot of stuff on... there's something about PV right down there. High quality solar panels can exceed 23% efficiency.

But the majority of PV solar panels are not above 20%.

30B: Where is it?

30A: Right at the bottom…

30B: Oh, yeah.

30A&B: [Read a search result page]
30B: Is there… Is there better way to look up like PV solar panels versus others?

30A: You could just type… type versus others. I don't know a better way to put it.

30B: [Searching "pv solar panels versus others"]

In this next excerpt, Pair 6A and 6B used the “scrutinizing featured snippets in the search results page” strategy in the same way that individuals did after generating the search keyword. However, when performed together, participants showed a negotiation process in selecting potentially useful links as well as generating search terms. Together, this pair realized that the search results weren’t about the “actual panels” they were looking for, so they changed the search term to “photovoltaic panels” and pointed to a link on the search results page that appeared as a result. They guessed the reliability of the hyperlink based on the URL’s top-level domain, like “.org.”

6A: So I guess we start by looking at photovoltaic. Right?

6B: Mm hmm.

6A: [Searching "photovoltaic"] [Read first result text] Okay, well photovoltaic just means of that substance exposed to light and electric currents that make sense. We were looking for the actual panels. [Searching "photovoltaic panels"] Look up panels. [Pointing] They have like, a .org. website, should we use that? Or…

6B: Seems good. It looks like some sort of company. So maybe..

6A: [Click (seia.org)] yeah, maybe they're selling.
For pairs that did not jointly make decisions, search keywords were generated without discussion. In the excerpt below, 10B clicked on the hyperlink at the top of the search results page because “it’s right there.”

10B: Going to try.. just look up pros and cons of PV solar.. solar panels.

[Searching "pros and cons pv panels"] [Click solar-estimate.org] Okay, I'll just use the first one because it's right there.

**Meaning-making**

Regarding meaning-making strategies, “comprehending information within a web page” was used most often by both individuals and pairs. This strategy included processes to comprehend and construct the meaning of a text in a web page, such as overviewing, identifying important information, generating inferences, analyzing parts of text, and synthesizing different parts of text. Among them, the “identifying important information on a web source” strategy was used most often by both individuals and pairs.

Among the three higher performing individuals selected for follow-up analyses, students used the “identifying important information on a web source” strategy to read a section of text and then summarize it in their own words. The summarized information was often stored in notes; this is called the “reserve important information” strategy. In this case, the contents were copied and pasted, but there were many cases of paraphrasing text contents. Higher performing participants generated inferences in order to better understand the text content by applying it to examples.
they already know; this was called the “generating inferences consciously to enhance the construction of meaning from a web source” strategy.

25: Um, so it says, [Read aloud] “The conversion efficiency of PV solar cells as a percentage of the solar energy shining on a PV device that's converted into usable electricity, improving this conversion efficiencies, the key goal or a key goal or Research and helps make PV technologies cost competitive with conventional sources of energy.” So it appears to me that the big game changer or something that's competitive in the market is what the efficiency of each panel. [Typing] so I just want to know that for competition... competition... is mostly around efficiency... solar panels. Make sense. it's like which phone is better than the other at or which wireless service?

In the excerpt above, 25 first summarized what she read in her own words—for example, “So it appears to me that the big game changer or something that’s competitive in the market is what the efficiency of each panel is.” Then, she tried to understand the content by applying the “phone” example she already knew.

Higher performing participants used the “analyzing parts of text on a web source” strategy to compare and connect pictures, images, and graphics with written text for better understanding. In the example below, 13 examined the efficiency of the price of solar panels by analyzing a table showing solar panel prices across the United States.

13: Okay, so Rhode Island is spending $3 and 36 cents per kilowatt of solar photovoltaic energy. And they spend about 12,876 to $16,961 to a six
kilowatt system and then a 10 kilowatt system would be $21,460 $3,268

which is a lot of money. And once these are installed, do you have to
continue to pay like a maintenance fee? because I know for like a lightning
bill, if you're using electricity, you're going to get A bill every month, but
I'm not sure if you can get builds by using this one.

After analyzing the content, 13 elaborated her understanding by inferring about
the parts she wanted to know—“And once these are installed, do you have to continue
to pay, like, a maintenance fee?”

Higher performing participants constructed meaning not only by building their
understanding of content within one text but also by linking content between texts; this
is called the “constructing intertextual meaning across different web sources” strategy.
In this next excerpt, 13 noticed that the content she was reading in one location
matched what she had read on another website.

13: [Read aloud] Okay, gets its name from “the process of converting the light
to electricity. The photovoltaic effect, started in the 1950s” I know that.

[Read aloud] “solar cells being used power space satellites.” That's
interesting. [Read aloud] “And also calculators and watches so they
become cost competitive in many regions. photovoltaic systems are being
deployed at large scales to help power the electric grid okay made from
Silicon sold into larger modules.” They mentioned that in the previous
website.

Similarly, 25 linked what she was currently reading with what she had read on
another website and noticed that both sources were telling her that the price of solar
panels was going down. Through this linking process, it appeared that participants increased their confidence of knowing that the content of the text was more likely to be true.

25: [Read aloud] So this says that “the price of solar panels and installation falling and an extension of the Federal Tax Credit now's a good time to consider solar.” So the energy crisis was in the 70s as the other website said, a lot has changed within 37 years solar costs have dropped.

Most of the pairs in the focus group showed similar patterns to those of individual performances in their use of meaning-making strategies. However, the pair that worked more collaboratively employed a process of negotiating with each other as jointly constructed meaning.

22B: Rain... Rain can... Okay, [Read aloud] "it's actually help.... washing away dirt."

22A: I guess that makes sense. I wouldn't have never thought about that. that helps like wash away dirt.. That's gonna cool.

22B: I think it's gonna pros?

22A: Um.. I guess.. Oh yeah.

22B: Yeah.

22A: Um maybe just say like most efficient during sunny days or after rain

22B: [Typing "Rain is helpful because it can wash away dirt"] Rain is helpful... wash away dirt or wash away dirt or.. just wash away dirt.

In this example, Pair 22 worked together to read the same section and recognize the important information. Regarding the newly discovered information—
“rain is actually helpful in washing away dirt”—they agreed that rain played a positive role in solar panels, and so they constructed a common meaning while interacting one another. Their jointly constructed understanding developed into an inference that the panels would be highly efficient on sunny days or after rain.

Another aspect of meaning-making among higher performing readers involved deciding if information they encountered in their search could be useful for helping to complete the inquiry task. In the conversation below, after reading one section aloud, 6A asked 6B if she thought if the information was important enough to save in their notes. In reply, 6B said that it would not be necessary because the information is related to “how it affects” something else.

6A: Um, [Read aloud] "PV devices can be used to power anything from small electronics." Okay, so they can do a whole bunch of stuff. That's cool. Okay, so it says [Read aloud] "photons strike an ionized semiconductors"... Do you think we should save this as like important information?

6B: I feel like it's not … we're not gonna need to use it that much, since it's more about like, how it affects.

Through these discussions, the pair determined that the information they had just read had little relevance to what they were looking for; they eventually decided not to keep it.

In the dialogue below, Students 30A and 30B read a text about the cost of PV solar panels. Together, they construct a joint meaning and reach a more sophisticated meaning-making process. From the text, 30B learns that although the price of energy
is not dropping, solar installation has improved and solar panels prices have fallen, making PV solar panels increasingly popular. Additionally, Student 30A guesses that prices to install solar would continue to become cheaper because of market competition as equipment becomes easier to produce. This process of elaboration through additional reasoning and explanation is one example of a joint meaning-making process observed in pairs during an activity.

30B: Ah, there's about a 30% tax rate. I'm trying to read the entire thing. So that was only made

30A: Price of energy is not dropping, we have... installation has improved.

30B: That's cool. I didn't know that. The prices have fallen, installation, well, they're going to become more popular... Like inventory is going to go up so as demand at some point. So,

30A: Installation would become a common service at that point, which would mean that it would be less it would be more of a competition. So people would be willing to install for cheaper

In this next example, 22B had just finished explaining that, based on her prior knowledge, abandoning solar panels could be harmful. Here, 22A and 22B expressed their mutual understanding of the text content in connection with the prior knowledge that 22B had mentioned. Toward the end of this exchange, when 22B couldn’t think of a suitable word to write in a note, 22A suggested the word “disposal” to support her partner’s meaning-making.

22A: [Read aloud partially] “Human health risks…” “toxic chemicals are used to clean the surface to...”
22B: “Cells themselves...” “are harmful to people...” Oh, “if improperly thrown away...”

22A: Oh yeah, that's what you were saying about like getting rid of them?

22B: So I think if you don't properly throw them away, that's when they could be harmful.

22A: Okay, so do you want to put in cons just like produced using harmful chemicals? And then something about like how people improperly throw them away could like, negatively effect

22B: [Typing] "produced using harmful chemicals" improper... well, "improper".

22A: It's hard typing in front of people, guys mess up.

22B: Improper...

22A: Disposal?

22B: That's the word. [Typing] "Disposal can be harmful to humans"

In addition to jointly constructing meaning together, a little later in the task, this same pair showed how they collaborated in writing notes to store the information they sought to understand. In the conversation below, pair 22 interacted to connect information from the text they were currently reading about the cost of the solar panels with information from previously read texts. After jointly making these connections, the pair decided to keep this information, agreeing that the information in the text they read “makes sense.”

22A: [Read aloud] “Now the outright cost of the typical home ranges from 16,000 to 21,000, which is a 62% average annual decrease.”
22B: Yeah, because the other one was 25,000 so like down 4,000...

22A: Okay that makes sense because that's like what we said earlier. About how like, cost is decreasing over the years. Okay. I'll paste that in and I'll quote it. [Copy the outright cost ~]

Systematic note organization was also characteristic of high performing participants. When reserving important information, participants often organized the structure of the notes in line with the task. For example, after reading the task description, pair 22 decided to organize their notes into a list of pros and cons before deciding to save what they deemed as important information. Organizing the note structure systematically provides additional opportunities, such as identifying other necessary information or selecting more important information in the process of constructing meaning. The back and forth nature of their conversation revealed efforts to collaboratively negotiate meaning-making with a lens toward a productive task outcome.

22A: Okay. Um, okay. [Read description] So now should we talk about like the pros and cons?

22B: Mm hmm.

22A: Okay, I'll put a space for pros and cons just like for the other one [Typing "Pros" and "Cons"]

22A: a little bit more organized.

**Source Evaluation**

“Source evaluation” was comprised of three sub-strategies including “determining relevant sources,” “discerning reliable sources,” and “assessing each
source’s significance.” One example of individuals “determining relevant sources” is provided next. In the excerpt below, higher performing individual 33 “determined relevant sources” as part of determining what she would say about photovoltaic systems. Since the text she read provided some information about PV systems, she assumed that it was a relevant source to help her achieve her reading goals; thus, she decided to read further.

33: Just scrolling through the article because that was mainly about... just the, this is what I want to see is, the photovoltaic systems, kind of see what is has to say about this.

Researcher: What do you think?

33: It’s helpful. It does give a little bit of information. I think there's more to come if I kept reading, but I do like what it has to say. Just gonna keep reading a little bit more because I see more about the panels, the PV panels.

In another example, higher performing individual 13 evaluated the source as irrelevant and did not save it.

13: [Read aloud] “Water use… they do not use water for generating electricity. However, some water is used to manufacture solar PV components.” I'm going to put all of this really what I don't want to leave out any information [C&P] Okay. [Pointing] This focuses on CSP, which I'm not really super focus focused on right now.

In this case, 13 copied and pasted all of the explanations of solar PV components into her notes, because, she explained, “I don’t want to leave out of any
information.” On the other hand, she judged the next passage about CSP as irrelevant because it was not the section she was focusing on.

Another observed evaluation strategy among this set of high performing students related to their use of the “discerning reliable sources” strategy. One participant working individually relied on URLs to evaluate the reliability of sources on the search results page.

13: [Click nrel.gov]

Researcher: Do you have any reason why you clicked on link?

13: It had .gov at the end, which is not normal .com, .org and also this kind of it made me it's not like a normal website that you see. It's kind of run by an organization or something. So that's kind of why I chose it and because it said the basics and that's kind of what I'm trying to figure out. Now I'm just gonna read some of the things that he has to say.

