Technology-Based Intervention in L2 Reading Comprehension: Toward Digital Scaffolding

by

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A thesis submitted in conformity with the requirements for the degree of Doctor of Philosophy
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Abstract

Technology has created abundant resources and opportunities for language learners to enhance their reading comprehension competencies. Despite an increase in access to written input, reading comprehension has stayed challenging for many, including language learners. Digital scaffolding can contribute to improving reading comprehension skills for L2 learners. Motivated by such a premise, in this study, alternative implementations of digital scaffolding have been tested in an English as a Foreign language (EFL) context and their impacts assessed. Two digital scaffolding interventions were examined including contextual conversation (COC) and adjunct questions (AJQ). A total of 172 EFL students read two reading passages in three different conditions: COC, AJQ, and control. In COC, a conversation focused on the primary concepts of the text was included prior to reading the passages. In AJQ, six questions were inserted within each of the reading passages. The assessments included Pathfinder Network Scaling, multiple-choice questions, fill in the Blank test, familiarity question, and interest question. The results of the study provided evidence that both of the treatments were effective with statistically significant differences between the COC group and controls on most measures and statistically
significant differences between the AJQ group and controls on some measures. Furthermore, Pathfinder scaling revealed both treatment groups displayed a better organization of the passage according to the graph representation. However, the COC group displayed fewer missing links than the AJQ group and the network properties of the COC were more similar to the network properties identified by experts for both passages. Additionally, the study measured the participants’ overall use of reading strategies using the Survey of Reading Strategies (SORs). The findings suggested a medium use of reading strategies by the study participants.

The overall findings suggest that although both interventions have potential, COC may be a more potent strategy than AJQ for EFL learners. In light of the fact that reading is a critical skill determining school success, the present study contributes to the evidence that digital scaffolding can successfully be implemented as an intervention to improve learners’ reading comprehension.
Dedication

This thesis is dedicated to my partner, Masoud Mohseni,

who showed me the beauty of scientific thinking.
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Chapter 1
Introduction

1 Overview of the Issues

1.1 Statement of the Problem

According to the International Telecommunication Union (ITU), the United Nations specialized agency for information and technologies, and the United Nations Educational, Scientific and Cultural Organization (UNESCO), it is estimated that 50% of the global population (approximately 3.8 billion people) will have access to the Internet by the end of 2018 and 75% by 2025 (ITU and UNESCO, 2018). The report further stressed that “[t]he transformative potential of technology and the Fourth Industrial Revolution (illustrated in the rise of diverse digital players) are shifting the focus of our modern economy from physical assets to the ability of harvest and utilize information and insight” (ITU and UNESCO, 2018, p. 6). New technologies including artificial intelligence (AI), big data analytics, gaming, and cloud computing have significant relevance to the future of education. The Fourth Industrial Revolution has the potential to transform many aspects of our lives including education. One of the core aspects of education is reading literacy which can be assisted or fundamentally transformed by rapid advances in digital technology.

Reading ability is an important predictor of excellence in school and succeeding in the workplace. Reading literacy is defined as, “understanding, using, evaluating, reflecting on and engaging with texts, in order to achieve one’s goals, to develop one’s knowledge and potential, and to participate in society” (Organisation for Economic Co-operation and Development [OECD], 2016a, p.11).

Seventy percent of the youth population (ages 15-24 years old) were reported to be taking advantage of Internet access compared to 48% of the total population (ITU, 2017). Therefore, more access to written materials may translate to an improvement in reading literacy, especially among youth populations with a higher percentage of Internet access.

Despite such an increase in access to written input, the reading comprehension of many learners has not improved. For example, according to the latest results published by the Program for
International Student Assessment (PISA), the average reading proficiency of students in OECD countries has not improved since 2000 (OECD, 2016b). PISA is an initiative of OECD member states and provides information every three years on trends in the achievement of OECD country members in surveys of the knowledge and skills of 15-year-old students. In fact, the trajectory of mean reading performance in 42 countries/economies shows that not only do most countries have no significant improvement, some countries such as New Zealand and Sweden show a significant negative trend (for the full report see OECD 2016b).

Research has shown a strong correlation between the amount that students read and their reading achievements (for example, Guthrie, 2004). However, the lack of improvement in reading literacy in OECD countries is raising a question about reliance on access rather than the effectiveness of access to the written input. Motivation, engagement, and metacognition are contributing to the reading achievements (OECD 2016a; See Klauda and Guthrie, 2015, for the definition of motivation and engagement construct). PISA has also studied the effect of engagement on different groups of students indicating that “… engagement and metacognition proved to be robust predictors of reading achievement, mediators of gender or socioeconomic status (OECD, 2010b) and also potential levers to reduce achievement gaps” (OECD, 2016a, p.35). The report showed that students from some countries with low socioeconomic backgrounds, but highly engaged in reading outperformed students from countries with high socioeconomic backgrounds, but poorly engaged in reading. Similarly, boys (with poorer reading comprehension performances as compared to girls) performed better when they were engaged in reading.

Despite the improvements in literacy rates and access to print input, acquiring adequate reading comprehension proficiency remains challenging for many, especially second language learners (L2). Moreover, with so many fast-paced technological changes, educators face challenges in attempting to develop a high level of literacy while engaging with new technologies.

How can educators promote reading engagement and motivate readers for extensive reading in the digital era? In particular, how can educators motivate L2 and EFL (English as a foreign language) readers—even with lower proficiency—to find L2 reading meaningful and engaging? There is considerable promise if educators can constructively integrate concepts and techniques from information technology to shift our pedagogy toward more scalable and adaptable teaching.
Motivated by such a premise, in this thesis, alternative implementations of digital scaffoldings have been tested in an EFL context and their impacts assessed. In the present study, digital scaffolding refers to a variety of digital supports in order to assist a language learner to learn new skills within the zone of proximal development with the goal of moving toward greater self-regulation. At the end of the thesis, a discussion on how such digital scaffolding can lead to more advanced educational systems is provided. Digital scaffolding could be integrated with online recommendation systems, an algorithmic system for predicting future preferences of a user from past choices. Moreover, digital scaffolding can be improved by reinforcement learning, that is a class of machine learning systems that dynamically encourage or steer a user’s decisions on the correct path based on a set of rewards accumulated over a set of previous actions. Incorporating these advanced algorithmic techniques for digital scaffolding could be essential elements for the future personalized learning environments.

1.1.1 Design of the Study
The present study is designed with four general objectives: (a) to improve reading comprehension through enhanced engagement of the readers; (b) to field test simple interventions for potential digital scaffolding; (c) to measure reading comprehension gains with various types of reading comprehension assessments; and (d) to compare reading comprehension strategies used by the participants of the study with other EFL or L2 learners.

To pursue these objectives, two basic interventions were selected to be examined in this study: adjunct questions (AJQ) and contextual conversations (COC). Adjunct questions are questions that were inserted within the passages of one of the interventions. For the other intervention, a conversation was included prior to the participants actually reading the passages.

1.1.2 Research Questions
The specific research questions guiding the studies are:
1. Do adjunct questions facilitate EFL readers in recalling what they have read for potential reading comprehension improvement?
2. Do contextual conversations facilitate EFL readers in recalling what they have read for potential reading comprehension improvement?
3. What kind of reading strategies do EFL college students/adolescents use when reading academic materials in English? Is there any correlation between strategies and performance on the reading comprehension tests used in the present study?

1.1.3 Theoretical Background

It is not always possible to connect experimental studies to a well-established background theory. Hence, the interactive approach in reading comprehension research and theory which posits both bottom-up and top-down influences on reading will guide this study.

This study examines reading comprehension strategies with potential integration for digital scaffolding. One of the strategies used in the present study, contextual conversation, is directly connected to schema theory. The interactive approach along with theoretical background on schema theory will be discussed in Chapter 2. The pathfinder theory was adopted as a theoretical basis for the design of intervention and also as one of the post-intervention assessment strategies. Pathfinder algorithm scaling will be discussed in Chapter 3.

1.1.4 Organization of Dissertation

The first chapter provides an overview of the problems, the scope of the study, and the context of the study. The second chapter presents a literature review. Chapter 3 provides a review of pathfinder algorithm scaling. The fourth chapter details the design and methodology. Chapter 5 presents the results. The sixth chapter is a discussion and conclusion.

The literature on second language (L2) and English as a foreign language (EFL) was used interchangeably in the present study. Although adolescents and adult learners are the target of this study, the literature related to children was reviewed when the related adolescents’ literature was scarce.

In the remainder of this chapter, first, an overview of the technology used for L2 reading comprehension will be reviewed. Next, the English teaching practices in Iran will be discussed. At the end of the chapter, the definition of terms and abbreviations will be presented.
1.2 Technology and Reading Comprehension for L2

In this section, an overview of technology for improving reading comprehension for L2 will be provided. The purpose of this section is not an exhaustive discussion on available/potential technology for supporting L2 reading comprehension. It rather provides an overall view of the type of technologies that are or can be offered to L2/EFL readers.

Technology has created abundant resources and opportunities for language learners. However, technology should not be considered as magic bullet to solve the many challenges that L2 or EFL readers may face. Many technologies may not be effective for the targeted learners. Moreover, many technologies are in their infancies, and it may take years to become available in a typical classroom setting (See Crossley and McNamara, 2017 for review of some of the future adaptive technologies).

Technology can be an effective tool to encourage L2/EFL learners for extensive reading. This can especially be supportive for many second/foreign language learners who are reading lengthy L2 texts that are beyond their ability to read independently. Some digital scaffolding and supports provide opportunities for those readers to adopt important reading strategies and skills, and encouragement for extensive reading.

1.2.1 Digital Scaffolding

The concept of scaffolding, which was introduced by Wood, Bruner, and Ross (1976), refers to a variety of instructional techniques provided by the educator, or more competent peer to assist a learner as he or she is led though the zone of proximal development. The general theoretical concept of zone of proximal development (Vygotsky, 1978) “refers to the gap between what a given child can achieve alone, their potential development as determined by independent problem solving, and what they can achieve through problem solving under adult guidance or in collaboration with more capable peers” (Wood & Wood, 1996, p.5).

In the context this thesis, scaffolding refers to a range of tasks that a learner can perform with the help and guidance of “others” but cannot perform independently. The “others” here implies the guidance from a teacher, a peer, any digital form of tutoring, or any interactive digital system. Thus, technology has the potential to help learners through their zone of proximal development. In other words, digital scaffolds and supports can contribute to improving reading
comprehension skills for those learners. In short, digital scaffolding refers to a variety of digital supports that assist a language learner to develop new skills (e.g., reading) within the zone of proximal development with the goal of moving toward greater self-regulation to complete a given task. In the following, a brief overview of current technologies for L2 reading will be introduced.

1.2.2 Current Technologies for L2 Reading

The technologies that support second language reading development can be generally divided into three different categories (Liaw & English, 2017): (1) Self-developed courses and commercial courseware; (2) Online activities with individual tools and mobile devices that can be considered as a smaller scale of courseware (such as online dictionaries and online gloss activities); (3) Computer-mediated communication which includes features such as chats, chatbots, and emails. Such computer-mediated communication features provide opportunities for cooperative reading among different learners with different cultural backgrounds.

According to Liaw and English, self-developed courses and commercial courseware refer to the design of language learning tools to meet specific needs of L2 learners. These courses can be developed by different educators or developed as a licensed commercial Courseware. These educational materials are diverse and can help a variety of learners improve comprehension of text through different built-in features such as dictionaries, glosses, graphics, hypermedia, and intelligent systems to provide customized feedback.

For example, the e-Lective Language Learning program, created by Cummins (1998), provides extensive reading opportunities for L2 readers through features such as access to L1 dictionaries, cloze procedures with an adjusted level of difficulties, and feedback on the spelling of the words. The efficacy of e-Lective was investigated by comparing electronic and hard-copy environments for supporting vocabulary acquisition (Cummins, Ardestiri, Cohen, 2008). It demonstrated that both e-Lective and hard-copy were equally effective in supporting new vocabulary acquisition but students looked up more vocabulary items in the electronic version.