In this example, 13 said that her reason for clicking on the “nrel.gov” hyperlink was that the URL ended in “.gov.” She evaluated URLs with the top-level domain “.gov” as more reliable than URLs with “.com” or “.org,” because, she believed, a URL with “.gov” means that “it’s run by an organization.”

In addition to the URL, the source’s date of creation or update was another major criteria for determining the reliability of online information. In the next example, after evaluating the reliability of the source on the search results page, 25 clicked the hyperlink because she thought the source was reliable. Afterward, she paused to assess the reliability of the web page’s content.
25: [Searching "poor pv efficiency"] It says... energy.gov seems to be a reliable source. [Clicked energy.gov] I want to look into it [as it’s] from a while ago, so I'm not sure, hmm… not that bad… about seven years ago.

Initially, 25 accessed the “energy.gov” website because the URL contained “.gov,” suggesting that this source is reliable. But when she saw that the date of the content created was August 20, 2013, she wondered if it would be reliable, because the content was created seven years ago. She knew that information so many years old may not be highly reliable, especially in a scientific field in which information changes rapidly. Ultimately, she determined it was acceptable to include ideas from this website in her notes.

In this next example, because the author was not clearly identified, 33 started doubting whether the website was reliable. She also speculated that the website was part of a business for selling solar panels, because it contained information such as the office phone number and address. Finally, she doubted the credibility because the information in the text cited no sources.

33: I didn't. I didn't like the way… Because I couldn't see clearly… not an author. But it looks like from the sides of right here on the website, not all of this, it looks like it's a business because it's showing where they're often offices and services are along with phone numbers and addresses to reach them. But I'm not. It's not really giving me kind of anything about what this website is from. And just looking over the information briefly; doesn't seem like it has a source that already was found from? just kind of stating the facts.
Stopping to make judgments about the source of online information characterized the evaluation processes of higher performing individuals as they completed the online inquiry task.

Regarding “assessing each source’s significance,” higher performing readers in this study modeled two ways of “judging the importance of the web page contents.” One involved a superficial positive or negative reaction to the content, and the other reflected a balanced, even reaction that included explanations about why the content of the text appeared to be important.

First, here is an example of a superficial level of an individual reader “judging the importance of the web page contents.”

13: [Read] Okay. “Advantages, disadvantages, and that's it.” Um, okay, advantages. “Electricity is clean and silent.” That's good. “They do not use other than sunshine, they do not release any harmful air or water pollution into the environment deplete natural resources or endanger animal or human health.” That's good.

In this example, 13 expressed a superficial “That’s good” in response to what she had just read. She felt good about the information she read, but because she did not cite a specific reason, her evaluation of the content’s importance was at a superficial level.

Unlike the previous example, in another part of the task, 13 included more specific reasons for how they evaluated the importance of an article’s content.

13: Because I find it really interesting that you can have different things size, things like this. Whereas like a wind turbine, you can't really fit a wind
turbine in your backyard for everybody. But these, you can put them on your house. You can put them in your backpack, they feed you and I think that's pretty efficient. Okay, so so let's see over here, disadvantages, some toxic chemicals. Okay, that one is pretty important. [C&P] And then, um, solar energy is more expensive to produce. I think I'll just... maybe just this one.. [C&P] let me take a look at the Oh, yes, no, this one's important because When there's a quote, okay, [C&P] so if there is no sun or like during the night will you not get any energy in your house?

In the excerpt above, 13 decided that the information she had read was important. At that time, her reason for finding it interesting or important was clearly supported: she was interested in the fact that solar panels can be made in a variety of sizes, and she thought this made them more efficient than other devices, such as wind turbines.

In the case of pair performance, each partner often assessed relevance, reliability, and importance without any interaction with their partner, but sometimes they did interact with their partner to determine the usefulness of certain content. An example of source evaluation in a paired activity is shown below.

6A: So I guess we start by looking at photovoltaic. Right?

6B: Mm hmm.

6A: [Searching "photovoltaic"] [Read first result text] Okay, well photovoltaic just means of that to substance exposed to light and electric currents that make sense. We were looking for the actual panels. [Searching
"photovoltaic panels"] Look up panels. [Pointing] They have like, a .org. website, should we use that? Or…

6B: Seems good. It looks like some sort of company. So maybe..

6A: [Click (seia.org)] yeah, maybe they're selling.

In this excerpt, 6A pointed out a link to a website containing “.org” and asked for the partner’s opinion. The partner said, “Seems good. It looks like some sort of company,” and 6A agreed. These participants thought that if the URL’s top-level domain was “.org,” then it was a company’s website. In other words, participants recognized that the website’s owner could be different, indicated by the URL.

Similarly, in this next excerpt, participants jointly evaluated the relevance of information they encountered online. When 6A read a portion of the text aloud and asked if he should keep it as important information, 6B assessed the information as unnecessary because it was not relevant to the information they were seeking.

6A: Um, [Read aloud] "PV devices can be used to power anything from small electronics." Okay, so they can do a whole bunch of stuff. That's cool. Okay, so it says [Read aloud] "photons strike an ionized semiconductors"... Do you think we should save this as like important information?

6B: I feel like it's not we're not gonna need to use it that much since it's more about like, how it affects.

In the dialogue below, Student 30B is reading a text, when Student 30A cautions that it is necessary to keep in mind that the information may be biased because the web page seems to have been made by a solar panel company. At first,
30B did not seem to notice or care much about the reliability of the text, but following 30A’s prompt, he suggests that they more critically evaluate the validity of the text later. In this way, when performing a task together rather than as individuals, participants are provided with more opportunities to be involved in critical source evaluation process because they can remind each other and draw attention to details that the other may have missed.

30A: I have taken out that that website... seem to come from a solar panel company.

30B: Okay.

30A: so maybe we should keep that in mind.

30B: Yeah.

30A: Because it could be biased. Yeah, it might be all biased.

30B: All right that I'll write that one thing down for now and then we can look more on to verify. that's where we need validity

Pair performance also plays a role in confirming individual judgment through peer interaction. In the conversation below, Student 22A suggests that more recent sources would be better and wonders aloud whether the particular source they are viewing is valid or significant in the process of scrutinizing information to access potentially useful texts. Student 22B confirms that it is about validity. If the participant had performed the task alone, he or she would not have been able to get help in this difficult-to-judge situation.

22A: [Read aloud title] "what do solar panels cost and are they worth it?" You want to look at a couple other ones? [Read aloud title] "Are solar panels
really worth it in 2020?” That one would be like effect though, like, which ones is it like current? Would it be like validity or like significance? Since it's like recent, a recent source would probably be better.

22B: Yeah, that's validity then.

22A: All right. Do you want to click on that one [Click]

**Self-monitoring**

In relation to “self-monitoring”, higher performing participants mainly used detailed strategy actions involving “managing information searches,” “adjusting meaning-making processes,” and “monitoring the task.” “Managing information searches” refers to regulating the information location process. As higher performing individual participants completed the online QGT, they occasionally stopped to reflect on what they had gained during the search and what information would be needed in the future; in this next case, 25 adjusted the search order as a result of this reflection.

While 25 was searching and visiting related sites by entering the search keyword “photovoltaic.” she returned to the Google search results, thinking about what additional information she would like to find. She recalled that learning about solar panel efficiency was interesting to her in a previous search, so she decided to search for PV solar panel efficiency.

25: Um I'm just gonna go back to Google again. And I'm going to do.. that was very interesting when I was learning about the efficiencies. So I kind of want to learn more about that. So PV solar panel efficiency. [Searching "pv solar panel efficiency"]
In another example of self-monitoring, this same individual reader monitored the task goals and their process in the task by referring to their own notes or task descriptions. She checked her notes, looked at the information she had obtained so far, and based on these actions, judged whether there was anything more she could look for in the future.

25: [Read notes] I'm just gonna look over my notes and see if there's something I want to look up because time is dwindling down. So I have what solar panels are, who can get them how they work, the history of it. The efficiencies, advantages and disadvantages, what people should everyone consider solar panels I think I'm going to think about.. And get the access I think.. like Can people actually afford solar panels? Generally

Of specific relevance to this study was that more of these self-monitoring activities were observed in pair performances rather than in individual performances. In particular, it was observed that the pairs deepened their monitoring process through their interactions. For example, in the excerpt of pair 6 below, 6A searched for “how much do PV panels cost” to get related information, and 6B wondered about the extent to which the cost would be related to CSP, so 6A revised their search terms to search for “PV costs compared to CSP costs.”

6A: [Searching "How much do PV panels costs"] [Read first result text] Okay, “solar panel costs for an average installation range from 11,000 to 14,000.”

6B: Okay, I wonder what that is in comparison to like the... other ones CSP?
6A: Oh yeah. Okay, so PV, so I can look up [Searching] "PV costs compared to CSP costs". Maybe that'll like recognize that there's two different types of cost of energy is more important. [Read first result text] since PV is a lot cheaper than CSP, warmer energy.

Through this interaction, 6A established a new search pathway as they completed the task to address 6B’s wondering (or monitoring) about relevant topical knowledge she did not yet have.

In addition, this higher performing pair modeled the process of modifying search keywords or setting the search direction in relation to the task goals more than the individual readers did. As revealed below, 6A thought that laws and regulations were not important in relation to solar panels. She went back to the task description and checked to see what further information they were to look for. Through the interactions with one another, the pair realized that they had only dealt with public health at a general level. As a result, they concluded that they would like to find more specific cases.

6A: [Go back to search results] All right, maybe laws and regulations are not important. [Read description] Also benefits and drawbacks impact on environment we have public health generating electricity Okay, so we looked at public health in general but we could maybe look up like specific...

6_B: Yeah, maybe like… if there's any like cases or something like a…

6_A: Yeah, like a case where like something happened.
In this third excerpt below, pair 21 was searching for pros and cons of solar panels. However, 21A asked to reread the assignment description, and so the two students read the assignment description again.

21A: could you go back to like the handout like the like paragraph thing?
21B: This one, this one?
21A: Like at the bottom... like tells us specifically. Yeah. Okay. So okay, so

[Read aloud partially, description] "benefits and drawbacks impact on the environment public health cost." Okay. So maybe we go into more detail about the impacts on the environment? Yeah, we can go like one by one on those?

21B: Okay, I'm gonna open up a new tab.

As a result of their collaborative interactions, this pair was able to think more carefully about what specific information was needed to complete the inquiry task.

Summary of Qualitative Analysis

The purpose of this follow-up qualitative analysis was to extend the interpretation of the quantitative analyses and identify critical patterns of similarities or differences in online reading strategy use between higher performing individuals and pairs of readers as they completed an online QGT.

Overall, findings reveal that higher performing individuals and pairs of readers generally performed the task by using a variety of reading strategies in appropriate situations. However, it was observed that pairs of readers elaborate each other's
cognitive processes by deepening all reading strategies through peer interaction, providing external feedback that could not be received during individual performance.

Relative to information location, patterns suggest that both higher performing pairs and individuals appear to be actively generating and modifying search terms. However, it seems that pairs support each other's performance and reduce each other's burden on information location by creating and modifying search terms and scrutinizing the search results together.

With respect to meaning-making, common patterns suggest that both higher-performing pairs and individuals paraphrase important information rather than copy/paste, and use a high-level of meaning-making strategies such as inferring and synthesis. However, pairs demonstrated a unique phenomenon. They helped each other when reading the text, such as providing additional detailed explanations about unknown content or sharing various inferences from various viewpoints to provide a variety of interpretations.

Relative to source evaluation, common patterns in source evaluation suggest that both higher-performing pairs and individuals are aware that information on the Internet can be inaccurate, yet not many source evaluation strategies were observed in the verbal data. However, pairs help each other in source evaluation through interactions such as creating additional opportunities to evaluate when, for example, someone does not notice important information. Peer interaction also offers individuals the chance to reconfirm their own judgments by hearing the opinion of others.
And finally, with respect to self-monitoring, data from higher performing participants in this study suggested that pairs of strategic and metacognitive online readers supported each other’s monitoring, information location, and meaning-making in ways that were less likely to occur when readers engaged in online inquiry by themselves.