Another example of learning tools for supporting text analysis is Coh-Metrix Core Text Ease and Readability Assessor (TERA, http://cohmetrix.com). Jackson, Allen, and McNamara (2017) introduced TERA, a text analysis tool for identifying text difficulty (For comparison of Coh-
Metrix and traditional readability formulas, See Crossley, Allen, & McNamara, 2011). The text difficulties were analyzed for specific aspects of language. For example, TERA measured syntactic complexity. Several indices were calculated for syntactic complexity such as main average number of clauses per sentence, the number of words per sentence, and the number of words before the main verb. Other aspects measured included genre, words, referential cohesion (overlaps between words, word stems from one sentence to another), and deep cohesion (how the information components of a text are tied together). TERA also estimated basic grade level which helps educators and teachers to assign a text to a well-matched student for the reading activities (Jackson, Allen, & McNamara, 2017).

Similarly, many licensed or commercial e-books are available such as Oxford Learner’s Bookshelf. In evaluating the Oxford Learners Bookshelf, Woo (2018) included advantages such as accessibility across platforms and operating systems and various features including audio recording, glossaries (with pronunciation recording), and supplementary reading questions.

Finally, Wijekumar, Meyer, and Lei (2017) introduced an Intelligent Tutoring of the Structure Strategy (ITSS) which is a tutoring system for teaching comprehension strategy. The tutoring system supported learners with activities such as scaffolding the selection of the most important elements and supporting comprehension monitoring (e.g., Do I remember the solutions to the problem?). ITSS supported reading comprehension through tasks (e.g., writing a main idea using the pattern for a particular text structure), assessment, and scaffolding feedback (Wijekumar et al., 2017).

Reading comprehension skills are related to other language skills such as writing and speaking. Also, reading comprehension relies on vocabulary and grammar knowledge. Hence, many technologies have been developed to support reading comprehension in conjunction with those relevant skills. Various technologies have also been developed to address the needs of language learners by designing supporting tools for scaffolding, feedbacks, and writing. All of those tools are valuable and useful for developing second language literacy.

However, many language learners are susceptible to distraction and losing engagement when using technologies (Andrade, 2014). This may occur due to lack of adequate language knowledge. Yet, in many instances, the variety of available tools may become counterproductive and create more distraction. Using digital technologies for multi-tasking activities (such as
emailing) resulted in poorer performance for college students and served as a distraction (Wood, Zivcakova, Gentile, Archer, De Pasquale, & Nosko, 2012). Similarly, some multimedia interactive features such as games, animations, or sounds to be activated by clicking on or touching a spot in an illustration were identified to be distractive for storybook reading (Takacs, Swart, & Bus, 2015). Language learners, however, may benefit from the features tailored to their particular needs.

A critical challenge for digital scaffolding is to identify ways of countering distraction issues among language learners. The current study attempts to fill the gap by offering a technological approach to support reading for adult learners that maintains the flow of reading. Part of the rational for this approach is that a reduction in distractions could support extensive reading. Two basic interventions are explored in the current study. First, a contextual conversation (COC) about the reading content to be read is offered prior to reading. The second intervention involves inserting adjunct questions and providing the answers to the questions during reading comprehension. Both of these interventions can be implemented as a digital scaffolding tool both to support reading comprehension and identify ways of providing personalized learning for the targeted readers.

1.3 Context of the Study

1.3.1 English as a Lingua Franca

English as a global language is spoken by approximately 1.75 billion people worldwide (British Council, 2013). In other words, the English language is used by almost a quarter of the world’s population. David Crystal (2003) has noted that “a language achieves a genuinely global status when it develops a special role that is recognized in every country” (p.3). One of the roles of the English language as a global language is its use as the language of science and technology.

The Internet has provided virtually unlimited access to information. This access to information has increased the urgency to improve English language skills as a large proportion of the information on the Internet is accessible through English. In other words, given the rapid pace of technological advancement, the English language may be considered not only as a global language but also it is the lingua franca of international science and international trades. Hence, the necessity to develop English language literacy, particularly for those who learn English as a
foreign language (EFL), has grown. In the following section, the current English language teaching practices in Iran will be briefly reviewed.

1.3.2 English Teaching and Learning in Iran

Borjian (2013) provided a comprehensive description of the social, political and educational challenges of post-revolutionary Iran that have affected English teaching practices in the country. Borjian has divided the post-revolutionary period into four phases: Phase 1: The revolutionary period (1979–1988); Phase 2: The period of reconstruction and privatization (1989–1997), phase 3: The period of global outlook (1997–2005); and Phase 4: Returning to revolutionary roots (2005–Present). The country, however, may have entered a new phase in recent years. Discussion about each phase is beyond the scope of this study. The following review aims at the pedagogical and practical implication of teaching and learning English in Iran with limited references to the historical aspects required to justify any shifts in the current practices. The present review, however, falls mainly into Borjian’s Phase 4.

It is important to know that the state interests play an important role in direction of English language teaching practices in Iran. More specifically, there is “a conflict between the interest of state and some non-state actors on various matters, including borrowing and lending of foreign ideas in education in general, and English education in particular” (Borgian, 2013, p. 158). Such conflicts justify shifts exposed to the foreign language policies and practices in Iran. Although all the educational sectors follow the state’s regulations, the private sector may also develop different English language teaching practices with the goal of satisfying parents’ preferences as well.

Education in Iran is centralized and divided into K-12 education and higher education. The Ministry of Education administers K-12 levels. The Ministry of Science, Research and Technology supervises universities of science, art, and technology. The Ministry of Health and Medical Education oversees medical universities. The K-12, higher education, and private language schools will be discussed separately.

1.3.2.1 K-12

There are both public and private schools at all levels of K-12. Mandatory education starts in first grade. Primary education lasts six years (age 6-12). Secondary education (also called high
school) is divided into lower-secondary and upper secondary. The lower secondary levels last for three years (age 12-15), and upper-secondary also lasts three years (age 15-18).

According to Iran’s Ministry of Education, all students are required to learn a foreign language (English, French, German, Italian, Spanish, or Russian) when they start lower secondary education (Ministry of Education, 2012, p. 144). The English language is predominantly taught in public schools. However, a limited number of private schools in major cities may offer other languages such as French or German as a second foreign language (Private communication with a principal of a private school in Tehran, June 2018).

English language instruction starts at grade 7 in public schools. Teaching English commonly starts at the primary level in private schools. The Ministry of Education recommends private schools start English language instruction after the students have acquired enough competency in their first language (i.e., 2nd or 3rd grades). However, many private schools do not follow the recommendation and start English language instruction as early as the 1st grade. The reason is that early English language instruction is considered one of the most important criteria for many parents to choose a private school for their children (Private communication with a principal of a private school in Tehran, June 2018). Additionally, private schools may utilize more flexible curricula and syllabi. For example, a limited number of private schools in Iran are reported to employ Montessori Method of Education (Akbarzadeh & Solgi, 2015).

In lower secondary levels (middle schools), students receive two weekly hours of instruction in 7th grade; and students receive four weekly hours of instruction in grades 8 and 9 (Ministry of Education, 2013, p. 109). The weekly hours of instruction may vary between 2-3 hours in upper secondary (Ministry of Education, 2013, p. 170). As already mentioned, private schools may have a more flexible syllabus with respect to the hours allocated to teach English or other foreign languages. In this way, students at private school may have access to more authentic materials. For example, the high school that participated in the present study used one of the recent Oxford University Press series (Teen2Teen) as one of the designated textbooks.

The Curriculum and Textbooks Development Office – an organization for educational research and planning of the Ministry of Education in Iran— has offered new textbook series in recent years. For example, the 7th grade textbook was launched in 2013. In the teacher’s guide of the 7th grade book it emphasized that the main purpose of the introduction of the new textbooks was to
implement a communicative approach in teaching English as a foreign language (Khadir Sharbian, et al., 2013, p. 12). The content of the new textbooks is designed in a way to cover different domains such as personal, social, educational and professional (p. 12). Furthermore, each theme focuses on notions, functions, language knowledge and four skills (p. 12). Several studies have been conducted to evaluate the effectiveness of the newly launched textbooks. It has been suggested that the new textbooks are relatively user-friendly for teachers and students with respect to physical appearance, content, and objectives (Salehi & Amini, 2016). Mahdavi and Abdolmanafi-Rokni (2015) found that teachers believe in the authenticity of the new textbooks to reinforce communicative competence in students. However, some educators raised questions with respect to limited writing opportunities, lack of adequate consideration for teaching grammatical structures, and absence of realistic cultural exposures of the new textbooks (Asadi, Kiany, Akbari, & Samar, 2016; Janfeshan & Nosrati, 2014; Salehi & Amini, 2016).

1.3.2.2 Higher Education

English courses in higher education are divided into two subcategories: general English courses and English for Academic Purposes (EAP). The general English courses are mainly designed to improve the four language skills, speaking, listening, reading and writing. By contrast, the EAP courses are targeted to improve English skills required in academic settings in specialized disciplines (e.g., physics and biology). Bachelor degree students are typically required to take three units/courses in general English (3 hours per week) and two EAP courses/units (on average 2 hours per week), depending on their disciplines and their school recommendations.

In contrast with its centralized educational system, there is not a specific definition for EAP practices in Iran’s policymaking documents (Atai, Iranmehr, & Babaei, 2018). For this reason, different universities may offer EAP courses differently in terms of allocated time. The EAP course may be offered from one to four units depending on various disciplines (Atai, Iranmehr, & Babaei, 2018). EAP courses are designed to improve reading comprehension skills and vocabulary knowledge of students in different disciplines. Therefore, EAP courses may pay particular attention to translation skills (Farhady, Sajadi Hezaveh, & Hedayati, 2010). It is reported that more than 200 textbooks have been published for different disciplines under the supervision of the Iranian Ministry of Science, Research, and Technology (Atai, 2006).
Some of the criticism of EAP teaching practices in Iran are related to the limitations of centralized textbooks and pedagogy. Although instructors may utilize various references in their teaching practices (such as peer-reviewed papers from international publications and online references), the centralized textbooks are still predominantly used in many disciplines. The centralized EAP textbooks create several limitations for the students in terms of access to updated resources (Atai, Iranmehr, & Babaei, 2018).

Furthermore, there is no established pedagogy among instructors for teaching EAP courses (Atai, 2006) which is partly related to inconsistency in the selection of EAP course instructors. An EAP instructor may be selected from a specialist of the same disciplines. For example, an EAP course in physics may be taught by a graduate level instructor in physics. Similarly, a general English language instructor may be chosen to teach an EAP course. These two types of course instructors may follow different pedagogical approaches which may minimize the gain from the course for the students. An effective EAP pedagogy in the Iranian context requires an integrated model for EAP teacher education regarding the role of the instructors (Atai, 2006). Also, mastery of reading skills may not be enough for many students, especially at graduate levels. Many students at graduate levels have identified an urgent need for both English reading and speaking skills (Atai & Asadi, 2013). Allocating more instructional hours (Hayati, 2008) is also recommended to maximize gain from EAP courses.

1.3.2.3 English Language Institutes

The English language institutes mainly offer English courses for improving general English skills and preparing for standardized international tests (such as TOEFL and IELTS). A limited number of the institutes may offer other foreign languages such as French and German. There has been a proliferation of language institutes in Iran for the past twenty years and the number of language institutes in major cities in Iran is growing. For example, Kish Language Institutes and Safir Language Academy, have increased their branches in recent years. Kish Language Institutes has reported that it offers courses in 120 branches in Iran (www. Kish-ist.net), and Safir Language Academy has 107 branches in Tehran and 80 branches in other provinces (www. Gosafir.com).

The students choose language institutes to improve their language proficiency for many different reasons. Some of reasons for attending a language institute are exposure to relatively authentic
materials, preparation for international standardized tests such as IELTS and TOEFL, and better career opportunities. The institutes are allowed to select the textbooks, and the instructors mainly select supplemental authentic materials from newspapers or online resources. The English institutes typically choose textbooks from international publishers (Sadeghi & Richards, 2015). For example: the Kish English Institute may be “regarded as the first agent of the ‘internationalization’ of the field of English in Iran, responsible for the importation of communicative language teaching (CLT) together with the British English textbooks Headway and Interchange into the country back in the early 1990s” (Borjian, 2013, p. 145).

Evaluation of the quality of teaching practices in English language institutes in Iran is beyond the scope of this study. The language institutes offering English courses are diverse and include a wide variety of teaching practices. Moreover, there are only a limited number of studies investigating teaching practices in such English language institutes in Iran. For example, the approach to teaching speaking skills in private institutes in Iran has been questioned. It is noted that the teaching of speaking skills offered in such private language institutes often misrepresent the nature of spoken English (Sadeghi & Richards, 2015).

To sum up, considering the minimal time allocated to teaching the English language in public schools combined with limited access to authentic material in general education, such institutes have been relatively successful in supporting their students in improving their language skills. Moreover, many of the institutes successfully assisted their students to pass standardized tests such as IELTS and TOEFL or assisted their students to secure a better career opportunity in the country and/or overseas.

1.4 Definition of Terms and Abbreviations

**Adjunct questions (AJQ):** Adjunct questions are questions added to instructional text. Two types of adjunct questions are: Standard adjunct questions (SA) or typically what question and elaborative interrogation (EI) or why question.

**Competence:** Competence refers to linguistic knowledge, processing skills, and cognitive abilities.
**Contextual conversation (COC):** COC is one of the experimental conditions in the present study. In this condition, a conversation between two characters is included prior to the actual reading passages. This conversation summarizes the main ideas presented in the reading passage.

**Digital Scaffolding:** Digital scaffolding refers to a variety of contextual digital supports designed to assist a language learner to learn new skills (especially reading in the present study) within the zone of proximal development with the goal of moving toward greater self-regulation.

**Elaborative Interrogation (EI):** EI refers to adjunct questions that ask inferential questions or activate background knowledge. Why questions are typically used for this type of adjunct question.

**English Language Learner (ELL):** ELL is a term used predominantly in the US and Canada that refer to individuals who are learning English as an additional language and come from a non-English speaking county.

**English as a foreign language (EFL):** The term EFL refers to learners who learn English as a foreign language in the countries where English is not the first language such as Iran.

**English for Academic Purpose (EAP):** The term EAP in the present thesis refers to English courses taught for scientific or academic purposes. It is a course taught at the university level in Iran in conjunction with general English courses.

**Global Reading Strategies (GLOB):** GLOB refers to a subscale in SORS and MARSI self-report instruments.

**First language (L1):** L1 refers to the first language or mother tongue.

**Second Language (L2):** L2 refers to a language that is not the mother tongue.

**Primary Concept Related Multiple-choice Questions (PCR):** In the present study, PCR refers to the multiple-choice questions that are related to the primary concepts in reading passages. Those concepts are also included in experimental conditions, AJQ and COC.

**Pathfinder Algorithm Scaling:** Pathfinder Algorithm Scaling is a method to identify the interrelationship of concepts within a content domain.
Problem-Solving Strategies (PROB): PROB refers to a subscale in the SORS and MARSI self-report instruments.

Standard Adjunct Questioning (SA): SA refers to the adjunct questions that ask about specific text content. What questions are typically used for this type of adjunct question.

The Survey of Reading Strategies (SORS): SORS refers to the self-report survey developed by Mokhtari and Sheorey (2002) to measure self-perceived strategies L2 learners used when they read academic passages in a second or foreign language.

Support Strategies (SUP): SUP refers to a subscale in the SORS and MARSI self-report instrument.

Target language: Target language is a language that is focus on instruction.
Chapter 2
Review of Literature

2 Introduction

Reading comprehension is an essential component for both academic and career success. Acquiring higher proficiency in reading is challenging for many learners. It typically takes at least five years (Cummins, 1981) for second language (L2) learners to develop reading comprehension skills similar to those of native speakers of the target language. It may be specially challenging for L2 or English as a foreign language (EFL) learners to become skilled readers and use cognitive reading strategies while reading, with an ultimate goal of gaining metacognition (thinking about how we think). To address some of those challenges, the present study attempts to shed some lights on different aspects of textual interventions to facilitate reading comprehension. Two particular reading comprehension interventions were examined in the present study: Contextual conversation and adjunct questioning. This chapter focuses on the research literature related to the experimental conditions of the present study and the theoretical background.

In the beginning of this chapter, the general reading comprehension models and reading comprehension definition will be reviewed. Second, some concepts related to L2 reading such as threshold hypothesis and vocabulary knowledge will be discussed. Third, schema theory and relevant L2 reading strategies studies will be reviewed. Next, studies employing adjunct question interventions in both L1 and L2 contexts will be presented. Finally, the survey of reading comprehension strategies (SORS) (Mokhtari & Shoerey, 2008) and studies that have employed SORS in the EFL contexts will be reviewed. The present study has also utilized SORS.

In the L2 research literature, three general reading comprehension models are discussed: Bottom-up models, top-down models, and interactive models. The bottom-up models of reading characterize the reading process as a series of discrete stages, and each stage advances the input to a higher level (Stanovich, 1980). According to bottom-up models, the reading comprehension process starts from building lower level subskills from smallest linguistics units such as recognizing letters and phonemes and later processing more extensive units such as sentences.
and so on. These models emphasize mechanical aspects of reading comprehension process and decoding skills. The bottom-up models have been criticized for overemphasizing the requirement of building decoding subskills in order to acquire comprehension competency. Additionally, it was criticized for overlooking the role of background knowledge. For example, Samuels and Kamil (1988) argued that because of “the lack of feedback loops in the early bottom-up models, it was difficult to account for sentence-context effects and the role of prior knowledge of text topic as facilitating variables in word recognition and comprehension” (p. 31).

In contrast, top-down models have emphasized the importance of the higher-order stages in reading comprehension. In top-down models, higher-order stages guide the direction of comprehension processing (Samuels & Kamil, 1988). For example, Grabe and Stroller (2013) identified readers’ goals and expectations as the higher stage that direct reading process. Moreover, in top-down models, background knowledge plays an important role. What different top-down models have in common is that fluent readers engage in a hypothesis testing process (Stanovich, 1980). In other words, a reader starts reading a text with a general idea and will continue the text processing to confirm and modify previous expectations which are aligned with his/her background knowledge. The top-down models are also criticized for vagueness in their conceptualization. Grabe and Stroller (2013) argued that in extreme interpretations of the models, “there is a question about what a reader can learn from a text if the reader must first have expectations about all the information in the text” (p. 26).

The interactive model of reading, on the other hand, offers a combination of both bottom-up and top-down views of reading. Reading comprehension occurs as a result of top-down and bottom-up processing. The incoming written data provokes bottom-up processing until it converges to a higher level. Stanovich (1980) argued that interactive models of reading “posit neither a strictly bottom-up not strictly top-down processing, but instead assume that a pattern is synthesized based on information provided simultaneously from several knowledge sources (e.g., feature extraction, orthographic knowledge, lexical knowledge, syntactic knowledge, semantic knowledge)” (p. 35).

Furthermore, due to some fundamental contradictions arising from combining the two views, Grabe and Stroller (2013) suggested a modified interactive model that emphasizes the process of reading from each view with little interference from the other processing levels. For example, a
fluent reader may not necessarily need to activate grammatical knowledge when reading a text. However, if a sentence contains a complex structure, and meaning cannot be extracted, a reader may be required to activate relevant grammatical knowledge.

2.1.1 Reading Comprehension Definition

Emphasizing the complex nature of reading comprehension, Grabe and Stroller (2013) defined four factors for explaining the concept of reading. They include: The purpose of reading (e.g., reading to learn from the texts), processes required for fluent reading (e.g., a linguistic process), components of reading (e.g., lower-level components such as lexical access and higher-level components such as background knowledge use), and model of reading (e.g., Construction-Integration model).

To address some of the factors in the reading comprehension process, Grabe (2014) defines reading comprehension as:

[A]bilities to recognize words rapidly and efficiently, develop and use a very large recognition vocabulary, process sentences in order to build comprehension, engage a range of strategic processes and underlying cognitive skills (e.g., setting goals, changing goals flexibly, monitoring comprehension), interpret meaning in relation to background knowledge, interpret and evaluate texts in line with reader goals and purposes, and process texts fluently over an extended period of time. These processes and knowledge resources allow the reader to generate text comprehension to the level required. (p.8)

In addition, skilled readers build a strong metacognitive awareness. This metacognitive awareness assists them to monitor their reading and demonstrate higher reading competency. Metacognitive awareness refers to, as Baker indicated, “comprehension monitoring, which involves deciding whether or not we understand (evaluations) and taking appropriate steps to correct comprehension problems that are detected (regulated)” (Baker, 2008, p.25).

2.2 Related L2 Key Concepts

Although the general consensus among researchers is that L1 and L2 reading comprehension are related, the relationship between L1 and L2 reading may be conceptualized differently. L2 comprehension is basically reading comprehension which in some ways includes elements of L1
and L2 entanglements. L2 and L1 readers may apply different linguistic resources and supports; however, the question is whether such differences may lead to a specific disadvantage for L2 readers.

This question may be partially answered by one of the influential hypotheses in explaining the language transfer in L2: threshold hypothesis (Cummins, 1976). According to the threshold hypothesis:

“…there may be threshold levels of linguistic competence which bilingual children must attain in their first and second languages both in order to avoid cognitive disadvantages and to allow the potentially beneficial aspects of becoming bilingual to influence cognitive functioning” (Cummins & Swain, 1986, p. 6).

Although the threshold hypothesis was originally proposed in the context of bilingual education, it can be applied to other learners such as EFL. With adequate exposure to a target language, cognitive skills development in any language can be beneficial when a learner is using other languages. Thus, the L2/EFL learners may not be at a specific disadvantage, if they have passed such a threshold.

L2/EFL learners consist of learners with many different characteristics. One important aspect is to distinguish between younger and older L2/EFL learners. Older language learners usually begin second/foreign language acquisition after the first language competency is developed. Perhaps many older L2/EFL learners — with adequate L2 input — have already passed threshold levels of linguistic competence. For this reason, overemphasizing some bottom-up skills may not be required for older L2 learners with adequate L1 literacy skills. Some research studies were conducted to investigate the effect of decoding and vocabulary knowledge in younger children. By reviewing the relevant literature, Grant, Gottardo and Geva (2011) stated that “reading comprehension in younger children is more highly related to decoding, whereas in older children, who are assumed to have mastered basic decoding skills, vocabulary knowledge is more important for reading comprehension” (p. 69).

Even for younger language learners, lower-level of language processing may not be considered the main contributor to possible poor language performance. Geva and Farnia (2012) argued that:
[T]here is research evidence that L2 status, and in particular, underdeveloped L2 skills do not compromise seriously the performance of English language learners (ELLs) on underlying cognitive skills such as phonological awareness, naming speed, verbal working memory, and on word based reading skills such as accurate and fluent word-level reading skills. (p. 1820)

For adult L2/EFL learners with adequate L2 linguistic competency, who are already literate in their first language, the lower-level processing (i.e., decoding) may not fundamentally interrupt reading competency. However, lack of adequate vocabulary knowledge seems to be a predictor of low levels of comprehension for adult L2/EFL readers (Qian, 1999). Geva and her colleagues in extensive studies on school-aged children (for example, Farnia and Geva, 2011; Grant, Gottardo and Geva, 2011) demonstrated that English language learners (ELLs) lag behind English L1 learners in vocabulary knowledge. Similarly, Nassaji (2003) found that lexical knowledge was strongly correlated with L2 reading comprehension among adult ESL learners.

One question may arise from the L2/EFL disadvantage on vocabulary knowledge is what percentage of a text’s vocabulary should readers know to comprehend the text? To answer this question, Laufer attempted to quantify the vocabulary knowledge required for adequate comprehension in a series of studies (for the full review of studies see Laufer, 2013). Laufer (1989) suggested that the knowledge of 95% of the text’s vocabulary (i.e., lexical threshold) was usually required to score adequately on a comprehension text.

Adequate vocabulary knowledge is a particularly important aspect to consider when a study examines reading comprehension. For this reason, this study provided a supplemental vocabulary sheet, with English-Farsi translation equivalents throughout the study to prevent the possible adverse effect of inadequate vocabulary knowledge of the participants in the present study. In this way, it is attempted to ensure that the possible inadequate vocabulary knowledge neither interfered with the reading flow nor created an extraneous cognitive load. The research literature related to schema theory and background knowledge will be reviewed in the next section.
2.3 Schema Theory for L2 Reading Comprehension and Background Knowledge Interventions

2.3.1 Schema Theory

“A schema is a high-level conceptual structure or framework that organize prior experience and help us to interpret new situations” (Gureckis & Goldstone, 2010, p. 725). We construct knowledge by integrating new information with our schema or background knowledge. For example, we all have schemas of a classroom which may include chairs, tables, and a board. We will use our schema when we enter a new classroom, so that we are not required to remember every element of a classroom (Gureckis & Goldstone). Our schemas help us to organize our perception and interpretation. Similarly, our schemas help us to reduce our cognitive load when we interpret new information.