Chapter Summary

This chapter first presented the results of descriptive statistics, independent samples t-tests, Mann-Whitney U tests, two-way mixed ANOVAs, and hierarchical regression analyses used to address the three main quantitative research questions. The second part of the chapter shared illustrative examples of qualitative verbal protocol data to address the fourth research question. These qualitative data revealed both shared and unique patterns of strategy use among high-performing individual and paired readers as they completed the online QGT. Key takeaways from the quantitative results and follow-up qualitative findings and implications for the field are discussed in Chapter 5.
CHAPTER 5

DISCUSSION

This study applied a quantitative-based qualitative approach (Chi, 1997) to examine the value of working together by comparing the frequency of different reading strategies used by individual and paired students during an Online Inquiry-based Question Generation Task (online QGT) and their corresponding outcomes (e.g., the quality of generated questions/justifications and learning gain). Additionally, this approach was used to determine the factors that influenced the results of the online QGT. The goal of this chapter is to briefly summarize the quantitative and qualitative findings presented in Chapter 4 and to discuss implications of these findings for existing literacy theory, classroom practice, and future research.

Summary of Findings Comparing Strategy Use, Knowledge Gains, and Attitudes toward the Online QGT among Paired and Individual Readers

The first research question (RQ1) explored differences in the frequency of using four reading strategies (information location, source evaluation, meaning-making, and self-monitoring) (RQ1a) as well as differences in the quality of reader-generated questions and justification (RQ1b) between individuals and pairs of American undergraduate students completing an online QGT. To answer RQ1, independent samples t-tests and Mann-Whitney U tests were used to identify any differences in the frequency of various online reading strategies and in the outcomes of the online QGT between groups of individual and paired readers. In particular, in the case of pairs, simply verbalizing the same strategy repeatedly was coded as using
one strategy to avoid duplicate coding. Only when the other strategy was newly verbalized was it coded as the use of two separate strategies.

The second research question (RQ2) explored the extent to which paired students retained knowledge about the inquiry topic and changed their attitudes toward online inquiry after completing an online QGT when compared with students who completed the QGT individually. Two-way mixed ANOVAs were used to verify the pre-and post-test changes in student knowledge of the reading topic, general attitudes toward online QGT’s, and the potential differences in these values between individual and paired readers. The main findings were that students in the paired group demonstrated significantly higher frequency of use of meaning-making strategies and self-monitoring strategies compared to students in the individual group as they completed the online QGT. In addition, both paired and individual groups of students demonstrated significant pre-post differences in topic knowledge and online QGT attitudes. Each of these findings will be discussed in turn.

**Paired Readers Demonstrated Significantly Higher Frequency of Meaning-Making Strategy Use Compared to Individual Readers**

First, the frequency of using the meaning-making strategy in the paired student group (Mean rank = 27.11) was higher than those of the individual group (Mean rank = 18.70), $U (N_{pair} = 23, N_{individual} = 22) = 158.50, z = -2.147, p = 0.32$. The higher frequency of meaning-making strategies among paired students suggests that when paired individuals interacted with one another to complete the online QGT, the act of sharing tasks and information with another person may have naturally facilitated more meaning-making processes for both individuals in the pair. This finding is line with
previous research that found peer interaction helped cognitive elaboration, such as encoding, activation of schemas, rehearsal, metacognition, and retrieval (O’Donnell and Hmelo-Silver, 2013) and that verbalizing was a good way to elaborate on one’s thinking (O’Donnell & O’Kelly, 1994; Staarman et al., 2005). When people interact by verbalizing their own thinking, they tend to focus on clarifying the details of their thinking process to deliver thoughts more coherently, which, in turn, helps the subject to internalize learned information. Thus, the process of verbalizing and clarifying one’s thinking to a partner during an online inquiry task may have helped facilitate one’s own meaning-making process. In addition, when someone expresses his/her thoughts through a meaning-making process, partners can share their own ideas about the texts’ content and provide feedback about their partner’s thoughts. Therefore, it makes sense that students who engaged in online inquiry with a partner may likely have had more opportunities than individual readers to expand their own cognitive processing in ways linked to higher levels of meaning-making.

**Specific Meaning-Making Actions Used More Frequently by Paired Readers Were Linked to Higher Level Processes of Cognitive Elaboration**

Results of the present study further demonstrated that the paired group used the specific meaning-making actions of “generating inferences consciously to enhance the construction of meaning from a web source” ($p = 0.015$), “copying and pasting important information” ($p = 0.08$), and “organizing note structure” ($p = 0.082$) more frequently than their unpaired peers. Using meaning-making strategies and sharing in meaning-making processes, such as generating inferences and reserving important information (e.g. copy/pasting important information, organizing note structure), may
have helped readers jointly construct a common understanding, while also deepening each individual’s understanding of ideas they encountered during online inquiry. These findings are in line with results of previous studies of comprehension strategy use during online reading (Coiro et al., 2011; Coiro et al., 2014; Kiili et al., 2012; Staarman et al., 2005).

To construct meaning together during the Online QGT required discussion and, through the course of the discussion, paired readers posed high-level questions, explained or argued ideas, and interpreted texts. These types of activities can stimulate knowledge construction and promote a deeper level of understanding. In particular, acts of inferring, integrating, and interpreting through interaction with a partner represent high-level reading strategies due to their recognition as processes linked to cognitive elaboration (Alexander, 2005). These cognitive elaboration processes involve the explicit comparison of different perspectives or conceptions, the development of shared meaning, and the co-construction of new knowledge and/or collaborative resolution of conflicting points of view (Staarman et al., 2005). Many studies have shown that active peer interaction has a positive effect on reasoning strategies (Fawcett & Garton, 2005; Teasley, 1995). Thus, as demonstrated in previous studies (Coiro et al., 2011; Coiro et al., 2014), the frequent use of multiple high-level cognitive strategies while completing the online QGT may therefore have promoted more productive interactions.

Although not statistically significant, student pairs used the “constructing intertextual meaning across different web sources” strategy (i.e., another high-level cognitive strategy related to information integration) 52 times more than individual
students. Again, the greater use of various high-level meaning-making strategies among students in the paired group suggested that readers were more likely to engage in more active meaning-making strategies and to reach deeper understanding when performing tasks together.

**Paired Readers Demonstrated Higher Frequency of Self-Monitoring Strategy Use Compared to Individual Readers**

Next, the frequency of using the self-monitoring strategy among readers in the paired group was also significantly higher than in the individual group with a statistically significance mean difference of $12.842$, $95\%$ CI $[6.763, 18.920]$, $t_{(40.116)} = 4.269$, $p < .001$. A self-monitoring strategy consists of three main parts: information location regulation, meaning-making regulation, and task management. In other words, using self-monitoring strategies more often during the online QGT would indicate that, compared to individuals, paired students exhibited a higher degree of regulating their information location and meaning-making processes and managing their entire inquiry process based on the goals of the online task.

In particular, readers in the pair group used the more specific *regulating information location strategy*, or “directing and redirecting the process of information searching” (mean rank = 32.54), much more frequently than readers in the individual group (mean rank = 13.02), $U (N_{\text{pair}} = 23, N_{\text{individual}} = 22) = 33.5$, $z = -5.002$, $p < 0.01$). This sub-strategy involved readers perceiving and planning their own goals relative to the task at hand, and subsequently directing and redirecting their processes of searching for information, determining the order for reading multiple texts, and the resultant path construction through hyperlinks of online information.
Previous research suggests that information location processes demand a high level of self-regulation from the reader (Brand-Gruwel et al., 2005; Rouet et al., 2011), as the process involves recognizing instances of unsuccessful searches wherein readers adapt their searches by trying alternative keywords in search engines until they are able to turn ineffective strategies into more effective ways to find desired information (Guinee et al., 2003). In this regard, the paired group’s high use of self-monitoring strategies related to information location during the online QGT provides initial evidence that readers were more likely to find sources that were more relevant to the task's goals and were less likely to get lost or distracted during information location when working with another student.

In addition to monitoring their location of information during the online QGT, readers in the pair group (mean rank = 26.72) also used significantly more meaning-making regulation strategies, such as “monitoring the stimulation of cognitive processing and activating processes to accommodate characteristics of the text,” than readers in the individual group (mean rank = 19.11), $U (N_{pair} = 23, N_{individual} = 22) = 167.5, z = -1.961, p < 0.05$. This sub-strategy involves regulating the meaning construction process when participants read webpage content, such as recognizing and solving problems in reading comprehension.

Other researchers have found that regulating the meaning-making process is a typical reading strategy used by proficient readers (see Cho et al., 2017; Coiro & Dobler, 2007). The more actively the reader regulates their understanding and approach to the text by way of the meaning-making process, the more successful they are at connecting different perspectives, absorbing content, and building integrated
understandings (Anmarkrud et al., 2014). Therefore, the greater use of self-monitoring strategies by paired groups to regulate their meaning-making process as part of the QGT may have contributed to deeper and more integrated understanding of the content they read.

A third kind of self-monitoring strategy is that of monitoring task performance. Findings from this study indicated that readers in the pair group (mean rank = 26.48) used the task managing self-monitoring strategy, or “monitoring the reader’s progress toward the reading goals” more than readers in the individual group (mean rank = 19.50), albeit this difference was only marginally significant ($p < 0.1$). Other researchers have found that monitoring task performance with the task goal in mind helps individual readers with both information location (Bilal, 2000) and meaning-making (DeSchryver, 2017). As an extension of this process, when students worked together to complete the online QGT, they appeared to be even more likely than individuals to engage in activities that helped them regulate or monitor their reading comprehension while keeping the task goal in mind; consequently, the paired readers’ more frequent use of the task managing self-monitoring strategy may have contributed to the higher quality of overall task outcomes.

Taken together, these findings provide at least some evidence that increases in frequency of meaning-making and self-monitoring relate to increases in overall quality in performance outcomes. In this study, students in the pair group (Mean rank = 27.78) received significantly higher scores on the generated question and justification as a final outcome of the online QGT than those in the individual group (Mean rank = 18.00) ($p = 0.01$). In other words, it seems that the active use of reading strategies
through participants’ verbal interaction during the online QGT facilitated cognitive elaboration processes in ways that ultimately contributed to improving the quality of task outcomes. This is in line with a previous study that demonstrated the active exchange of ideas through verbal interaction is a key element of effective peer interaction because verbalization involves a cognitive elaboration process (Fawcett & Garton, 2005).

**Paired and Individual Readers Demonstrated Significant Pre-Post Differences in Topic Knowledge and Online QGT Attitudes**

Regarding whether or to what extent paired students retained knowledge about the inquiry topic and changed their attitudes toward online inquiry after completing an online QGT, compared with students who complete the QGT individually (RQ2), no differences between the pair and individual groups were found. However, perhaps unsurprisingly, there were significant differences between the pretest and posttest scores in all participants for both topic knowledge and online QGT attitudes. Although previous studies have suggested that cognitive development and content knowledge learning can be promoted when students perform tasks together (Fawcett & Garton, 2005; Kiili et al., 2012), there was no significant difference in content knowledge learning between groups in this study.

This may be because university-level students often have similar cognitive abilities. That is, from a Vygotskian (1978) perspective, social interactions foster learning when the people working together have an imbalanced level of cognitive development. However, in the present study, two students of similar age and educational backgrounds worked together to solve the online QGT, in contrast to the
typical Vygotskian setup of one mentor (usually an adult) and one mentee (usually a child). Since the participants were both undergraduate students, it can be assumed that there was no significant difference in their general cognitive functioning and task performance abilities. It is difficult to judge whether paired students had a great influence on each other's content knowledge learning. However, because most of the recruited participants demonstratively did not have much prior knowledge about the topic of PV solar panels (i.e., judging by pretest scores on topic familiarity), it seems more likely that the content knowledge learning of the two students was done individually.

Because all participants, including paired students, took individual content knowledge tests before and after the QGT, the findings from the present study suggest that there was no loss of knowledge in pairs even though students worked together. In fact, all participants actually gained more knowledge regardless of placement in either group. However, the results of groups of individual readers and paired readers differed in how much knowledge they acquired and how retained content was applied. In response to RQ1b, I found the quality of the averaged results produced by the paired groups was significantly higher than that of the individual group.

This means that the quality of the results (e.g., justifying their questions, etc.) of the paired readers was quantitatively better than the quality of the results made by individual readers, even if both the individual and the pair demonstrated the same level of knowledge on a given topic in their posttest scores. An important element of this point is that there were additional task goals beyond content learning, which involved how students applied the new content knowledge to a given task at hand.
These findings are in line with the results of previous studies that peer interaction can improve the outcomes of reading tasks such as multiple-choice or short-answer questions (Lazonder, 2005) as well as for other kinds of tasks that involve creating written responses (Hmelo-Silver, 2004).