The credit of introducing the concept of a schema for existing development is given to Bartlett (1932). In conceptualizing schema, the term of active organization is used. “The term active was intended to emphasize what he saw as the constructive character of remembering, which he contrasted with a passive retrieval of fixed and lifeless memories” (as cited in Anderson & Pearson, 1984, p. 39).

It has been argued by Grabe that, “the fact that we know we can call up prior knowledge from long-term memory, and that information seems to be integrated in efficient ways, it is difficult to know exactly how this prior knowledge is called up and used” (Grabe, 1991, p. 384). Although there is some inherent ambiguity in how the prior knowledge is retrieved and activated (also criticism of top-bottom models), scholars have identified various processes in order to characterize how schema theory operates. Comprehending a text occurs when readers have adequate linguistic knowledge, and their background knowledge is activated. For effective comprehension, readers are required to relate the textual information to their background knowledge. “Three assumptions are implicit in schema-theoretic approaches concerning the way knowledge is utilized in comprehension: (1) that schemata are preexisting knowledge structures stored in the mind, (2) that comprehension is a process of mapping the information from the text onto these preexisting knowledge structures, and (3) that knowledge-based processes are predictive and reader-driven” (Nassaji, 2002, p. 444).
Three types of schemata are generally suggested in literature: Content schema, formal schema, and linguistic schema. Carrell (1983a) identified formal and content schemata. Content schemata refer to the background knowledge of the text (e.g., a biology text on ruminant and non-ruminant diet). Formal schemata refer to the organizational structure of the text (Carrel & Eisterhold, 1983) such as different expository rhetorical organization (cause and effect vs. comparison and contrast). Linguistic schemata “provides the most basic threshold for beginning to read a text” (Hedgcock, & Ferris, 2018, p.59) such as decoding process, words, sentences and how all these segments fit together in a sentence.

Our schemas help us to organize our perception and interpretation. Similarly, our schemas help us to reduce our cognitive load when we interpret new information. Since the initiation of the schema theory or background knowledge, scholars have studied different dimensions of the schema theory including reading comprehension. In the following section, studies that used strategies related to background knowledge to support reading comprehension for L2 are reviewed.

2.3.2 Pre-reading Comprehension Interventions for L2/EFL Learners

Researchers have implemented various pre-reading strategies to examine the effectiveness of background knowledge on L2/EFL reading competency. The present study has utilized a pre-reading intervention (a contextual conversation) as one of the experimental conditions. Although no similar studies in the literature employed a contextual conversation associated to the experimental reading passage identical to this study, a handful of studies have been conducted to investigate the effect of different pre-reading strategies in activating background knowledge in support of improving reading comprehension competency. The pre-reading strategies implemented in these studies cover diverse initiatives used to activate background knowledge. Carrell (1988) provided some examples of direct prereading activities such as viewing movies, slides, pictures, field trips, class discussions, plays, role-play activities and text pre-reviewing. Furthermore, key vocabulary may also be presented in different formats such as keyword/key concepts association activities.

Carrell and her colleagues initially examined extensive empirical studies on the role of background knowledge in L1 and L2 readers and reading comprehension competency (See Carrell, Devine, & Eskey, 1988). Carrell (1983b) examined components of background knowledge such as
familiarity, context, and transparency. To clarify each component, Carell defined familiarity (vs. novel) as readers’ familiarity with the content in the text. The participants answered comprehensibility rating questions for the familiarity component. The context (vs. no context) condition referred to “the prior knowledge that the text is about the particular content area” (p. 184). In no context condition, the title and associated picture to the passage were blank. The transparency (vs. opaque) condition was “the degree to which the lexical items in the text reveal what the text is about during processing” (p. 184). Each reading passage was written in two versions of transparent and opaque. For example, an item such as “clothes” (in transparent version) was changed to “things” (in the opaque version).

Two dependent variables were measured in this study. The familiarity question was presented as the first variable. The second variable of the study was the percentage of idea units the participants remembered. For this variable, the participants were required to write down in a recall sheet as many of the ideas they remembered from the passage in L2. Participants in the study were undergraduate students. By examining the two variables in her experimental conditions on the role of background knowledge on L1 and L2 readers, Carrell (1983b) reported that for L1 readers background knowledge plays a significant role in reading, understanding and recalling. However, L2 readers showed no significant effects of background knowledge. Only for advanced L2 learners in this study was the familiarity component significant.

Lee (1986) replicated Carrell’s study for L2 readers with the exception that Lee modified the recall assessment of the study. The subject’s in Lee’s study wrote down recall units in their L1 language (English). The subjects of Lee’s study were undergraduate students who studied Spanish. The result of Lee’s study did not support Carrell’s conclusion. In contrast to Carrell’s study, Lee found a complex interaction between the reader and text for L2 readers and components of background knowledge did not affect comprehension uniformly. In Lee’s study, recall of the familiar topic was enhanced when the learners were provided with a title and picture page. The highest mean was observed when content was provided in a transparent version and the subjects were familiar with the topic. In general, these two studies demonstrated the usefulness of the context, familiarity, and transparency components for L2 learners.

Many empirical studies have compared the effects of various types of pre-reading strategies. Hudson (1982) examined three types of strategies including re-reading the passage, a vocabulary
list, and pictorial cues and questions in a repeated measure design. In the re-reading condition, subjects were given the reading passage followed by a comprehension test and were then asked to read the identical passage again. In the vocabulary list condition, the subject received a list of key vocabulary to study and discuss. In the pictorial cue and question condition, the subject received some pictorial cues followed by cue picture discussion when the participants were asked set of focus questions, and then subjects wrote down some predictions of what they guessed to happen in the story.

Hudson’s (1982) experiment used a repeated measure design using nine graded reading passages. The participants were adult ESL learners from an English language institute. The results of the study indicated that the different types of intervention were differentially effective at the different levels of proficiency—beginning, intermediate and advanced. Subjects in the beginning level performed significantly higher in the pictorial cue condition than in the two other conditions. There were no statistically significant main effects for the advanced level subjects.

Tudor (1988) investigated the effect of two prereading strategies of text summary and pre-question with Belgians college students. The summary group provided a summary or overview of the content of the main sub-topics in each experimental text and the pre-question group responded to a set of questions related to the sub-topics of the experimental text. The treatments were presented in learners’ first language (French) in this study to avoid possible comprehension problems. The subjects were required to read two passages each of 400-500 words. A cloze test was administered at the end of the study, and the subjects were allowed to respond either in English or French. Both pre-reading treatments facilitated comprehension for subjects with lower proficiency but not for the more advanced subjects. Levels of facilitation were similar for the two treatments, with a slight advantage of the summary strategy.

The result of Tudor’s study is similar to Hudson (1982) where the pre-reading interventions were more effective for the subjects with lower language proficiency. Also, in Hudson’s study, the treatments had a greater effect at the beginning level.

Similar to Hudson’s study (1982), Taglieber, Johnson, and Yarbrough (1988) examined the effects of three prereading activities including pictorial context, vocabulary pre-teaching, and pre-questioning and a control group for Brazilian EFL pre-university students. For pictorial context, the subjects were shown three pictures related to the content of the reading passage. In
the vocabulary group, the subjects were taught the key vocabulary of the passage through exposure to written input and class discussion. For pre-questioning, first the participants received a one-sentence oral summary of the reading passage and then they were guided to self-generating questions that addressed their interpretation of the passage. The control group did not receive any pre-reading activity. Four reading passages between 500 and 1,650 words were selected for the study. The assessment included open-ended questions and multiple-choice comprehension questions. Both tests included items addressing text-explicit and text-implicit information.

The results of this study showed that the three prereading activities produced significantly higher multiple-choice scores than the control condition. The results of the open-ended questions were not at the significant level. However, the vocabulary pre-teaching was significantly less effective than the other two strategies. The study also reported that the more effective pre-reading activities, pictorial context, and pre-questioning, may have produced a deeper and more active involvement for the subjects of this study.

Karakaş (2005), compared two conditions of previewing/brainstorming and brainstorming only in EFL Turkish college students. The experiment included three phases: (1) answering some pre-reading questions to identify familiarity with the short stories, (2) reading short stories in two different conditions of previewing/brainstorming and brainstorming only, and (3) a post-test. The post-test included 10 wh- questions. Learners in the brainstorming/previewing condition performed significantly better than the brainstorming only condition in this study.

Mihara (2011) examined the efficacy of two pre-reading strategies including vocabulary pre-teaching and comprehension question presentations among Japanese college students. The vocabulary group received a list of keywords and phrases. The question group received two different types of questions for different reading passages including True/False questions and writing down answers to questions. Mihara found that vocabulary pre-teaching was less effective than the comprehension question intervention for these Japanese students.

Pre-reading activities have also been investigated for Iranian students. Alemi and Ebadi (2010) compared the effect of three combined pre-reading activities with the performance of a control group which received no specific treatment among Iranian university students participating in an English for Specific Purposes (ESP) course. The pre-reading activities included pictorial clues, vocabulary pre-teaching and pre-questioning. The treatment groups received all the pre-reading
activities which were carried out in five sessions. The pictorial cue procedure was similar to Hudson’s (1982) study where the subjects received some pictorial cues followed by picture discussion and then subjects wrote down some predictions of what they guessed had happen in the story. The pre-questioning followed the procedure explained in Taglieber, Johnson, and Yarbrough’s study (1988) where the participants received a one-sentence oral summary of the reading passage and then they were guided to self-generate questions that they thought the passage to be about. The assessment included 20 comprehension questions (the type of the test was not specified). The study concluded that the pre-reading groups performed better than the control group.

Moghaddam and Mahmoudi (2016) studied the effect of three pre-reading activities on high-school EFL learners in Iran in a two-month study (seven sessions). The experimental groups consisted of a pre-reading vocabulary group, a movie-watching group, and a pre-reading summarization group. In the vocabulary group, the new words were elaborated by providing synonyms, definition, and contexts. The movie-watching group watched movies, and then read a passage provided by the teacher, and finally engaged in oral questioning. For the summarization group, the summary of the related passage was written on the board prior to the reading the experimental passage. A pre-test and post-test design was used in Moghaddam and Mahmoudi (2016) study. The result of the post-test indicated that the treatment groups performed better than the control group. However, the movie-watching group outperformed the other two groups.

The studies reviewed in this section demonstrate the effectiveness of pre-reading interventions for L2 text comprehension. Taken together these studies indicate that enhancing readers’ background knowledge by pre-reading interventions is beneficial for L2/EFL readers. However, the results of these studies should be interpreted cautiously. First of all, many studies have used different assessment for measuring reading comprehension. Secondly, some studies utilized only one type of assessment instrument. For example, in the Tudor (1982) and Hudson (1982) studies that demonstrated the effectiveness of pre-reading strategies for subjects with lower language proficiency, Tudor employed a cloze test and Hudson used multiple choice tests. This raises the question of whether the use of just one particular instrument can provide a comprehensive account of the effect of any pre-reading comprehension intervention.
Among the pre-reading comprehension interventions, however, it seems that vocabulary instruction is less effective compared with other pre-reading interventions (Hudson, 1982; Taglieber, Johnson, and Yarbrough, 1988; Mihara, 2011). It can be argued that even when the vocabulary is contextualized, a pre-reading vocabulary strategy may fail to completely activate schemata at a comparable level to other pre-reading interventions such as pre-questioning.

Taglieber, Johnson, and Yarbrough suggested that “[i]t might be that prereading activities that introduce words and concepts from the passage in a more global context are more effective in evoking or building readers' appropriate schemata for a passage than prereading activities that introduce words in isolation” (p. 466). Therefore, a pre-reading intervention which involved more engagement is likely to be more effective for L2/EFL readers. It should be mentioned that in Moghaddam and Mahmoudi's study (2016), the vocabulary group performed slightly better than the summarization group. However, that study was conducted in a two-month intervention and the advantage of vocabulary group may be attributed to a possible deeper engagement of the participants over an extended period of time in that particular study.