General attitudes toward online QGTs and about working together did not differ between the two groups. However, like knowledge gains, the change in attitude was significant between the pre-test and the post-test for both groups. After performing the online QGT, the positive attitudes toward online QGTs and working together increased and negative attitudes decreased. The overall positive change in the paired readers’ attitude may be attributed to an increase in self-efficacy, or the degree to which an individual feels that he or she will be able to achieve a specific task or goal (Bandura, 1997). The most influential source of self-efficacy is the interpreted result of mastery experiences and other strong sources of self-efficacy are related to working with others, including (a) the vicarious experience of the effects produced by the actions of others and (b) the verbal persuasions they receive from others (Bandura, 1994; Pajares, 1997; Usher & Pajares, 2008). In other words, when participants performed an online QGT together, perhaps they accumulated experiences in which they were satisfied with their performance and the results they made, which may have subsequently improved their self-efficacy. Likewise, in line with previous research, when students work together, they are often likely to have a more positive attitude toward the task because they feel the burden of the task is reduced and tend to view it as more solvable (Henry et al., 2012; Schraw et al., 2006).
Implications from RQ1 and RQ2

First, an important implication of this study is that students produced high-quality results when performing the online inquiry task together. Although the study design did not control for productive collaboration, I found that the quality of the QGT test results was higher for the participants who performed the task together than those who performed it alone. This suggests that instructors could help participants work together more effectively by recognizing that student performance can be improved even when a collaborative situation is not guaranteed.

Online QGTs are good instructional tools for not only content knowledge learning, but also for developing cognitive reading skills and strategies. Evidence from this study suggests that there may be more opportunities for students to develop their reading strategies when they work in pairs. Moreover, because all students gained more knowledge and positive attitudes toward online inquiry than they had when they started, it appears that this type of structured paired inquiry task could be viable in higher education environments moving forward. Although students in the paired group did not differ from students in the individual group in terms of content learning or in attitudes towards the online QGTs, paired students used significantly more strategies for reading comprehension and problem-solving. As a result, they produced quantitatively better quality results on the online QGT outcomes. This suggests that performing a task together may provide additional opportunities for participants not only to learn content knowledge, but also to observe, imitate, and internalize their partner's strategic performance to solve problems with greater success. In other words,
these results hint that reading strategies of one individual can be transferred to another when performing an online QGT together.

Therefore, this study supports the claims of previous studies that highlight the transferability of reading strategies (Wertsch, 1979), which maintains that cognitive functions and strategies can be transferred by observing each other's activities when learners engaged in learning together. This is because as students performed more metacognitive self-regulation processes, they not only metacognitively regulate their own activities during peer interaction, but they also become more involved in co-regulating activities by observing the partner's activities (Boekaerts & Corno, 2005; Bridges, 2014; Wang & Lin, 2007; Wolters, 2011). Teachers might use similar strategies by encouraging students to think-aloud and reflect on and self-regulate their thinking, which in turn can serve to develop their knowledge, and increase their positive attitudes and self-efficacy.

In this study, when students performed online inquiry activities, students that worked together produced higher quality results when those who worked alone. This result suggests that learning can be more successful through social interaction, which supports the results of other studies on social learning theory from a theoretical point of view (Webb, 1989; Wertsch, 1979). The results of this study also suggest that teachers or instructors may be more able to take advantage of peer interaction in teaching and learning situations. According to the results of the study, even without teacher intervention or guidance, college students were successful in content knowledge learning, positive attitude development, cognitive/metacognitive function development, and quality of results through peer interaction in their inquiry activities.
Thus, peer interaction not only compensates for the disadvantage of performing tasks by dividing the roles of tutor and tutee in cooperative learning, but also has the advantage of effectively performing cognitive strategy learning through interaction between students (Manion & Alexander, 1997). Even on unfamiliar topics, students in this study learned enough about the topic by conducting their own inquiry without direct instruction from an instructor. However, instructors should keep in mind that performing a task together does not necessarily guarantee collaboration (Ha`kkinen & Ma`kitalo-Siegl, 2007).

**Summary of Findings Exploring Relationships between Reading Strategy Use, Task Outcomes, and Learning Gains**

Another set of research questions warranted further exploration of the relationships between quality of student performance outcomes, and types of reading strategies they implemented during the online QGT and learning gains measured by subtracting the score of the knowledge pretest from the knowledge posttest. A set of regression analyses was used to determine whether a reader’s use of the four reading strategies and learning gain significantly predicted the outcome of the online QGT. Hierarchical regression analyses were then conducted to test the hypotheses that new strategies emphasized in either online reading contexts (e.g., information location and source evaluation) or metacognitive strategy use (e.g., self-monitoring) can predict the outcome of an online QGT more than learning gains and the use of other reading strategies.

The results of the first regression indicated that the five predictors explained 53.7% of the variance in outcome quality on the question generation task. Except for
information location, all independent variables (self-monitoring, learning gain, meaning-making, and source evaluation) significantly predicted the quality of generated question and justification. The influence of the four variables was shown in the order of self-monitoring (\(\beta = .523\)), meaning-making (\(\beta = .279\)), source evaluation (\(\beta = .272\)), and learning gain (\(\beta = .258\)).

Evidence from this study suggests that the self-monitoring strategy was the most predictive of outcome quality on the question generation task, followed by meaning-making and source evaluation strategies and learning gain. However, of the two strategies emphasized in online reading (information location and source evaluation), only source evaluation was found to significantly predict the quality of results. Findings support the hypothesis that when students increase their use of self-monitoring, meaning-making, and source evaluation strategies and when learned content knowledge is greater, the quality of outcome of the online QGT improves.

**The Role of Self-Monitoring Strategy Use During The Online QGT**

Self-monitoring strategy appears to be the most important strategy that affects the information location process, meaning-making process, and task monitoring process. These results are consistent with previous studies that explored the relationship among reading strategies used to complete hypertext or Internet-based reading tasks (c.f., Azevedo & Cromley, 2004; Azevedo et al., 2004; Azevedo et al., 2008; Cho et al., 2017; Coiro & Dobler, 2007; Kiili et al., 2009). For example, Cho et al. (2017) found that self-monitoring strategy plays a role in appropriately activating all other reading strategies (information location, meaning-making, and source evaluation) and that the three strategies interacted with each other; further, Cho and
colleagues argued that competent readers are also metacognitively competent, meaning they use self-monitoring strategies or self-regulation strategies as the appropriate time in the reading comprehension process.

Kiili et al. (2009) also found that readers who struggled to find relevant information were limited in their use of metacognitive strategies related to adjusting their activities to the task demands at the macro-level. In addition, Azevedo and colleagues found through a series of studies that students who were trained with self-regulated learning strategies were more effective in learning content knowledge using the Internet (Azevedo & Cromley, 2004; Azevedo et al., 2004; Azevedo et al., 2008). This study reaffirms that when student readers apply more metacognitive strategies, such as self-monitoring strategies, their learning outcomes may be improved.

The Role of Information Location Strategy Use During The Online QGT

Although previous studies have found the information location strategy to be a significant predictor of learning outcome, this study did not find this to be significant. Cho et al. (2017) provided three possible explanations for why information location might not have a significant effect: 1) the information location strategies may already be automated for the majority of adult readers, and 2) readers may experience a ‘representational bottleneck’ when selecting between meaning-making and information location strategies due to time constraints, and 3) readers may struggle to extract meaningful text during information location due to insufficient prior knowledge of the subject matter.

Given the experimental design of the present study, the possibility that information location strategies may have been automated for the participants is the
most likely explanation. More specifically, the information location strategies in this study consisted mainly of strategies for generating online search terms or clicking on links to access potential information sources in search results, which may already be automated in college age readers accustomed to web browsing and therefore less critical to successful information location. Although it is possible that the process of regulating the information location process may be more important than the automated information location strategies, the former was coded as part of a self-monitoring strategy, not explicitly as its own strategy. Many previous studies support the idea that the process of regulating information location has a significant effect on more successful information location (Bilal, 2000; Guinee et al., 2003; Hinostroza et al., 2018) rather than using automated information location strategies such as generating keywords and clicking links.

I propose an alternative reason for why information location strategy was not found to be significant. Namely, that scrutinizing processes cannot be captured by verbal protocol because readers may not think aloud when engaging in such processes. Although thinking aloud is a useful tool that provides information about the reader's moment-by-moment reading process, and the researcher can obtain implications for the reader's strategic reading process (Anmarkrud et al., 2013), if readers do not have sufficient training for thinking aloud, there is a possibility for them to systematically misreport their cognitive processes and to omit or distort the content when thinking aloud (Kuusela & Paul, 2000). Although two trainings were conducted to familiarize students with thinking aloud in this study, it may have still been difficult for the
participants to verbalize all of their fast-paced cognitive processes inherent in the act of information location.

**The Role of Source Evaluation Strategy Use During The Online QGT**

A hierarchical regression analysis was conducted to examine to what extent both source evaluation and information location strategies emphasized in recent Internet reading studies uniquely explain the quality of the outcome of the online QGT. Although source evaluation significantly predicted the quality of outcome in the base regression model, results of the first hierarchical regression showed that source evaluation explained an additional 6% of the variance in the quality of generated questions and justifications after controlling the effects of other variables. It therefore seems that the influence of source evaluation is lower than the level presented in previous studies.

One possible reason why the influence of the source evaluation strategy was small may have been that participants experienced difficulties in using these types of strategies. Previous research suggests that readers often struggle to evaluate sources when they lack sufficient prior knowledge and often complete their evaluations only at a superficial level (Baildon & Damico, 2009; Brand-Gruwel et al., 2017). Students might not evaluate content critically, but rather base their evaluations on superficial cues or criteria, such as a professional-looking design and/or ease of use (Coiro et al., 2015; Salmerón et al., 2018; Zlatkin-Troitschanskaia et al., 2021). Younger readers are also more likely to rate sources on a more visual and superficial level (Rouet et al., 2011). According to Salmerón et al. (2013), readers apply a heuristic of choosing the link at the top of the search results page right after entering the search keyword...
because it is a significant cognitive burden to carefully examine all of the information on the search results page and evaluate each item’s relevance and reliability (Salmerón et al., 2013).

The findings of this present study imply that college students indeed performed source evaluation at a superficial level and potentially had difficulty in successfully implementing source evaluation strategies. Another possible explanation for source evaluation’s small effect could be that source evaluation is related to other strategies and the effect is absorbed into other variables. Cho et al. (2017) reported that self-monitoring and meaning-making are inherently linked and together affect source evaluation. This means that in order for students to do well in source evaluation, they likely need to have meaning-making skills and self-monitoring skills as well.

**Self-Monitoring Strategy Use Is Central to the Quality of Inquiry Task Outcomes**

The results of another hierarchical multiple regression analysis with self-monitoring added last, indicate that the addition of the frequency of self-monitoring strategy use to the regression model explained an additional 19% of the variance in the quality of generated questions and justifications after controlling all other variables. The results of this study support the claims of previous research that self-monitoring is central to success in online inquiry tasks (Cho, 2014; Coiro & Dobler, 2007; Stadtler & Bromme, 2007).

As mentioned in the discussions of Research Questions 1 and 2 above, self-monitoring strategies encompass metacognitive strategies that not only regulate information location and meaning-making processes, but also regulate overall task performance according to task goals. In particular, many studies have emphasized that
keeping the goal of the task in mind and checking and adjusting the task performance process is a key point for successful reading of multiple documents (Britt & Rouet, 2012; Rouet et al., 2017; Strømsø, 2017). For example, according to The Multiple Documents-Task-based Relevance Assessment and Content Extraction (MD-TRACE) model and its extension Reading as problem SOLVing (RESOLV) model, when readers work on multiple texts, they create (and later update) a task model—i.e., a representation of the specifications, goals, and means to be used to complete the task (Britt & Rouet, 2012; Rouet et al., 2017; Strømsø, 2017).

**The Relationship Between Learning Gain and QGT Outcome**

In the present study, the learning gain variable was defined as the value obtained by subtracting the score of the knowledge pretest from the knowledge posttest, and the knowledge test, which consisted of multiple choice, true/false, and short answer questions. Although learning gain does not appear to significantly affect QGT outcome in our base regression model, when additional reading strategies are included, it significantly predicts the outcome of the online QGT.