Furthermore, interventions may have different effects on L2/EFL readers at different levels of language proficiency. However, mixed results have been reported concerning the correlation between effectiveness of the pre-reading interventions and the level of language proficiencies.

The studies discussed in this section were chosen in part to examine the effect of induced schemata in reading comprehension through some pre-reading interventions—presented prior to a reading comprehension activity. Induced schemata appear to facilitate comprehension by directing the readers’ attention to more relevant textual information. More engaging pre-reading interventions can facilitate a better comprehension. Taken together the studies presented here demonstrate the usefulness of pre-reading interventions for L2/EFL readers.

### 2.4 Adjunct-Question Intervention in Reading Comprehension Studies

The adjunct question intervention refers to inserting some questions within the text in order to facilitate the comprehension of that text. Although, some studies examined the adjunct questions without characterizing the types of questions inserted within the texts, two types of adjunct
questions have been generally examined in the literature. The two types of questions are as follows: (a) adjunct questions that ask about specific concepts stated in the text; (b) adjunct questions that go beyond the text and ask inferential questions and/or activate prior knowledge. The adjunct questions that ask about specific text contents have been referred to by different names in the relevant literature such as: *embedded questions*, *targeted segment*, or *what* questions. To avoid possible confusion with respect to the terms ‘embedded questions’ or ‘targeted segment’, the term *standard adjunct question* (SA) or *what question* is used in the present study. For this type of adjunct question, the learners usually answer *what* questions inserted in the text.

The second type of adjunct questions that typically ask inferential questions is referred to as *elaborative interrogative (EI) or why questions* in the relevant literature. This type of adjunct question is described by Dornisch and Sperling (2008) as, “designed to facilitate the integration of to-be-learned information with prior knowledge” (p. 318). In elaborative interrogative questioning, the learners typically answer the *why* questions in the text. Consistent with the relevant literature, EI is used in the present study to refer to the adjunct questions that ask inferential questions designed to connect with learners’ prior knowledge.

The following are examples of the two types of adjunct questions. Question (a) is inquiring about a specified fact in the second sentence, whereas question (b) is inquiring about inferential information that is not stated explicitly in the text:

*Qinling’s pandas may soon have to find another food source. A new study published in the science journal Nature reports that warming temperatures may cause the loss of most of the region’s bamboo by the end of the century.*

(a) *What causes the loss of bamboo?*

(b) *Why is warming temperature dangerous for pandas?*

The adjunct questions can guide the readers to direct their attention to crucial segments of the text that may result in a better comprehension of the text. The premise underlying the use of adjunct questions is that these types of questions have the potential to promote the construction of a more coherent representation of the text or a better mental representation of the given text,
resulting in greater support for reading comprehension.

The following section includes studies using adjunct questions (summarized in Tables 1 and 2). Since L2 literature on adjunct questions is limited, studies in both L1 and L2 are included in this review. Further, studies using brief texts (e.g., a single sentence) to examine the efficacy of adjunct questions are not included. Additionally, some studies compared other forms of text enhancement strategies to examine the efficacy of adjunct questions (e.g., underlining the topic sentences). The information in regard to the other forms of textual enhancement is included in Table 1. However, this review focused on the types of adjunct questions and their implementation. Other forms of text enhancement strategies are only referred to when needed.

As shown in Table 1, studies employed different modes for presenting or responding to an adjunct question intervention. In adjunct question studies, the readers are typically presented with a passage that they are asked to read. In most of the studies, the readers answered the researcher-developed questions; however, in some studies, readers generated their own questions (See Boudreau, Wood, Willoughby, & Specht, 1999; Dornisch & Sperling, 2008). The questions may be presented with different frequencies (e.g., in every paragraph or in between different sections). Further, the participants were required to provide different types of responses (i.e. write answers to the questions, answer the question verbally, or just think about the questions). In most of the studies, however, participants were required to write down the answers. Some studies requested participants to pause in order to consider the answer to each question (e.g., Brantmeier, Callender, and McDaniel, 2011).

2.4.1 L1 Adjunct Questioning

In a review of the literature, Hamaker (1986), initially argued that adjunct questions that are placed within the text typically improve comprehension for L1 readers, particularly when those embedded questions are similar to, or are related to, the final questions used for assessment. The body of literature on adjunct questioning suggests that this strategy might be a useful addition to students' existing strategic repertoires (e.g., McDaniel & Donnelly, 1996). On the other hand, some studies have reported small effect size (e.g., Woloshyn, Willoughby, Wood, & Pressley, 1990) or non-significant effects (e.g., Dornisch & Sperling, 2008). A summary of adjunct questioning literature in L1 presented in Table 1.
To support the learning outcomes of EI adjunct questions in L1 research, McDaniel and Donnelly (1996) used short texts (one paragraph in length) and reported gains both in factual and inference learning when why adjunct questions were employed as a text enhancement strategy. Seifert (1993), however, used longer expository texts (three passages, each 6 paragraphs) to compare the two conditions of “underlining the topic sentences” and “answering adjunct why questions about topic sentences”. The study reported better recall of the main ideas (but not specific details from the texts) when the students were able to answer adjunct why questions about the main ideas.

Ozgungor and Guthrie (2004) extended the scope of their study by incorporating a Pathfinder algorithm scale (detailed in Chapter 3) to measure the coherence of mental representation in university students when reading a fairly long expository text. The participants who answered the why question identified more accurate inferences and had more coherent mental representations than the group who read the same passage twice for understanding. It was also reported that intervention was more effective for students with less prior knowledge and less interest in the topics as measured through questionnaires prior to reading.

Although these studies demonstrated the effectiveness of EI for L1 readers, other studies reported mixed results for the effectiveness of employing EI. Woloshyn, Willoughby, Wood, and Pressley (1990) used fairly short experimental material (5 texts, each one paragraph) to compare different experimental conditions including “answering why adjunct questions” and “creating an image of factual process” with the control group. Woloshyn et al. (1990) reported that the EI group performed significantly better than the control group. Dornisch, Sperling, and Zeruth (2011) examined different elaborative strategies including: (a) students were provided further examples, (b) students were provided with elaborative interrogation, (c) students generated elaborative interrogations, (d) students generated elaborative interrogations and provided an answer for their questions, and (e) students generated an example related to text content. Dornisch et al. (2011) reported such strategies were beneficial only for the participants who were able to apply an elaborative strategy appropriately. Ramsay, Sperling, and Dornisch (2010) compared the why adjunct question strategy with the main idea strategy, where the participants identified main ideas and found no overall significant differences between those two groups and the control group. However, this study suggested that the reader may benefit more from the why adjunct questioning strategy when they had greater adequate prior knowledge of the text. Thus,
these findings are in contrast with Ozgungor and Guthrie’s (2004) observation that students with less prior knowledge benefitted more from employing the *why* adjunct questions.

Furthermore, identifying the effectiveness of answering *why* questions for factual information in undergraduate materials, Boudreau, Wood, Willoughby, and Specht (1999) compared the manipulation of different types of *why* question conditions (unsupported, supported with pre-underlined main ideas, and supported with pre-underlined main ideas plus author-developed *why* questions) with self-study and repetition conditions. Although, the overall ability to identify the main ideas was poor amongst all the participants in the study, the *why* question group correctly located the main ideas better than the self-study group. Compared to the unsupported *why* question group (no pre-underlined main ideas), the supported *why* question group (with the pre-underlined main idea) demonstrated higher free recall and better multiple-choice test scores.

Studies carried out by McDaniel and Donnelly (1996) and Woloshyn, Willoughby, Wood, and Pressley (1990) used shorter experimental material. It seemed that the *why* adjunct questions demonstrated more potency for shorter texts rather than for longer texts. Further, workloads for conditions in which the participants were required to both generate and respond to self-generated *why* questions seemed less effective than alternative strategies (Boudreau, Wood, Willoughby, & Specht, 1999). Alternatively, it can be argued that excessive cognitive workloads in implementing adjunct question strategy may interrupt the flow of reading and appear to be less effective. Another factor is the quality of elaboration. When the participants were able to answer the *why* questions correctly, the EI was effective (Seifert, 1993).

Studies also examined the efficacy of the standard adjunct questions or typically *what* question. By comparing the *what* (or SA) and the *why* (or EI, elaborative interrogation) questions, Dornisch and Sperling (2008) reported no significant differences between the performance of the groups that read text with either adjunct question types and the performance of the control group (read text only). Similarly, Callender and McDaniel (2007) examined both types of *what* and *why* adjunct questions in university students amongst high and low structure builders (low and high level comprehenders). For determining structure building ability, the Multiple-Media Comprehension Battery (Gernsbacher & Varner, 1988) was administered. Low and high comprehenders were determined by a cutoff procedure where participants who scored in the middle comprehension range were excluded from the study. Only *SA (what)* questions improved
the performance of low-ability readers and assisted them in constructing a more coherent mental representation of the text. In fact, with the *what* adjunct questions, the study reported improvement in low structure builders to the level of high structure builders (Callender & McDaniel, 2007). To justify the ineffectiveness of *why* questions for the low structure builders, it was argued that the low structure builders might not exhaustively use their prior knowledge or alternatively activate too much irrelevant information. Therefore, the *why* questions may not be beneficial for those readers. Neither the *what* (SA) or *why* (EI) questions appeared to improve the test performance amongst the high level comprehenders.
### Table 1

**Summary of Adjunct Question Studies in L1**

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Experimental conditions</th>
<th>Experimental Texts (Type and Length)</th>
<th>Adjunct Question (Q)</th>
<th>Response to Adjunct Q</th>
<th>Post Reading and related Assessments</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woloshyn, Willoughby, Wood, and Pressley (1990), (Exp 1)</td>
<td>Under-graduate university students N=80</td>
<td>(a) <em>Why</em> adjunct Q, (b) Imagery (create an image of the factual relations), (c) Self-reference (explain their decision-making process), and (d) Reading-control (read two times)</td>
<td>Expository (factual information about universities), 5 texts (each a paragraph of 6 sentences)</td>
<td>EI (<em>why</em>)</td>
<td>Written</td>
<td>(Total one Q in every text)</td>
<td>1. Free recall 2. Associate matching Test (Match the facts with the name) 3. Post-test interview: Subjects provided information about test process, rate difficulty, and rate prior knowledge</td>
</tr>
<tr>
<td>Wood, Pressley, and Winne (1990)</td>
<td>Students Grades 4-8</td>
<td>Exp 1: (N=139)</td>
<td>Exp 1: (a) base sentence only, (b) precise elaboration added to the base sentences, (c) imagery (create an image of the factual relations), and (d) EI.</td>
<td>Subjects read and listened to the tape recorder. Exp 1: 18 sentences and 3 pictures presented</td>
<td>EI (<em>why</em>)</td>
<td>Researcher developed and presented both in written and by an audiotape</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exp 2: (N=257)</td>
<td>Exp 2: (a) control, (b) base sentence only, (c) explanatory</td>
<td>Exp 2: 9 stories with 6 statements/sentences in each story and</td>
<td></td>
<td>Exp 2: One after each sentence (Total=18).</td>
<td>Exp 2: 2. Recall of 54 Qs.</td>
</tr>
</tbody>
</table>
elaboration provided, (d) imagery, (e) imaginary plus EI, and (f) EI.

Seifert (1993)  
Student Grades 6-7  
(N=114)

(a) underline-only the main ideas, (b) underline plus elaboration or extra information, (c) generate EI, and (d) EI with study sheet (from the previous session).

Expository (biology),  
Three passages each six paragraphs

 EI (why)

Expository, 12 texts (one paragraph each)

EI (why)

Written  
(Total=54).

Written

1. Motivation rating Q  
(interest, difficulty, efficacy, importance, and effort)

2. Free recall (students failed to complete)

3. Short-answer Q

4. Test of associative memory (connect animals with their characteristics in mixed groups by drawing a line)

Generating EI group demonstrated better performances for main ideas. Underlined with EI group demonstrated better for inferences problems.

McDaniel  
and Donnelly (1996),  
(Exp 2)

University Students  
N=87

(a) Basic texts for control, (b) modified with background material added to basic texts; and (c) why Q added to modified texts

Expository, 12 texts (one paragraph each)

Written  
(Total one Q at the end of each text)

Written

1. Multiple-choice Recall (where the first few words of each text were provided)

2. Recall (where the first few words of each text were provided)

EI improved both factual and inference learning.
<table>
<thead>
<tr>
<th>Study Authors</th>
<th>Undergraduate/Masters Students</th>
<th>Number</th>
<th>Type of EI/SA</th>
<th>Textbook/Pages</th>
<th>Memory Performance Assessment</th>
<th>Behavioral Performance Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boudreau, Wood, Willoughby, and Specht (1999)</td>
<td>Undergraduate university Students</td>
<td>N=100</td>
<td>(a) Unsupported EI, (b) self-study, (c) repetition, (d) EI with preunderlined main ideas, and (e) EI with preunderlined main ideas plus structured why Q</td>
<td>Expository (Psychology textbook), 8 Pages with 3,034 word (23 paragraphs)</td>
<td>EI (why) Written (Total 18)</td>
<td>1. Free recall (for important information) 2. Multiple-choice Q. (targeted main ideas and secondary points)</td>
</tr>
<tr>
<td>Ozgungor and Guthrie (2004)</td>
<td>University Students</td>
<td>N=119</td>
<td>(a) EI, and (b) reading control (read the passage twice)</td>
<td>Expository, 1,481 words</td>
<td>EI (why) Written</td>
<td>1. Prior knowledge and interest Qs (prior to the experiment) 2. Recall (short answer &amp; Matching tasks) 3. Inference (True/false Q) 4. Coherence (Pathfinder scaling algorithm only for consistency)</td>
</tr>
<tr>
<td>Callender and McDaniel (2007)</td>
<td>University students</td>
<td>N=84</td>
<td>(a) EI, (b) SA, and (c) No adjunct questions</td>
<td>Expository (social psychology textbook), 16 Pages</td>
<td>EI (why) &amp; SA (what) Q Written</td>
<td>1. Short answers 2. Multiple-choice 3. Coherence (Relatedness rating with Pathfinder Algorithm scale)</td>
</tr>
<tr>
<td>Experiment</td>
<td>Participants</td>
<td>Conditions</td>
<td>Study</td>
<td>Textual Enhancement Description</td>
<td>Outcomes</td>
<td></td>
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<tr>
<td>------------</td>
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</tr>
<tr>
<td>Dornisch and Sperling (2008)</td>
<td>Undergraduate Students</td>
<td>N=257</td>
<td>Text only (control), text signals (with text headings and key terms in bold print), factual <em>what</em> questions (answer found within one sentence), factual <em>what</em> organization questions (answer found across sentences), and EI</td>
<td>Written and delivered electronically</td>
<td>All textual enhancement conditions outperformed the control group. However, no differences were found on experimental learning outcomes by conditions.</td>
<td></td>
</tr>
<tr>
<td>Ramsay, Sperling, and Dornisch (2010)</td>
<td>University Students</td>
<td>N=353</td>
<td>Main idea identification and restatement, and independent study or control</td>
<td>Written (delivered electronically without supervision)</td>
<td>Neither main idea nor self-generated <em>why</em> was a more effective comprehension strategy.</td>
<td></td>
</tr>
</tbody>
</table>

*Note. EI= elaborative interrogative adjunct question, Exp= experiment, N/K= Not known, SA= standard adjunct question, Q= question,*
2.4.2 L2 Adjunct Questioning

Only a few studies have addressed adjunct questioning strategy for L2 learners. In a series of studies, Brantmeier and her colleagues (Brantmeier, Callender, & McDaniel, 2011; Brantmeier, Callender, & McDaniel, 2013; Brantmeier, Callender, Yu, & McDaniel, 2012; Callender, Medina, & Brantmeier, 2013) reported no significant improvement on different assessment tasks (e.g., free recall and multiple choice test) when adjunct questions were used as textual enhancements with L2 learners. A summary of those studies along with other adjunct questioning studies in L2 is presented in Table 2.

Brantmeier, Callender, and McDaniel (2011) examined the effect of both what and why adjunct questions among English speaking university students (N=97) who studied Spanish as a second language. In this study, the participants were required to read two passages in three different conditions of why adjunct questions, what adjunct questions, and no adjunct question. Two questions were inserted to examine the effect of adjunct questions. The participants were required to pause and consider the answer for adjunct question conditions. The reading comprehension assessments included written free recall (in L1, English) and multiple-choice questions. Brantmeier, Callender, and McDaniel (2011) found no significant differences for both why and what types of adjunct questions for recall and multiple-choice testing, although the recall task was slightly higher for adjunct question conditions compared to control group.

In a follow-up study, Brantmeier, Callender, and McDaniel (2013) further analyzed the effect of gender on adjunct question types for 97 university-level L2 learners. Out of two experimental passages from the field of social psychology (526 and 646 words), male students (N=26) scored statistically higher when what questions were inserted in the first experimental passages. However, the result only observed for recall assessment (not multiple-choice). Similarly, female students (N=71) statistically performed better when why questions were inserted in the text for recall measure on the first experimental passage. The multiple-choice assessment, however, did not reveal any statistically significant differences between the groups. The author argued that the effectiveness of the adjunct questions varied according to the topic and individual learner...
characteristics. These results, however, should be interpreted cautiously because of the relatively small number of male participants in the study.

In another study, Brantmeier, Callender, Yu, and McDaniel (2012) examined the impact of what adjunct questions along with instructions to either “pause and consider” or “pause and write” in relation to the performance of a control group that read the text without any adjunct questions. Experimental materials of this study were the same as in the previous studies reviewed earlier with the exception that a sentence completion reading comprehension assessment was also included. The participants answered to the adjunct question in Chinese (L1), for the pause and write adjunct group and all the assessments were administered in L1. Topic familiarity questions were presented both in L1 and L2. The result of the recall assessment showed that the groups “pause and consider” and the control group performed similarly on recall and sentence completion measures. The group “pause and write” performed significantly lower than the other groups on recall and sentence completion measures. All groups performed similarly on the multiple-question test.

Similarly, Callender, Medina, and Brantmeier (2013) reported that both what and why adjunct questions decreased the recall rate; however, the adjunct questions had no effect on multiple choice assessment tasks. Between the two conditions of “pause and consider” and “pause and write”, the participants scored significantly lower on the recall task on “pause and write” than on the no adjunct question condition (control).

In her dissertation, Loschky (2014) outlined interesting insights into L2 reading comprehension. One of the issues addressed in her study was to examine to what extent ELL students’ ability to make L2 inferences was affected by their L2 proficiency. The participants of the study were 117 university level students. The students’ standardized test scores at the university were used to determine the level of L2 proficiency. The study included both SA (factual/non-inferential what question) and EI (inferential why) interventions. The assessment consisted of multiple-choice questions. Overall, all participants responded more accurately to the non-inferential questions (what questions). Furthermore, lower-proficient ELL students were less likely to make appropriate inferences or perform well in inferential why questions and higher-proficient students showed little difference between question types. However, the result did not show a statistically significant interaction between question type and proficiency.
Finally, Medina, Callender, Brantmeier, and Schultz (2017) studied the efficacy of both SA and EI for L2 readers in relation to working memory capacity among university students. The automated reading Span Task (Unsworth, Redick, Heitz, Broadway, & Engle, 2009) was administered to assess working memory capacity. The assessment measured the automated reading span task which included a three-step process of read, judge, and memorize. For the memory task, the participants read a sentence and judged if the sentences made sense (such as “Andy was stopped by the policeman because he crossed the yellow heaven”). The reading comprehension assessments included written recall, sentence completion, and a multiple-choice question test. The study reported that there was no statistically significant effect of any type of adjunct questions. In other words, none of the assessments provided a statistically significant result for inserting adjunct questions. However, the regression analysis revealed that the effect of adjunct questions depended on the working memory ability of the participants. Hence, the participants with greater working memory found the adjunct question intervention more beneficial.
<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Experimental conditions</th>
<th>Experimental Texts (Type and Length)</th>
<th>Adjunct Question (Q) Type</th>
<th>Presentation &amp; Frequency</th>
<th>Response Mode to Adjunct Q</th>
<th>Post Reading and related Assessments</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brantmeier, Callender, and McDaniel (2011)</td>
<td>English-speaking university students N=97</td>
<td>(a) Why Q, (b) What Q, and (c) No adjunct Qs</td>
<td>Two passages (from social psychology textbook), 526 and 646 words</td>
<td>Why Q (El) &amp; What Q (SA) about main ideas and concepts</td>
<td>Written (L2) (Total 2 Qs, after every two or three paragraphs)</td>
<td>Pause and consider the answer (No writing was required)</td>
<td>1. Written recall (L1, English) 2. Multiple-choice 3. Topic-familiarity questionnaire</td>
<td>There were no significant effects of any type of adjunct questions for recall and multiple-choice tests. Mean recall score for the no adjunct (control) was lower.</td>
</tr>
<tr>
<td>Brantmeier, Callender, Yu, and McDaniel (2012)</td>
<td>Chinese-speaking university students N=185</td>
<td>(a) What Q for pause and consider, (b) What Q for pause and write, and (c) No adjunct questions</td>
<td>Two passages (from social psychology textbook), 526 and 646 words</td>
<td>What Q about main ideas and concepts</td>
<td>Written (L2) (Total 2 Qs, after every two or three paragraphs)</td>
<td>(a) Pause and consider, and (b) pause and write down in L1 (Chinese)</td>
<td>1. Written recall (L1) 2. Sentence completion (L1) 3. Multiple-choice (L1) 4. Topic-familiarity questionnaire (L1 and L2)</td>
<td>Groups a (pause what Q) and c (control) performed similarly on recall and sentence completion measures. Group b (write what Q) performed significantly lower than other groups on recall and sentence completion measures. All groups performed similarly on the multiple-choice test.</td>
</tr>
</tbody>
</table>
| Brantmeier, Callender, and McDaniel (2013) | English speaking university students | N=97  
(L2: Spanish) | (a) Why Q, (b) What Q, and (c) No adjunct questions | Two passages (from social psychology textbook), 526 and 646 words | Why Q & What Q about main ideas and concepts | Written (L2) (Total 2 Qs, after every two or three paragraphs) | Pause and consider the answer (No writing was required) | 1. Written recall (L1, English)  
2. Multiple-choice test  
3. Topic-familiarity questionnaire | There was a significant effect of gender and Q type for recall assessment only for one experimental passage. Females performed better in *why* and male performed better in *what* Q. |
| Callender, Medina, and Brantmeier (2013) | English speaking university students | N=96  
(L2: Spanish) | (a) What Q, (b) What Q, and (c) No adjunct question | Two passages (from social psychology textbook), 526 and 646 words | Why Q & What Q about main ideas and concepts | Written (L2) (Total 2 Qs, after every two or three paragraphs) | Write down in L2 (Spanish) | 1. Free recall (in L1, English)  
2. Multiple choice Q (L1)  
3. Topic-familiarity questionnaire | The why question negatively affect recall (not significantly). There was no effect on multiple-choice questions. |
| Loschky (2014) | ELL University Students | N=117  
(L2: Spanish) | (a) adjunct Q  
(b) control (read 2 times) | Five texts (each one paragraph long) adapted from academic reading materials. | *What* and *why* | Written | Write down | 1. Multiple-choice (factual/non-inferential and inferences) | There was no statistically significant main effect of the adjunct question manipulation on accuracy. Higher proficiency participants showed the larger effect of adjunct question manipulation. |
| Medina, Callender, Brantmeier, and Schultz (2017) | English speaking university students | N=76  
(L2: Spanish) | (a) What Q, (b) Why Q, and (c) No adjunct question | Two texts (expository) | *What* and *why* | Written | Write down | 1. Written recall (L1, English)  
2. Sentence completion  
3. Multiple-choice test  
4. Topic-familiarity and text difficulty questionnaire | No significant effect for any type of adjunct question is reported. However, EI was slightly more facilitative. Adjunct questions were more effective for L2 readers with greater working memory capacities. |

*Note. EI= elaborative interrogative adjunct question, Q= question, SA= standard adjunct question.*
To summarize, L2 research has demonstrated less support for the effectiveness of the adjunct questioning strategy for improving L2 reading comprehension skills compared to L1 studies. This pattern of findings can be interpreted both in terms of designs and assessments of the adjunct questions. In general, any inclusion of adjunct questions which overload readers cognitively appears to fail to facilitate reading comprehension for L2 readers. As such, when inserting more cognitively demanding adjunct questions, L2 readers may allocate more cognitive resources to follow the adjunct question information rather than to comprehend the text. For this reason, EI—which is by nature more cognitively demanding—tends to fail to facilitate reading comprehension for L2 readers. However, EI implementation demonstrated mixed results for L1 readers. EI was more facilitative under conditions where the participants answered adjunct why questions correctly (Seifert, 1993), participants demonstrated more adequate prior knowledge (Ramsay, Sperling, and Dornisch, 2010), and participants were able to apply an elaborative strategy appropriately (Dornisch, Sperling, & Zeruth, 2011). Therefore, it is not unexpected that L2 readers find EI challenging and perform poorly when required to answer why adjunct questions. L2 readers scored significantly less well when required to pause and write down answers to questions (e.g., Brantmeier, Callender, Yu, & McDaniel, 2012). Similarly, when L1 readers were required to generate adjunct questions, the intervention was less effective than when researchers developed the adjunct questions condition (See Boudreau, Wood, Willoughby, & Specht 1999). It is reasonable to argue that any adjunct question design that interrupts the flow of reading appear to be less facilitative for reading comprehension and recall.