Evidence regarding the role of prior knowledge in reading comprehension is mixed. According to List & Alexander (2019), prior knowledge can support the use of reading strategies to improve the reading of individual texts and the integration of content between texts. However, prior knowledge has not been found to play a significant role in all studies. For example, in Coiro (2011), prior knowledge did not significantly predict the achievement of online reading comprehension. The reason that the learning gain variable did not have a significant influence in this study may be because the criteria related to logically persuasive writing, such as relevance, validity,
and significance, were considered more important when scoring the quality of the results beyond the accuracy of content knowledge.

**Implications from RQ3**

The results of this study have implications for educational practice as they highlight which reading strategies teachers could emphasize more to build students’ competencies in Internet and digital reading. Previous studies related to Internet reading or information retrieval have emphasized the importance of the reader’s information location strategy. However, the results of this study indicate that information location strategies are likely to be largely automated in some types of online inquiry tasks and that self-monitoring and meaning-making strategies were more important for successful task completion of the inquiry-based Question Generation Task. In addition, although researchers have recognized source evaluation strategy as very important, many are somewhat skeptical as to whether readers are proficient in using this strategy with a critical perspective (Baildon & Damico, 2009; Brand-Gruwel et al., 2017; Coiro et al., 2015; Rouet et al., 2011; Salmerón et al., 2018; Zlatkin-Troitschanskaia et al., 2021). This study supports this notion, suggesting that students had difficulty evaluating the content source or used the strategy only at a superficial level.

Similarly, the meaning-making strategy is an important strategy underlying the reading comprehension process regardless of the type of media or the situational environment (Cho et al., 2017). As content becomes more complex or the amount of text to be synthesized increases, the strategy of basic meaning-making is recognized as important. Therefore, teachers may need to focus more on strategies such as source
evaluation, meaning-making, and self-monitoring in classes related to Internet reading, online reading, and digital reading than on strategies that have a lesser effect on students’ outcomes, such as information location.

In that respect, the online inquiry activity conducted in this study can be an effective content knowledge learning tool and a reading strategy training tool. As confirmed by the results of this study, self-monitoring plays a very important role in reading comprehension results. Therefore, teachers need to devise effective learning methods for developing effective self-monitoring processes in students. One method of activating metacognitive regulatory processes such as self-monitoring is having individual readers practice thinking aloud. By verbalizing and externalizing their thoughts, readers can activate the cognitive elaboration process.

For elementary school students or middle school students, reciprocal teaching, in which the teacher demonstrates thinking and verbally and gradually transfers responsibility to learners, can be an effective method both in physical classrooms and online (Henry et al., 2012; Palinscar & Brown, 1984). However, for high school students or college students who have had more cognitive development, the training of co-regulating function through peer interaction can be more effective.

In this study, when conducting an online inquiry task in a paired setting, readers can engage in not only individual-level regulatory processes but also in co-regulative processes through interaction. One participant may observe the partner’s regulative processes during peer interaction and internalize it as their own. This suggests that reading strategies such as meaning-making and source evaluation can be
transferred or trained through the reader’s co-regulation process while engaging in active peer interaction.

Next, in relation to theory and research, researchers may need to pay greater attention to whether the indicators for different reading strategies can be clearly understood during experiments and how to best code the reading strategies for analysis. During the reading process, readers use different reading strategies so quickly that it is difficult to articulate them clearly. Therefore, a clearer articulation of how to identify strategies in the analysis of reading comprehension strategies would certainly be meaningful. Moreover, no matter how well trained a research team is, capturing every step of the participants’ strategic reading process while they are thinking aloud is ultimately limited. In addition, readers may not use each reading strategy individually, but rather use them together organically and complexly (Cho et al., 2017), which increases the difficulty of coding each strategy in isolation.

In particular, the fact that the self-monitoring strategy and the other three reading strategies are not as clearly distinguished requires further investigation by future researchers. Self-monitoring strategy is slightly different from other cognitive strategies because it is a metacognitive strategy, which is a strategy related to when and how to use other cognitive strategies. All cognitive strategies include metacognitive strategies. So, when categorizing reading strategies, it seems rather awkward to put metacognitive strategies, such as self-monitoring, on the same level as the other three reading strategies.

It seems possible to separate the more detailed strategies of self-monitoring that correspond to the three sub-strategy processes derived from the main strategy of
self-monitoring. For example, the meaning-making strategy could include related strategies that regulate meaning-making strategy. The self-monitoring strategy would then include only macro-level strategies such as setting goals, setting plans according to goals, and checking performance status according to goals. To verify this hypothesis, factor analysis could be performed as a follow-up study to understand the reading strategies more clearly. This could be used to check whether each strategy is clearly distinct or a single multidimensional single factor is in order.

In addition, this study subdivided the elements of self-monitoring in ways that were different from coding guidelines applied in previous studies. In the case of Cho (2014), the strategy of self-monitoring was composed of three subdomains: managing the determination of reading paths, regulating the construction of meaning, and perceiving the self. In this study, the strategy of self-monitoring was composed of six subdomains. One of them was labeled monitoring task goals and task progress. According to Cho’s classification, the act of monitoring task goals and progress was linked directly to each of the two comprehension strategies (e.g., monitoring information location and monitoring meaning-making). In this study, the strategy of monitoring task goals and progress was separated out and highlighted as a main macro-level strategy to raise it to a higher level of importance.

Summary of Findings from the Qualitative Comparison of Comprehension Strategy Use among Higher-Performing Individual and Paired Readers

In addition to the three quantitative research questions, this study also explored one qualitative question to analyze whether the individuals and pairs that performed
better on the online QGT expressed similar or unique characteristics of strategic reading processes. Three individuals and three pairs who got high scores (more than 8 out of 9 points) on the outcome of the online QGT and used all four reading strategies with high frequency were selected; then, their use of the four reading strategies were compared (see Table 7 in Chapter 3).

Previous evidence has posited that pairs negotiate each other's ideas during online inquiry to reach a common understanding during peer interaction, mainly through clarification, elaboration, and argumentation (Coiro et al., 2019; Kiili et al., 2012). This present study found that paired readers applied the reading strategies more frequently than individual readers and developed their use of the various strategies through peer interaction. I theorize that this interaction may have contributed to the paired readers’ deepening of their reading comprehension processes. For example, paired individuals were able to remind each other of the parts they missed or forgot and to point out parts that the other may not have considered. As previous research has found, giving and receiving feedback on each other's cognitive processes may facilitate the transferal of reading strategies to each other (Wertsch, 1979) and simultaneously lead to more successful task performance.

It has been previously proposed that searching for information together is more likely to produce better search results because multiple functions and experiences of the participants can be utilized simultaneously (González-Ibáñez et al., 2015). When using information location, the pairs in this study regulated their joint-search process by modifying keywords and resetting the search direction more frequently than higher-performing individual readers through a process of negotiation with a peer. It was also
observed that self-monitoring strategies, such as giving reminders of the purpose of the task by referring to the task prompts, were frequently used by higher-performing paired readers in conjunction with information location.

In addition, among students who successfully completed the online QGT, I observed many cognitive elaboration processes taking place alongside processes of joint meaning-making, such as inferring (reasoning) together, or helping each other understand what they did not know. This is in line with prior studies. According to Webb (1989), the level of elaboration is correlated with achievement such that when peer interaction includes a deeper level of elaboration (e.g., answering with a detailed explanation), students are likely to attain higher achievement. Recent research also showed that when participants negotiate, depending on the level of the interaction, they exhibit deep-level effective interactions such as elaborating and suggesting alternatives, as well as low-level ineffective interactions such as simple accepting or declining (Coiro et al., 2019). In addition, as reading strategies such as inferring (reasoning) and argument are activated during the meaning-making process, paired readers are increasingly able to reach a deeper level of text processing (Kiili et al., 2012). For example, Participant A in a given pair might give additional explanations to Participant B about what B did not know previously, helping B to understand (as observed in Participants #30 in Chapter 4).

Even during the source evaluation process, pair performance seems to have contributed to improving the quality of task performance. Continuing the example of paired peer interaction above (Participants #30), Participant B continued to read a given text without critically evaluating its source, but Participant A reminded B
several times that the text they were currently reading could potentially be biased. As a result, B accepted A’s proposal to evaluate the source. This kind of joint regulating and monitoring process appeared to help the pair of readers to be more successful with the task by reminding them to consider important issues that they might have missed if they had been reading on their own.

In other words, by participating in peer interaction, readers are able to activate the process of controlling and checking the overall strategy use and task performance at the pair level as well as at the individual level. Evidence from this study suggests that when working together, paired students can reduce the possibility of losing their focus on task goals and directions. Moreover, when working together (e.g., communication, sharing, negotiating ideas, etc.), paired students can elaborate their individual thoughts and generate better combinations of ideas. It appears that these joint metacognitive processes among paired readers contributed to cognitive clarification and elaboration, through which each reader has the potential to reach deeper levels of reading comprehension or to transfer each other's cognitive strategies to each other.

**Implications from RQ4**

The results of the qualitative portion of this study first have implications for the importance of having students perform tasks in pairs in literacy education settings. Findings of this study suggest that teachers should be encouraged to assign students to perform inquiry tasks or problem-solving tasks together not only in literacy classes but also in other content-subject classes. This study found that performing tasks together has a more positive effect on task quality, individual knowledge learning, and
activation and development of individual cognitive strategies than when individuals perform problem-solving tasks. In particular, through the qualitative analysis, this study found that, when performing a task together, participants are using not only individual metacognitive strategies but also co-regulative strategies, which can enable not only more successful reading comprehension but also facilitate the transfer of each other's reading strategies.

This study is additionally meaningful in that the above advantages of performing together were observed only through organic peer interaction initiated by participants, not by way of the direct intervention of the instructor. This advantage can be more effective when the reader's cognitive level is high, such as in college students, whereas additional help from the instructor may be needed in the case of elementary or middle school students. Some classroom examples that may facilitate the collaboration process might include structuring inquiry-based reading tasks to have students ask each other questions during interactions. This can encourage elaborated responses by structuring the interaction and control the effectiveness of peer responses (King, 1990). When questions posed between peers are high-level, they promote high-level thinking and learning (King, 2002); however, guides for generating questions can also serve as starting points to generate questions when people have difficulties generating their own questions (Choi et al., 2005). This study confirms that an inquiry activity or problem-solving activity centered on peer interaction is an effective teaching-learning method.

It is interesting from a theoretical point of view that the situation in which two students interactively perform a task together may have a positive effect on the
outcome despite not controlling other conditions for effective collaboration. Many studies have investigated the conditions for effective collaboration: participation (Johnson & Johnson, 2002), level of cognitive development (Fawcett & Garton, 2005; Teasley, 1995), task difficulty (Chen et al., 2018), group size (O'Donnell & O'Kelly, 1994) and so on. However, this study shows that working together can contribute to the improvement of students’ individual reading ability as well as the quality of joint task outcomes, even when such conditions are not considered thoroughly.

One possible hypothesis is that the result of the task would have been more positive because this task required active engagement and the continuous participation of students. For example, the participants had to take turns leading the task. In this regard, this study found that performing together has generally positive results in learning in situations where active participation is guaranteed, warranting more studies on situations of voluntary collaboration. In addition, future researchers should pay more attention to ways of enhancing the effectiveness of collaborative interactions beyond simply working together as a pair.

Limitations

One limitation to this study is that it only provided a cross-sectional analysis comparing students assigned to different treatment groups. To more rigorously compare the process and outcomes of individual and pair performance, it is necessary to compare individual and pair performance of the same participants (i.e., panel analysis). For example, it is possible to conduct research using a counterbalanced design that analyzes the results by dividing the group into one group that performed
the task individually and then performed the task in pairs, and the other group that performed the task first in pairs and then performed the task individually.

Next, the small sample size may have prevented statistically significant results for differences in topic knowledge and attitude scores. The results of this present study was not line with findings of previous studies (Fawcett & Garton, 2005; Kiili et al., 2012) that when performed in pairs, it is more effective for learning than individual performance. Alternatively, as mentioned earlier, this may be because the roles of tutors and tutors in peer interaction are not established according to existing social learning theory. The prior knowledge level or cognitive ability of each participating student was not taken into account when assigning student pairs, so it cannot be ruled out that there were ‘mentee students’ who were more developed among the pair students. Furthermore, this study was conducted on college students and did not control the cognitive level of the participants more generally. Conversely, the difficulty of the questions in the knowledge tests may have been so easy to students that they fail to differentiate the level of content knowledge learning.

Therefore, follow-up studies that address and improve upon these points are warranted. For instance, follow-up studies may investigate how online inquiry performance patterns differ depending on the participants' cognitive level or school level. In the case of elementary school students, for example, the effect of peer interaction may be less while the learning effect of interactions facilitated by a teacher may be greater.

Third, although this study is about peer interaction when working together, it is difficult to say whether this study explored the value of collaboration. Strictly
speaking, a situation in which peer interaction is effective could be said to be evidence of collaboration. According to Roschelle and Teasley (1995), collaboration can be defined as a “co-ordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem” (p. 70). Nevertheless, peer interaction is an essential but insufficient condition for collaboration because some kinds of peer interactions do not involve shared goals, the accommodation of different perspectives, or organized attempts to achieve goals (OECD, 2017). Therefore, it is difficult to interpret the results of this study as the results of performing a collaborative task, and it is necessary for a follow-up study to design a collaborative task by fully considering the conditions that promote collaboration and to examine the task performance patterns of participants in a collaborative setting.

Fourth, when learning gain is measured with only two data points (e.g., pre-post measurement), it may be difficult to ensure high reliability of the measurement. Therefore, in the present study, it is possible that the learning gain variable did not strongly predict the quality of the outcome in multiple regression analysis or could not uniquely predict the quality of the outcome in the hierarchical regression analysis. For a more reliable measurement, a longitudinal study using multiple measurement points may be more effective.

Finally, since no additional data, such as responses from retrospective interviews, were collected from participants, it is not possible to explain why participants used certain strategies or specific interaction styles over others. Therefore,
follow-up studies are needed to explore the reasons why participants may have exhibited specific reading strategies and interaction patterns.

**Concluding Thoughts**

My research began with the belief, as the saying goes, that “None of us is as smart as all of us.” Although the value of cooperative learning has been continuously emphasized throughout the education field, working together doesn’t always yield better results than working alone. In fact, more important than whether a student works alone or with a partner is the extent to which readers are exposed to opportunities to elaborate their cognitive processes. The findings from this study provided evidence that the more readers were involved in cognitive elaboration and self-monitoring processes, either through thinking-aloud or peer interactions, the better their performance outcomes could be. Furthermore, this study reconfirmed that the inquiry-based online question generation task is an effective teaching and learning tool that helps readers not only learn content knowledge but also develop reading comprehension strategies.
APPENDICES

Appendix A: Consent Form

THE UNIVERSITY OF RHODE ISLAND

IRB Consent Form for Research

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STUDY TITLE
Exploring Online Inquiry with a Question Generation Task

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KEY INFORMATION
Important information to know about this research study:

- The purpose of the study is to gain insight into the skills and strategies that college students use when they use the Internet to learn new content and construct a question that stimulates rich discussion about that content. Some of you will work with a partner and some of you will work by yourself.
- You will be participating in instruction about using the Internet for research as part of your work in EDC 102, Introduction to American Education. Regardless of whether you choose to participate in the study, as part of the course, you will spend approximately 3.5 hours using the Internet to complete an online inquiry task.
- On the first day, you will participate in a one-hour whole group session that involves learning more about the task and taking two short surveys. On the second day, about two weeks later, you will participate in two-hour session that asks you to use the Internet to complete a task and then take two follow-up surveys. You will earn class participation points in EDC 102 for these two sessions.
- Then, for class, you will write a short reflection about what you learned from the task. This reflection will take approximately 30 minutes and will be graded by your EDC 102 Instructor.
- If you decide to take part in this study, you will allow URI researchers (Changhee Lee and Dr. Julie Coiro) to analyze the data collected during the first two sessions.
- There are no expected risks.
- The study will help you learn and activate important reading comprehension strategies while using the Internet to foster a deeper understanding of challenging content.
- Taking part in this research project is voluntary. You don't have to participate and you can stop at any time. You will be provided a copy of this consent form.

INVITATION
You are invited to take part in this research study. The information in this form is meant to help you decide whether or not to participate. If you have any questions, please ask.
Why are you being asked to be in this research study?
You are being asked to be in this study because you are an undergraduate student enrolled in a section of EDC 102, Introduction to American Education, at the University of Rhode Island. You must be between 18 - 23 years of age to participate.

What is the reason for doing this research study?
This study is being conducted in order to explore how college students use the Internet to learn new content and construct a question that stimulates rich discussion about that content.

What will be done during this research study?
You will be participating in an online inquiry task as part of your work in EDC 102. Introduction to American Education. As part of the course, regardless of whether you choose to participate in the study (e.g., share your data with the researcher), you will spend two sessions (approximately 3 hours) completing the online inquiry task. In the first session (one hour), you will receive training on how to think aloud and how to generate questions while reading on the Internet. You will also complete a pre-task questionnaire about your relevant experiences, beliefs, and knowledge. Then, approximately two weeks later, in a two-hour session, you will be asked to a) use the Internet to learn more about a particular topic, b) construct a question based on what you learned and c) justify how it might stimulate rich classroom discussion. At the end of this session, you will be asked to complete a post-task questionnaire about your knowledge and beliefs. You might be asked to work individually or to work with a partner as you complete these tasks. The computer you use will be equipped with screen-capture software that will record your voice, face, and on-screen action.

After you leave the session, you will write a short reflection about what you learned from the task that will be graded by your instructor. This reflection will take approximately 30 minutes. Your grade from the two session inquiry experience (including class participation points for the two sessions and your written reflection of what you learned) will count for 10% of your final grade in EDC 102. Regardless of whether you choose to participate in the study, you will be expected to attend and participate in the two-session inquiry experience and complete the post-reflective essay. If you decide to take part in this study, you will allow the researchers to analyze all data including video recordings, outcomes of the task, and pre/post questionnaires.

How will my video recording be used?
Your video recording data will only be used by the researchers conducting the study unless you grant optional permission for short excerpts of your video to be shared with a larger audience (at a research conference or in a research journal). There is a separate space to provide this optional consent at the bottom of this form. Your name will never be shared with anyone.
THE UNIVERSITY OF RHODE ISLAND

IRB Consent Form for Research

Page 3 of 5

PRINCIPAL INVESTIGATOR
Dr. Adeola, School of Education, University of Rhode Island
Office: 401-874-4922, Email: sostad@uri.edu

PHD RESEARCHER
Christopher Lee, PhD student, School of Education, University of Rhode Island
Office: 401-874-4989, Email: cejlee@uri.edu

Exploring Online Inquiry with a Question Generation Task

What are the possible risks of being in this research study?
The expected minimal risk is the typical stress participants may feel about being observed and video recorded as they share what they are learning with others.

What are the possible benefits to you?
The study will help you learn and activate comprehension strategies in ways that foster understanding of challenging content when you conduct inquiry about a new topic using the Internet, which is useful for students who are just beginning to engage with others in a college-level academic community.

What are the possible benefits to other people?
Findings from this study will shed new light on college students' comprehension processes and learning products as part of online inquiry. In addition, this study will contribute to emerging work that examines the potential of generating questions as a means of improving the quality of strategy use and learning outcomes while using the Internet. Furthermore, the instructor will be able to evaluate the course curriculum and revise it based on your work. This information will help the instructor improve the curriculum for future participants in EDC 102.

What are the alternatives to being in this research study?
If you choose not to participate in the research study, your image will not be captured on video and all data including outcomes of the task and pre-post questionnaires will not be analyzed. You will still participate in the online inquiry task and post-reflection to earn points toward your EDC 102 grade.

What will it cost you to be in this research study?
There is no cost to you to be in this research study.

What should you do if you have a problem during this research study?
Your welfare is the major concern of every member of the research team. If you have a problem as a direct result of being in this study, you should immediately contact one of the people listed at the beginning of this consent form.

How will information about you be protected?
Reasonable steps will be taken to protect your privacy and the confidentiality of your study data. The data will be stored electronically through a secure server and will only be seen by the research team during the study. The only persons who will have access to your research records are the study personnel, the Institutional Review Board (IRB), and any other person, agency, or sponsor as required by law. The information from this study may be published in scientific journals or presented at scientific meetings, but the data will be reported as group or summarized data and your identity will be kept strictly confidential.

What are your rights as a research subject?
You may ask any questions concerning this research and have those questions answered before agreeing to participate in or during the study.

For study-related questions, please contact the investigator(s) listed at the beginning of this form. For questions concerning your rights or complaints about the research contact the Institutional Review Board (IRB) or the Vice President for Research and Economic Development:

- IRB: (401) 874-4328 / researchintegrity@etal.uri.edu
- Vice President for Research and Economic Development: at (401) 874-4576

What will happen if you decide not to be in this research study or decide to stop participating once you start?
You can decide not to be in this research study, or you can stop being in this research study at any time before, during, or after the research begins for any reason. Declining not to be in this research study or deciding to withdraw will not affect your relationship with the investigator or with the University of Rhode Island. You will not lose any benefits to which you are entitled.

Documentation of informed consent
You are voluntarily making a decision whether or not to be in this research study. Signing this form means that (1) you have read and understood this consent form, (2) you have had the consent form explained to you, (3) you have had your questions answered and (4) you have decided to be in the research study. You will be given a copy of this consent form to keep.

Participant Name and signature:

_____________________________ _______________________________ _____________
(Printed Name) (Participant Signature) (Date)

OPTIONAL AUDIO/VIDEO ADDENDUM TO THE CONSENT FORM FOR RESEARCH
The data collected in this project will be valuable information for the larger educational community. As such, your responses or clips from these videos may be selected for use in research reports, presentations and/or conference. Your name will be kept confidential.

PLEASE CHECK ONE:

_____ Yes, I give consent for my personal audio/video data collected from this project to be retained for three years and used in external publications and/or presentations.

_____ No, I do not give consent for my personal audio/video data collected from this project to be retained for three years and used in external publications and/or presentations. Only the researchers involved in this study should have access to this audio/video data.

MARCH 2019
IRB
Consent Form for Research

PRINCIPAL INVESTIGATOR
Dr. Julie Coiro, School of Education, University of Rhode Island
office: 401-874-1640; email: jcoiro@uri.edu

PHD RESEARCHER
Changho Lee, PhD Student, School of Education, University of Rhode Island
office: 401-874-1640; email: changho@uri.edu

Exploring Online Inquiry with a Question-Generating Task

Researcher Name and Signature:

(Printed Name) (Researcher Signature) (Date)

MARCH 2019
Appendix B: Knowledge Test

Survey 1: Photovoltaic (PV) solar panels

Please answer the following questions about Photovoltaic (PV) solar panels.

[1-10] Select a single answer choice.

1) Which of the following is an unsustainable energy source?
   a. Geothermal power
   b. Hydrogen power
   c. Solar power
   d. Wind power

2) Which of the following is false?
   a. PV solar energy is an example of alternative energy.
   b. PV solar energy is an example of renewable energy.
   c. PV solar energy is an example of stable energy.
   d. PV solar energy is an example of sustainable energy.

3) Which of the following is a main material for the semiconductor of PV solar panels?
   a. Aluminum
   b. Copper
   c. Tungsten
   d. Silicon

4) Which of the following is a toxic chemical in PV solar panels?
   a. Cadmium Telluride
   b. Mercury
   c. Nitrogen dioxide
   d. Uranium 235

5) Which of the following is true?
   a. PV solar systems reduce noise pollution.
   b. PV solar systems reduce soil pollution.
   c. PV solar systems increase air pollution.
   d. PV solar systems increase water pollution.
6) Which of the following is the **typical life span** of PV solar panels?
   a. Less than 5 years  
   b. 5 - 15 years  
   c. 20 - 30 years  
   d. More than 30 years

7) Which of the following is the **estimated cost** of PV solar panels for an average-sized home in the U.S. before a tax credit is applied?
   a. Less than $15,000  
   b. $15,000 - $30,000  
   c. $30,000 - $45,000  
   d. More than $45,000

8) Which of the following is a **necessary part** of a PV solar system in addition to PV solar panels?
   a. Battery  
   b. Cooler  
   c. Inverter  
   d. Mirror

9) Which of the following factors has the **largest influence** on the output of PV solar panels?
   a. Altitude  
   b. Dirt  
   c. Shading  
   d. Snow

10) What percentage of the total cost of installing PV solar panels in your home can be **claimed as a credit** on your federal tax return in the U.S.?
   a. Less than 10 % of the total cost of installing PV solar panels  
   b. 10 - 19 % of the total cost of installing PV solar panels  
   c. 20 - 30 % of the total cost of installing PV solar panels  
   d. More than 30 % of the total cost of installing PV solar panels
[11-20] For each of the following statements, choose either true or false.