The next issue is to what extent the relative effectiveness of adjunct questions in L2 studies is captured through different assessments employed in the research studies. Free recall, multiple-choice questions, and sentence completions were all employed as assessment instruments, with free recall and multiple-choice questions being the most frequent. In L2 studies, the participants were asked to use L1 in free recall assessments. Although the studies reviewed in this chapter have not reported any adverse outcome of using recall assessment in L1, it is possible that translation between L2 and L1 to report the recall negatively affected the performance of participants. Moreover, some participants, especially at college levels, may have developed some test-taking skills. A consequence of these confounding variables is that all the participants in a
study may perform equally well in multiple-choice tests. Therefore, including more assessment tasks may result in a more reliable evaluation of the efficacy of the adjunct question intervention.

To sum up, *why* adjunct questions seem to be a more cognitively demanding strategy. Therefore, they may not be a suitable intervention for EFL/L2 learners. Overall, the literature has not provided strong support for employing *why* adjunct questions for L2 learners. For this reason, this study has not used *why* adjunct question.

However, the rational for adjunct question intervention is to promote a more coherent representation of the text. Although some adjunct question designs appear to have increased workload and consequently resulted in no advantage in improving reading comprehension skills, there have been many promising results that support the effectiveness of SA adjunct question intervention. For example, Callender and McDaniel (2007) demonstrated that SA resulted in a better performance for low-ability readers, elevating their performance beyond what they could accomplish without this kind of support. Similarly, employing adjunct questioning has demonstrated to be effective for students with less prior knowledge and interest (Ozgungor & Guthrie, 2004).

The design of the adjunct question intervention should be tailored to the specific needs of each individual learner. Hence the present study employed standard adjunct questions where the participants were not required to write down the answer to prevent the possible cognitive overloading and interruption of the flow of reading. Furthermore, asking L2 readers pause and think about the answer of an adjunct question may not sufficiently support reading comprehension for L2 readers. Hence, this study provided an answer to each adjunct question after the reader was provided with a short opportunity to think about the question. Finally, the present study included the Pathfinder Network Scaling to measure the gain from the text along with other reading comprehension assessments including multiple-choice test and fill in the blank tests.

### 2.5 Metacognitive Self-report Instruments of Reading Strategies: MARSI and SORS

In this section, an overview of Mokhtari and his colleges’ instruments to measure L1 and L2 reading comprehension strategies will be discussed (Mokhtari & Reichard’s, 2002; and Mokhtari
The present study utilized the Mokhtari’s instruments to measure reading comprehension strategies used by the participants (See Chapter 4).

Reading comprehension strategies are intended to enhance reading comprehension competencies. According to Graesser (2007) “[a] reading comprehension strategy is a cognitive or behavioral action that is enacted under particular contextual conditions, with the goal of improving some aspect of comprehension” (p.6). In the relevant literature, there is a distinction between reading skills and reading strategies. “Reading strategies are deliberate, goal-oriented attempts to control and modify the reader’s efforts to decode text, understand words, and construct meaning out of text” (Afflerbach, Pearson, & Paris, 2008, p. 15). In contrast to reading strategies, “reading skills operate without the reader’s deliberate control or conscious awareness” (p. 15).

Take into account the deliberate and goal-oriented aspects of reading strategies, Mokhtari and his colleagues developed some instruments to identify the type of strategies readers employ to comprehend academic texts. Mokhtari and Reichard’s (2002) developed the Metacognitive-Awareness of Reading Strategies Inventory (MARS), which was first utilized for native speakers in the US. The Survey of Reading Strategies (SORS) was adapted by Mokhtari and Sheorey for L2 learners (See Appendix I).

Both SORS and MARS consist of 30 items with a 5-point Likert scale (1 means that “I never or almost never do this” and 5 means that “I always or almost always do this”). There are three broad subscales of reading strategies including: a) Global Reading Strategies (GLOB subscale, 13 items), b) Problem-Solving Strategies (PROB subscale, 8 items), and c) support strategies (SUP subscale, 9 items). GLOB strategies “represented a set of reading strategies oriented toward a global analysis of text” (Mokhtari & Reichard, 2002, p. 252). An example of this subscale is “I have a purpose in mind when I read.” PROB strategies address strategies for solving problems when text becomes difficult to read such as “I try to get back on track when I lose concentration.” SUP strategies refer to using outside reference materials, taking notes, and other practical strategies such as “I take notes while reading to help me understand what I read” (Mokhtari & Reichard, 2002).

The adaptation of SORS from MARS consisted of the following adjustment for second language learners: 1) redefining wording to make the items more comprehensible to ESL students for minor modification in five items (for example, I preview the text changed into I take
an overall view of the text); 2) changing two items in the support subscale: two items of “I summarize what I read to reflect on important information in the text” and “I discuss what I read with others to check my understanding.” changed to “When reading, I translate from English into my native language.” and “When reading, I think about information in both English and my mother tongue.” The rest of the 23 items were identical in SORS and MARSI.

Following Oxford and Burry-Stock (1995) for general language learning strategy usage, Mokhtari and his colleagues suggested the same benchmarks of three ranges of mean defined as: High (mean=3.5 or higher), Medium (mean=2.5 – 3.4), and Low (mean=2.4 or lower). The studies reviewed in the following section used this benchmark.

2.5.1 SORS Review of Literature

In the following, some studies which have employed the SORS instrument for EFL students will be reviewed. Each study included general findings, the comparison of the different subscales and overall means, and the most preferred strategies. Furthermore, the comparison of the most preferred strategies across the studies will be presented in Table 3. The mean of the strategies reported in each study will be discussed in accordance with the defined benchmark as High (mean=3.5 or higher), Medium (mean=2.5 – 3.4), and Low (mean=2.4 or lower).

Sheorey and Baboczky (2008) examined the perception of Hungarian college students about the types of reading strategies they reported using SORS. 545 Hungarian students participated in this study. The major modification that was applied to the standard SORS (Mokhtari & Sheorey, 2002) was to use a 6-point Likert scale rather than the 5-point scale.

The reported means of the strategies for the three categories are GLOB (M=3.83, SD=.62), PROB (M=4.00, SD=.77), SUP (M=4.03, SD=.70), and overall (M=3.95, SD=.57). The mean in this study is based on a 6-point Likert scale, thereby slightly higher than other studies. Therefore, the SORS scale was modified for this study as High (mean=4.5 or higher), Medium or moderate (mean=3.00 – 4.49), and Low (mean=2.99 or lower). According to the modified scale, the Hungarian students used or perceived the reading comprehension strategies in the moderate range. They show a preference for SUP and SORS followed by GLOB.
The three most favored strategies were PROB8 (While reading, if I don't understand something, I read it again), GLOB7 (I look at tables, figures, and pictures in the text to understand the text better), and GLOB13 (I look at the title before reading the text to get a hint about its content).

Sheorey, Kamimura, and Freiermuth (2008) reported a study on 237 Japanese students using SORS self-report questionnaire. Several modifications were applied to the SORS version used in this study including modifying wording of some statements and increasing the number of statements from 30 to 35. It further translated to Japanese. The reported mean strategies for the three categories were GLOB (M=3.04), PROB (M=3.06), SUP (M=2.64), and overall (M=2.91). The study indicates a moderate overall use or awareness of reading strategies according to the general criteria defined earlier. The most used subscale for Japanese students was PROB. The three most favored strategies were GLOB6 (I look at pictures, tables, etc. (if any), to better understand the text), GLOB10 (I look at the title before reading a text to get a hint about the content), and PROB8 (When the text becomes difficult, I pay close attention to it).

Jafari and Shokrpour (2012) examined the perception of Iranian university students about the types of reading strategies they report using SORS. 81 Iranian students from different disciplines participated in this study. The SORS version used in this study was translated into Farsi without any further modification. The reported strategies for the three categories were GLOB (M=3.24, SD=.32), PROB (M=3.14, SD=.53), SUP (M=3.72, SD=.37), and overall (M=3.36, SD=.25). Jafari and Shokrpour’s study reported an overall medium use of the strategies. The most used subscale for Iranian students in this study was SUP followed by GLOB. The three most favored strategies were SUP13 (Using reference materials e.g., dictionary), SUP30 (Thinking about information in both English and mother tongue), and SUP22 (Going back and forth in text to find relationship among ideas).

Finally, Tavakoli (2014) used the SORS instrument for Iranian students without further modification. The participants consisted of 100 undergraduate EFL majors. The reported strategies for the three categories were GLOB (M=2.91, SD=1.22), PROB (M=2.37, SD=.93), SUP (M=3.26, SD=.86), and overall (M=2.51, SD=1.00). The study demonstrated an overall medium usage of the strategies. The most used subscale for Iranian students in this study was SUB followed by GLOB. The three most favored strategies were GLOB1 (I have a purpose in
mind when I read), GLOB3 (I think about what I know to help me understand what I read), and GLOB4 (I take an overall view of the text to see what it is about before reading it).

Tavakoli (2014) also examined the relationship between employing reading strategies and reading comprehension achievements. Pearson correlation analysis was run to examine whether the participants’ overall use of metacognitive strategies was correlated with their English reading comprehension scores. The results indicated that there was a strong positive correlation between reported metacognitive awareness of reading strategies and reading comprehension achievement.

Table 3
Most favorable Strategies across EFL Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Top Five Strategies</th>
</tr>
</thead>
</table>
| Sheorey and Baboczky (2008)* | When text become difficult, I re-read it to increase my understanding. (PROB25)
I use tables, figures, and pictures in text to increase my understanding. (GLOB15)
I take an overall view of the text to see what it is about before reading it. (GLOB4)
I go back and forth in the text to find relationships among ideas in it. (SUP22)
I underline or circle important information in the text to help me remember it. (SUP10) |
| Sheorey, Kamimura, and Freiermuth (2008)* | I use tables, figures, and pictures in text to increase my understanding. (GLOB15)
I take an overall view of the text to see what it is about before reading it. (GLOB4)
When the text becomes difficult, I pay closer attention to what I am reading. (PROB14)
I use reference materials (e.g., a dictionary) to help me understand what I read. (SUP13)
I think about what I know to help me understand what I read. (GLOB3) |
| Jafari and Shokrpour (2012)* | I use reference materials (e.g., a dictionary) to help me understand what I read. (SUP13)
When reading, I think about information in both English and my mother tongue. (SUP30)
I go back and forth in the text to find relationships among ideas in it. (SUP22)
I check my information when I come across new information. (GLOB23)
When reading, I translate from English into my native language. (SUP29) |
Tavakoli (2014)  I have a purpose in mind when I read (GLOB1)
I think about what I know to help me understand what I read (GLOB3)
I take an overall view of the text to see what it is about before reading it (GLOB4)
I try to picture or visualize information to help remember what I read (PROB19)
When text becomes difficult, I read aloud to help me understand what I read (SUB5)

Note. For all items, the equivalents to the standard subscale SORS item numbers are provided in the table. * Those studies modified some of the statements. However, in the table, the equivalent of each item according to the standard version is included.