11) Greenhouse gases are produced during the process of manufacturing PV solar panels.
   _____ True    _____ False

12) A working PV solar power plant uses a lot of water.
   _____ True    _____ False

13) When people dispose of PV solar panels, some materials from the panels can make people sick.
   _____ True    _____ False

14) Workers who manufacture PV solar panels are exposed to harmful substances.
   _____ True    _____ False

15) Replacing fossil fuel power plants with PV solar power plants may help reduce the number of people suffering from respiratory diseases.
   _____ True    _____ False

16) It is becoming more expensive to produce PV solar panels.
   _____ True    _____ False

17) After the warranty period ends, PV solar panels should be replaced.
   _____ True    _____ False

18) It is more expensive to maintain PV solar panels than to buy PV solar panels.
   _____ True    _____ False

19) Some US citizens may not be eligible to get tax credits for owning PV solar panels.
   _____ True    _____ False

20) People can rent PV solar panels rather than owning them.
   _____ True    _____ False
[21 – 24] Provide your opinion on each statement below and provide at least one reason to support your opinion.

21) Some people argue that PV solar panels have negative effects on the environment. Do you agree with this statement? Why or why not?

22) Some people argue that PV solar panels have negative effects on human health. Do you agree with this statement? Why or why not?

23) Some people argue that PV solar power is more cost efficient than fossil fuel power. Do you agree with this statement? Why or why not?

24) Some people argue that PV solar systems are not affordable for low-income families. Do you agree with this statement? Why or why not?
Appendix C: Attitude Test  
Survey 2

We want to know more about your thinking as you use the Internet to learn new content. Please circle the best answer for each question below.

1. How confident are you when you do each of the following activities:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Absolutely unconfident</th>
<th>Unconfident</th>
<th>Slightly unconfident</th>
<th>Slightly confident</th>
<th>Confident</th>
<th>Absolutely confident</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formulating questions that help me to search for information on the Internet.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posing questions to another person to help me gather useful information.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Choosing the best link from the search results (e.g. a list provided by Google).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skimming a source to decide whether or not the information is useful for me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluating whether information in a source is reliable.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combining information from more than one source in a way that makes sense to other people.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Writing about my research and giving reasons to support my thinking.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formulating questions that help stimulate rich discussion</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
2. Over the course of a week, how often do you use the Internet to search for information in the following ways:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never</th>
<th>1-2 times a week</th>
<th>3-4 times a week</th>
<th>5-6 times a week</th>
<th>More than 7 times a week</th>
</tr>
</thead>
<tbody>
<tr>
<td>I search for information for my homework on school assignments.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In my free time, I search for information on the Internet about issues that interest me (e.g., hobbies, music).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>During class, I work with a partner or small group to search for information on the Internet.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In my free time, I work with others to search for information on the Internet.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Compare working by yourself and working with a partner. How much do you agree or disagree with each statement:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Somewhat Disagree</th>
<th>Somewhat Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I prefer working with a partner more than working by myself to solve a problem.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Somewhat Disagree</td>
<td>Somewhat Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>I am more confident when I work with a partner than when working by myself to solve a problem.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Somewhat Disagree</td>
<td>Somewhat Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>If I had an opportunity to choose, I would prefer to do an important exam by myself rather than with a partner.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Somewhat Disagree</td>
<td>Somewhat Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
</tbody>
</table>
If I had an opportunity to choose, I would prefer to do an important course project by myself rather than with a partner.

4. Think about your beliefs and preferences about using the Internet. How much do you agree or disagree with each statement:

<table>
<thead>
<tr>
<th>I believe the Internet makes it easier to get useful information.</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Somewhat Disagree</th>
<th>Somewhat Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I would rather complete research on the Internet than using a book or magazine.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Somewhat Disagree</td>
<td>Somewhat Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>I think students who do not use the Internet miss out on a lot of important information.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Somewhat Disagree</td>
<td>Somewhat Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>I believe using the Internet for research and reading has made learning more interesting.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Somewhat Disagree</td>
<td>Somewhat Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>Using the Internet for research is beneficial because it saves people time.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Somewhat Disagree</td>
<td>Somewhat Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>When I search for information on the Internet, I remember it better.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Somewhat Disagree</td>
<td>Somewhat Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
</tbody>
</table>

5. Think about your feelings about using the Internet to learn new content. How much do you agree or disagree with each statement:

<table>
<thead>
<tr>
<th>I cannot relax when I am reading/researching on the Internet.</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Somewhat Disagree</th>
<th>Somewhat Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Researching information on the Internet makes me feel tense.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Somewhat Disagree</td>
<td>Somewhat Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>Criteria</td>
<td>Complete (3)</td>
<td>Adequate (2)</td>
<td>Partial (1)</td>
<td>Lacking (0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>--------------</td>
<td>--------------</td>
<td>-------------</td>
<td>-------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Relevance</strong></td>
<td>The response is completely relevant to PV solar panels, uses information gained during the research (includes explicit evidence in the response) and presents multiple (more than three) relevant sources which were used to support the response.</td>
<td>The response is adequately relevant to PV solar panels, includes information gained during the research (includes explicit evidence in the notes) and presents one or two somewhat relevant sources.</td>
<td>The response is partially relevant to PV solar panels, alludes to information gained during the research (includes implicit evidence in either the response or notes) and may use one or two source(s)</td>
<td>The response is irrelevant to PV solar panels, is vaguely or not at all related to information gained during the research, and have no evidence about using sources</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Validity</strong></td>
<td>The response integrates question and justification logically into a coherent argumentative perspective, develops claims supported by more than one idea or single fact, and uses information easily identified as credible. (Mostly include (80% or more): .edu, .gov, .org for nonprofit, etc.)</td>
<td>The response relates question and justification to a similar argumentative perspective, includes claims using more than a single fact, and uses information mostly identified as reliable. (Include (60% or more): .edu, .gov, .org for nonprofit, etc)</td>
<td>The response includes question and justification that fit loosely together and so may not maintain an argumentative perspective, has claims that are not supported well by facts, and may misuse some unreliable and/or biased information. (Somewhat include (40% or more): .edu, .gov, .org for nonprofit, etc.)</td>
<td>The response includes a question and justification but they do not fit together or are superficial, presents few or no claims supported by facts, and offers no or little evidence that reliable information was used. (NOT include: .edu, .gov, .org for nonprofit, etc.) (Mostly include (80% or more): personal blogs, commercials, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td>The response reflects important and critical issues in PV solar panels, promotes critical thinking, and provokes discussion including a wide variety of facts and perspectives, which would result in heightened understanding. The response has two or more <strong>explicit</strong> evidence that they take into account both positive and negative sides of PV solar panels. The response has two or more <strong>explicit</strong> evidence that they take into account that a certain perspective can be biased by the stakeholders.</td>
<td>The response reflects somewhat important or critical issues in PV solar panels, might promote critical thinking, and might provoke discussion including some different facts and perspectives, which would result in increased understanding. The response has an <strong>explicit</strong> evidence that they take into account both positive and negative sides of PV solar panels. The response has an <strong>explicit</strong> evidence that they take into account that a certain perspective can be biased by the stakeholders.</td>
<td>The response reflects issues in PV solar panels that might not be important and critical, might not promote critical thinking, and is likely to provoke brief discussion at best, which might result in shallow understanding. The response has <strong>implicit</strong> evidence that they take into account both positive and negative sides of PV solar panels. The response has <strong>implicit</strong> evidence that they take into account that a certain perspective can be biased by the stakeholders.</td>
<td>The response fails to reflect important or critical issues in PV solar panels, would not promote critical thinking, and would not provoke discussion that would increase understanding. The response has <strong>no</strong> evidence that they take into account both positive and negative sides of PV solar panels. The response has <strong>no</strong> evidence that they take into account that a certain perspective can be biased by the stakeholders.</td>
<td></td>
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</table>
Appendix E: Handout for the Training Session

Training Session

How to think out loud

In the part of this training session, you will be encouraged to talk out loud about what you are thinking and doing while you engage in a task. First, you will watch a short video example of a man thinking out loud while solving a puzzle. After watching the video, you will practice thinking out loud with a partner about a different puzzle. Let’s watch the video and then you can let me know if you have any questions before you begin your practice think-aloud.

Think-Aloud Example #1 - The nine dot puzzle

You will try to solve the puzzle below while talking out loud with a partner about what you are thinking. One person will think out loud (like Kevin did in the video) and the other person will listen.

Your challenge is to draw four straight lines that go through the middle of all of the dots without taking your pencil off the paper. You can start from any position and each line should start where the last line finishes.
Think-Aloud Example #2 - House Puzzle

Now you will switch roles with your partner. The person who was the listener for Example #1 will now have a chance to think-aloud.

Please try to solve this puzzle while talking out loud about what you are thinking. Your challenge is to draw this shape without tracing the same line twice and without taking your pencil off the paper.
How to create a compelling question and justification

After researching on the Internet, you will develop a compelling question that sparks a discussion on the topic and you will justify why your question is compelling. To generate a compelling question and justification, you need to keep in mind three criteria: relevance, validity, and significance.

In order to make this clearer, we would like to go over an example to illustrate how to write a compelling question and justification and then let you practice.

**Relevant**: Is your compelling question and justification connected to the topic you were given and the Internet sources you read?

A relevant question and justification would have a strong connection to the topic and the Internet sources you read. An irrelevant question and justification would not be related to the topic and the Internet sources you read.

**Valid**: Is there a strong and logical connection between your question and your justification?

Does your justification include both a claim and related evidence (details)?

A valid question and justification would show a strong and logical connection between what you are asking and the claim and evidence you provided to justify it. An invalid question and justification would not provide sufficient evidence or would provide evidence that is not related to the claim or the question you are asking.

**Significance**: Will your question produce thinking about different perspectives and provoke extended discussion related to the topic?

A significant question and justification would encourage conversation about the topic with diverse perspectives connected to the real world. An insignificant question and justification would not encourage diverse perspectives on the topic or would not be connected to the real world.
GUIDED PRACTICE - COMPELLING QUESTIONS AND JUSTIFICATIONS
ABOUT VAPING

**Question.** How can we help young people to think critically about e-cigarette advertisements so that they can accurately assess the dangers of using these products?

**Justification.** Adolescents are regularly exposed to e-cigarette advertisements through TV, magazines, the Internet, and other media. According to Kantar Media, Juul Labs, one of the biggest e-cigarette companies, spent $104 million in the first half of 2019 for television, digital and print advertising in the U.S. Children can be especially vulnerable to this flood of advertising because many commercials target them using themes appealing to adolescents: tempting flavors, rebelliousness, and sex appeal. Adolescents who have never smoked may be attracted by e-cigarette advertisements instead of recognizing the danger of nicotine addiction. In addition, people in the commercials are often portrayed as charismatic and stylish. These ads may mislead adolescents to think that people who are charismatic and stylish use e-cigarettes so that using e-cigarettes themselves will make them charismatic and stylish people. This is an advertising strategy that tobacco companies used for decades to hook consumers on cigarettes. Adolescents should be taught to think critically about who makes advertisements and who really benefits from them.

<table>
<thead>
<tr>
<th>Relevance</th>
<th>Validity</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A <em>relevan</em> question and justification would have a strong connection to the topic and the Internet sources you read.</td>
<td>An <em>irrelevant</em> question and justification would not be related to the topic and the Internet sources you read.</td>
<td>A <em>valid</em> question and justification would show a strong and logical connection between what you are asking and the claim and evidence you provided to justify it. An <em>invalid</em> question and justification would not provide sufficient evidence or would provide evidence that was not related to the claim or the question you were asking.</td>
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**Example 1. Vaping (Electronic cigarettes)**

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252
1. With your partner, talk about the quality of the question and justification given below based on three criteria: relevance, validity, significance.

2. Then in the boxes below, write a + or – to show if that criteria is present in the question and justification. Please circle or underline information that supports your reasoning.

**Question.** What are the issues in vaping?

**Justification?** Vaping is a controversial issue. This topic is not just a health issue, but there are also political and economic considerations. Some people argue that vaping is less harmful and safer than smoking. Others insist that vaping is not safe and it can cause several side effects. Therefore, knowing about what issues are being debated about vaping is the first thing we can do to understand the topic more deeply.

<table>
<thead>
<tr>
<th>Relevance</th>
<th>Validity</th>
<th>Significance</th>
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**Relevant:** Is the compelling question and justification you provided connected to the topic you were given and the Internet sources you read? **Validity:** Is there a strong and logical connection between the question and the justification? Does your justification include both a claim and related evidence (details)? **Significance:** Will your question produce thinking about different perspectives and provoke extended discussion related to the topic?

A relevant question and justification would have a strong connection to the topic and the Internet sources you read. An irrelevant question and justification would not be related to the topic and the Internet sources you read.

A valid question and justification would show a strong and logical connection between what you are asking and the claim and evidence you provided to justify it. An invalid question and justification would not provide sufficient evidence or would provide evidence that was not related to the claim or the question you were asking.

A significant question and justification would encourage conversation about the topic with diverse perspectives connected to the real world. An insignificant question and justification would not encourage diverse perspectives on the topic or would not be connected to the real world.
Example 2. Vaping (Electronic cigarettes)

1. With your partner, talk about the quality of the question and justification given below based on three criteria: relevance, validity, significance.

2. Then in the boxes below, write a + or – to show if that criteria is present in the question and justification. Please circle or underline information that supports your reasoning.

**Question.** Is it justifiable to tax e-cigarettes at levels comparable with traditional tobacco products?

**Justification.** Currently, several states have passed legislation that would raise the tax rate on e-cigarettes to match the tax rates on traditional tobacco. The reason why this question is important is that we can think deeply about the rationale for high taxation on traditional cigarettes and determine if it is still valid for e-cigarettes while answering this question. The main reason why the cigarette tax has been set high is to reduce consumer demand for tobacco, thereby reducing the illness and death caused by tobacco. According to a report from the U.S. Department of Health and Human Services, approximately 480,000 Americans die from tobacco-related illnesses. But some insist that tobacco helps people’s mental health. In addition, they argue, more people die from car accidents than from tobacco.

Recently, however, many organizations, such as the National Academies of Science, Engineering, and Medicine, and the American Cancer Society, acknowledged that e-cigarettes are much safer than traditional cigarettes and they play an important role in tobacco harm reduction. According to a New Republic magazine, one milligram of nicotine costs about 15.7 cents for traditional cigarettes and 10 cents for electronic cigarettes. In addition, e-cigarettes are easy to access and can be used indoors so people prefer e-cigarettes. Therefore, this question provides a good opportunity for us to have a broad and in-depth approach to the issues surrounding e-cigarettes.

### Relevance vs. Validity vs. Significance

<table>
<thead>
<tr>
<th>Relevance</th>
<th>Validity</th>
<th>Significance</th>
</tr>
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</table>

**Relevant:** Is the compelling question and justification you provided connected to the topic you read. An *irrelevant* question and justification would have a strong connection to the topic and the Internet sources you read. An *irrelevant* question and justification
were given and the Internet sources you read?

would not be related to the topic and the Internet sources you read.

| Valid: Is there a strong and logical connection between the question and the justification? Does your justification include both a claim and related evidence (details)? | A **valid** question and justification would show a strong and logical connection between what you are asking and the claim and evidence you provided to justify it. An **invalid** question and justification would not provide sufficient evidence or would provide evidence that was not related to the claim or the question you were asking. |
| Significance: Will your question produce thinking about different perspectives and provoke extended discussion related to the topic? | A **significant** question and justification would encourage conversation about the topic with diverse perspectives connected to the real world. An **insignificant** question and justification would not encourage diverse perspectives on the topic or would not be connected to the real world. |
Appendix F: Handout for the Task Session (Individual)

Reminder 1

How to think out loud (Individual)
As you work on the task, you will be asked to think (and talk) out loud about your process.

- There is no wrong way to talk out loud!
- You can talk out loud about what you are thinking (and what makes you think that) or about what you are doing (and why you are doing it).
- Please use your cursor to follow along while you are reading – that will help me see what you are looking at on the screen.
- We will remind you to keep talking if you stop thinking out loud for more than 10 seconds.

Let’s practice!
Let’s practice how to think and talk out loud! You will conduct a three minute Internet research task about vaping!

Directions for your three minute practice think aloud.
- Speak as loudly and clearly as possible.
- Stay close to the laptop so the microphone can record your voice.
- Please use your cursor to follow along while you are reading.
- Use your mouse cursor when you want to point out a certain part on the screen.
- Use the Google doc file you are given to type a note.
- Focus on the process of locating relevant sources and learning something new about vaping.
Reminder 2

How to create a compelling question and justification

To generate a compelling question and the justification, you need to keep in mind three criteria: relevance, validity, and significance.

Relevance: Is your compelling question and justification connected to the topic you were given and the Internet sources you read?

- A relevant question and justification would have a strong connection to the topic and the Internet sources you read.
- An irrelevant question and justification would not be related to the topic and the Internet sources you read.

Validity: Is there a strong and logical connection between your question and your justification? / Does your justification include both a claim and related evidence?

- A valid question and justification would show a strong and logical connection between what you are asking and the claim and evidence you provided to justify it.
- An invalid question and justification would not provide sufficient evidence or would provide evidence that is not related to the claim or the question you are asking.

Significance: Will your question produce thinking about different perspectives and provoke extended discussion related to the topic?

- A significant question and justification would encourage conversation about the topic with diverse perspectives connected to the real world.
- An insignificant question and justification would not encourage diverse perspectives on the topic or would not be connected to the real world.
Internet Research Task

The goal of your assignment is to use the Internet to create a compelling question that stimulates rich classroom discussion about photovoltaic (PV) solar panels. To do this, you will navigate the Internet to find multiple useful sources, read them carefully, and create a compelling question and justification based on your reading.

Directions for completing the Internet research task

- Speak as loudly and clearly as possible.
- Stay close to the laptop so the microphone can record your voice.
- Please use your cursor to follow along while you are reading.
- Use your mouse cursor when you want to point out a certain part on the screen.
- Use the Google doc file you are given to type your notes.
- Focus on the process of locating relevant sources and learning as much as possible about the topic.

Directions for generating a compelling question and justification

- Speak as loudly and clearly as possible.
- Stay close to the laptop so the microphone can record your voice.
- Use the Google doc file you are given to create your compelling question and justification.
- Focus on the process of generating your compelling question and justification.
- You can use your notes and briefly look back the webpages you found to help with this process.

General directions

- You will only earn participation points in EDC 102 for engaging in this task today. You will not be graded on any part of this task or the answers you provide.
- If things break or don’t work, don’t worry! You will still earn your participation credits.
- When you finish the Internet task, you will complete a follow-up survey.
- Later, after today, you will complete a reflection on your participation; that reflection will be graded by your instructor as part of your EDC 102 grade.
Description of the Internet Research Topic and Task

Due to ever increasing energy demands, maintaining safe and sustainable energy sources continues to be an important issue. As an alternative to fossil fuels, and other alternative energy sources that do not naturally replenish themselves, solar energy has become an important provider of naturally renewable energy. One technique for using solar energy uses photovoltaic (PV) solar panels to convert sunlight directly into electricity. Although this technology has developed and gained popularity over the last several decades, there is increasing discussion among some groups about its relative benefits and drawbacks, including its impact on the environment, impact on public health, the cost of generating electricity, the efficiency of PV cells, and affordability.

Your assignment is to create a compelling question that guides classroom discussion about photovoltaic systems using the Internet. To do this, you will navigate the Internet to find different web sources deemed useful, read the sources carefully, and create a compelling question and justification based on your reading.

Your generated question should foster deeper thinking and discussion about your research topic, which will result in a richer and more complex understanding of the topic. A high-quality question and justification is relevant to the topic, is supported by a variety of information, and is of significant importance.
Appendix G: Handout for the Task Session (Pair)

Reminder 1

How to think out loud (Pair)
As you work on the task, you will be asked to think (and talk) out loud to your partner about your process.

- There is no wrong way to talk out loud!
- You can talk out loud to your partner about what you are thinking (and what makes you think that) or about what you are doing (and why you are doing it).
- Please use your cursor to follow along while you are reading – that will help me see what you are looking at on the screen.
- We will remind you to keep talking if you stop thinking out loud for more than 10 seconds.

Let’s practice!
Let’s practice how to think and talk out loud! You will conduct a three minute Internet research task about vaping!

Directions for your three minute practice think aloud.

- Speak as loudly and clearly as possible.
- Stay close to the laptop so the microphone can record your voice.
- Please use your cursor to follow along while you are reading.
- Use your mouse cursor when you want to point out a certain part on the screen.
- Use the Google doc file you are given to type a note.
- Focus on the process of locating relevant sources and learning something new about vaping.
Reminder 2
How to create a compelling question and justification

To generate a compelling question and the justification, you need to keep in mind three criteria: relevance, validity, and significance.

**Relevance:** Is your compelling question and justification connected to the topic you were given and the Internet sources you read?

- A *relevant* question and justification would have a strong connection to the topic and the Internet sources you read.
- An *irrelevant* question and justification would not be related to the topic and the Internet sources you read.

**Validity:** Is there a strong and logical connection between your question and your justification?

- Does your justification include both a claim and related evidence (details)?

- A *valid* question and justification would show a strong and logical connection between what you are asking and the claim and evidence you provided to justify it.
- An *invalid* question and justification would not provide sufficient evidence or would provide evidence that is not related to the claim or the question you are asking.

**Significance:** Will your question produce thinking about different perspectives and provoke extended discussion related to the topic?

- A *significant* question and justification would encourage conversation about the topic with diverse perspectives connected to the real world.
- An *insignificant* question and justification would not encourage diverse perspectives on the topic or would not be connected to the real world.
Internet Research Task

The goal of your assignment is to work with your partner to use the Internet to create a compelling question that stimulates rich classroom discussion about photovoltaic (PV) solar panels. To do this, you will navigate the Internet to find multiple useful sources, read them carefully, and create a compelling question and justification based on your reading.

Directions for completing the Internet research task

- Speak as loudly and clearly as possible.
- Stay close to the laptop so the microphone can record your voice.
- Please use your cursor to follow along while you are reading.
- Use your mouse cursor when you want to point out a certain part on the screen.
- Use the Google doc file you are given to type your notes.
- Focus on the process of locating relevant sources and learning as much as possible about the topic.

Directions for generating a compelling question and justification

- Speak as loudly and clearly as possible.
- Stay close to the laptop so the microphone can record your voice.
- Use the Google doc file you are given to create your compelling question and justification.
- Focus on the process of generating your compelling question and justification.
- You can use your notes and briefly look back the webpages you found to help with this process.
- You will make a joint outcome - Talk with your partner to reach agreement on what your compelling question and justification will be.

General directions

- You will only earn participation points in EDC 102 for engaging in this task today. You will not be graded on any part of this task or the answers you provide.
- If things break or don’t work, don’t worry! You will still earn your participation credits.
- When you finish the Internet task, you will complete a follow-up survey.
- Later, after today, you will complete a reflection on your participation; that reflection will be graded by your instructor as part of your EDC 102 grade.
Description of the Internet Research Topic and Task

Due to ever increasing energy demands, maintaining safe and sustainable energy sources continues to be an important issue. As an alternative to fossil fuels, and other alternative energy sources that do not naturally replenish themselves, solar energy has become an important provider of naturally renewable energy. One technique for using solar energy uses photovoltaic (PV) solar panels to convert sunlight directly into electricity. Although this technology has developed and gained popularity over the last several decades, there is increasing discussion among some groups about its relative benefits and drawbacks, including its impact on the environment, impact on public health, the cost of generating electricity, the efficiency of PV cells, and affordability.

Your assignment is to create a compelling question that guides classroom discussion about photovoltaic systems using the Internet. To do this, you will navigate the Internet to find different web sources deemed useful, read the sources carefully, and create a compelling question and justification based on your reading. You will make ONE question and justification as an outcome of pair work. Talk with your partner to reach an agreement on what your compelling question and justification will be.

Your generated question should foster deeper thinking and discussion about your research topic, which will result in a richer and more complex understanding of the topic. A high-quality question and justification is relevant to the topic, is supported by a variety of information, and is of significant importance.
Appendix H: Google Doc

Note & Outcome

Name: (  )

1. Please use this space for taking notes about what you learned about the topic.

Notes:

2. Please use this space to generate a compelling question and its justification on the topic (PV solar panels)

<table>
<thead>
<tr>
<th>Question:</th>
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<tbody>
<tr>
<td>Justification:</td>
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