As shown in Table 1, EFL readers in the studies used or reported different perceived reading strategies based on the itemized analysis. Some of the most used strategies were from the Global Reading Strategies subscale GLOB4 (I take an overall view of the text to see what it is about before reading it.), and GLOB3 (I think about what I know to help me understand what I read.).

Also, from the support strategy subscales, some of strategies used more frequently included SUP13 (I use reference materials—e.g., dictionary—to help me understand what I am reading.), and SUB22 (I go back and forth in the text to find relationship among ideas in it.). For the subscale of Problem-Solving Strategies, PROB25 (While reading, if I don’t understand something, I read it again.), PROB19 (I try to picture or visualize information to help remember what I read.), and PROB14 (When the text becomes difficult, I pay close attention to it.) were reported.

In summary, it is important for language learners to be aware of strategies proficient readers use when reading academic materials. Both the SORS and MARSI instruments provide valuable insight into students’ reported use of reading strategies. It is important to compare different EFL/ESL learners in order to find a possible trend in using any particular subscales. Such studies will be helpful to further assist the L2 learners to identify those strategies they need to improve their reading comprehension competencies.

In Chapter 2, research literature related to the present study has been reviewed. Based on a modified interactive model of the reading process that emphasizes the importance of both bottom-up and top-down strategies, reading comprehension was defined as involving many
different factors such as a purpose in reading. Furthermore, research studies related to the two interventions used in the present study (a pre-reading intervention and adjunct questions) were reviewed. Finally, an instrument to measure perceived reading comprehension strategies was discussed. The next chapter describes the Pathfinder Network Scaling, which were used as one of the assessment tools in the present study.
Chapter 3
Pathfinder Network Scaling

3 Introduction

In this chapter, Pathfinder Network Scaling will be introduced. Pathfinder Networking Scale was used as one of the post-reading assessments along with other reading comprehension assessments. Pathfinder is a method to identify the interrelationship between concepts within a content domain by creating networks. These networks demonstrate organization of knowledge within a particular domain based on data extracted from rating the concepts. The present study uses pathfinder network scaling as a measure of structural knowledge. In this chapter, Pathfinder Network concepts, Pathfinder-based assessment, and an overview of studies used pathfinder in reading comprehension assessments for adjunct questions are reviewed.

3.1 Pathfinder Network Scaling Concepts

Pathfinder Network (PN) Scaling is a technique to estimate the proximity between concepts in order to create the network of the interrelationship of the concepts within a content domain. Developed by Roger Schvaneveldt, PN Scaling has been used as a form of knowledge representation in different disciplines (Schvaneveldt, Durso, & Dearholt, 1989). For example, disciplines such as computer science, health care, and education have used the technique in order to represent the knowledge organization (e.g., for students and experts) or as a tool to assess knowledge organizations of the students. In the present study, PN Scaling used as a tool to compare knowledge structure on the reading comprehension passages between the experts (here the average network of the author and another expert1) and the students (participants in the study). The assumption of PN scaling is that when the individuals rate some concepts, a network can be created based on the rating of those concepts. Such a network can reflect the mental organization of the knowledge of individuals.

1 Second expert is a physicist with research experience in graphical models and complex networks.
The Pathfinder Network theory is based on graph theory. A graph consists of nodes and links and networks are derived using relatedness ratings. PN Scaling is a procedure based on the estimation of the distance between pairs of entities (concepts). In this representation, each entity or concept in the set will be denoted by a node in the network, and each link within the network has a weight which is determined by the distance between the two entities/concepts that are linked (Dearholt & Schvaneveldt, 1990). Pathfinder uses two parameters for calculating the proximities: q-parameter and r-parameter.

The q-parameter constrains the number of indirect proximities examined in generating the network. The r-parameter defines the metric used for computing the distance of paths. Both of the parameters have the effect of decreasing the number of links in the network as their values are increased. The network with the minimum number of links is obtained when \( q = n-1 \) and \( r = \infty \), i.e., Pathfinder Network Scaling \((n-1, \infty)\). With ordinal data, the r-parameter should be infinity. Other values of r require data measured on a ratio scale. This level of measurement is difficult to achieve, so usually r should be set to infinity. The q-parameter can be set to the value that yields the desired number of links in the network. As q decreases, links may be added to the network. Figure 1 depicts the expert rating of concepts of the first experimental passage \((q=n-1, r=\infty)\).

![Diagram of Pathfinder Network](image)

**Figure 1.** The expert’s Pathfinder Network. The Network was created using Java application for the first experimental passage.

In the next section, assessment based in Pathfinder Network Scaling was reviewed by using Java implementation of the Pathfinder software (JPathfinder).
3.2 Assessments via Pathfinder Networking Scales

The assessments and knowledge representations of Pathfinder Network are calculated by using a publicly available software application called JPathfinder. JPathfinder, developed by Roger Schvaneveldt (https://interlinkinc.net), is a Java implementation to create data from proximity data. Figure 2 depicts a snapshot of JPathfinder interface. There are different functions in JPathfinder.

Since several steps need to be completed in order to obtain the Pathfinder Network Scaling for different measures, a summary of the whole process was provided in Figure 2. The process started with identifying terms for each experimental passage. In the present study, the experts (the researcher and another expert) identified the keyword of each experimental passage. Based on the keywords, the pairs set were listed. The number of pairs were identified from the formula \( n(n-1)/2 \). The number of pairs for the present study was 28 for each passage (based on eight keywords for each passage). Next, both students and the experts rated the pair sets of terms or keywords from 1 to 7, where 1 was standing for least related and 7 for most related. The rating
could be done directly in any software that generated a matrix. For the present study, the rating was acquired separately as part of the post-reading assessments.

Then, all the rating data was entered manually into another publicly available software, JRate (https://interlinkinc.net), to create the matrix of ratings. Table 4 represents the matrix created based on the expert rating of the first experimental passage. The reason for using JRate was that a matrix needed to be created in order to run JPathfinder for any Pathfinder Scaling analysis. From this step data can be analyzed via JPathfinder software.

As shown in Figure 3, PN data were generated based on the created matrices. Basically, two types of data can be derived in JPathfinder: individual network property or comparison with other networks. The individual measures that were included are as follows: coherence, network properties, and network. Coherence is generated by “Get Proximity info”. Network structure is generated by “Display Network”. Network properties are generated by “Net Properties” function. All of those measures are acquired based on individual network matrix. However, the software provided tools to create the mean and median of network properties. Therefore, the property network of any group and network presentation of a group were derived for some of the analysis. Similarity measures were generated when two networks were compared. Similarity is generated by “Network Similarity” function. Similarly, the comparisons could be between two individual-generated networks or a comparison of a particular property of an individual network with mean or median of property of all the networks generated by group.
Figure 3. The flowchart of the steps in generating data from JPathfinder. Proximity data is generated by JRate. Based on the generated matrices, two types of data can be derived: individual network property or comparison with other networks.
Each of the measures is reviewed in the following sections. Further, parameters q and r have already been defined. The present study analyzed the data for the measures of coherence, similarity, network properties, and network structure.

### 3.2.1 Coherence

Coherence was calculated by using the JPathfinder for each participant. The coherence can be computed by the function “Get proximity info” (See Figure 3). The coherence measure basically represents average consistency between the pairwise relatedness within each proximity set for each participant. For example, if concept A is related to concept B (i.e., rating score of 6) and concept B is related to concept C (i.e., rating score of 6), when rating the concepts of A and C, a comparable rating should be allocated for rating the comparison of those two concepts.

Coherence is measured by correlating the proximities between all the pairs with indirect measures (Pathfinder Quick Guide). The higher the coherence (maximum 1), the more consistent is the pairwise comparison. If a participant fails to compare consistently the pair of concepts, he or she receives a low coherence value. Very low coherence values (less than 0.15) may indicate low comprehension because a participant failed to generate consistent data (Pathfinder Quick Guide).
For example, two networks were compared between the expert (coherence = 0.954) and two participants in Figure 4. A participant’s network with low coherence (C=0.002) and a participant with high coherence (C=0.931) is depicted.

*Figure 4. Comparison of Pathfinder networks of the Expert (right) and a participant with low coherence (left) and a participant with high coherence (center) for the geology passage.*

### 3.2.2 Similarity

Similarity was estimated by using JPathfinder when two different networks (or between a group of participants) are compared. Similarity can be computed by the function “Network Similarity” (See Figure 3). Network similarity is basically a measure of how two networks or two sets of networks are similar. Network similarity values range from 0 to 1. Two networks that share no links yield a similarity value of 0. Two identical networks yield a similarity of 1.

Figure 5 compared an expert network with a participant with very low similarity to the expert network (S= 0.111).
Figure 5. Comparison of networks between the expert (right) and a participant (left) when the networks' similarity is low. The similarity between the two networks is $S= 0.111$.

Figures 6 compared an expert network with a participant with high similarity to the expert network. The similarity calculated between the two networks was $S=0.857$

Figure 6. Comparison of networks between the expert (right) and a participant (left) when the network’s similarity is high. The similarity between the two networks is $S=0.857$.

3.2.3 Network Properties

The network property is a feature on JPathfinder software based on some concepts from graph theory. The network properties can be computed by the function “Net Properties” (See Figure 3). Three complementary notations for the core/central concept in each knowledge graph can be considered: (a) Maximum Degree, (b) Minimum Eccentricity (denoted by Center in JPathfinder), and (c) Minimum Mean-distance (denoted by Median in JPathfinder). Maximum degree refers to the concept(s) that comprise the largest number of links in a network. Minimum eccentricity refers to the concept/node that comprises the maximum number of (direct or indirect) links between that node and all other nodes in the network (this is related to the notation of chemical distance in physical sciences). In other words, a minimum eccentric concept is located near the center of a network with minimal distance to all other nodes/concepts at the boundary of the graph. A minimum mean-distance refers to a node that has minimum mean distance to all other nodes in the network. It refers to the average distance (number of direct or indirect links) that is required to cover the entire graph.
It should be mentioned that depending on the characteristic of a network, it is possible that only one node in a network qualifies as the central based on all of the three alternative definitions. However, in many (inhomogeneous) graphs different nodes would be considered central depending on whether one employs Maximum Degree, Minimum Eccentricity, and Minimum Mean-distance as the notation of centrality. In complex network theory, Maximum Degree is considered as the center or “hub” for graphs in particular in scale-free networks in which degree connectivity of graphs satisfies a power-law distribution (Barabási, 2009).

3.2.4 Network Structure

Network Structure was compared for the networks generated by JPathfinder software. The network structures are generated by the “Display Network” function in JPathfinder (See Figure 3). After generating the network, the visual presentation of the networks can be compared. This analysis identified any wrong associations and missing links. Wrong association refers to the connection of two terms when they are not related. The missing link refers to lower degree of connectivity between two terms when compared with an expert’s network.

The present study compared the expert network with the median of each study group. The median can be generated by the “average proximity” function.

3.3 A review of studies employed the Pathfinder Network Scaling in reading comprehension for adjunct questions

The Pathfinder Networks Scales have been applied in studies in different disciplines. For example, it has been used to measure structural knowledge by computing relationships between concepts in different disciplines such as computer science, nursing, and pilot training (See https://interlinkinc.net for a list of references in different disciplines).

In particular, two studies in the literature have used Pathfinder Networks Scales in the context of adjunct-question intervention: Ozgungor and Guthrie (2004) and Callender and McDaniel (2007). Both studies, however, computed the coherence, one of the measures explained in the previous section which quantifies the consistency of rating by a participant within a data set. The higher the coherence, the higher the consistency in an entry data. In general, high coherence could be a predictor for more coherent mental representation and better reading comprehension.
However, it is possible that a participant might confuse a concept and consistently answer all the ratings with high coherence. For example, in the present study, a participant could consistently interchange the answers to all questions for a ruminant as a non-ruminant. In this situation, the calculated coherence could have been reported high. When such a measure was compared with those of an expert for the similarity measure, it would show low similarity. Therefore, the coherence result needs to be interpreted cautiously. For this reason, similarity should also be calculated where an entry (rating) is compared with an expert reference.

In the present study, both coherence and similarity were calculated. Furthermore, the present study included network structure. Ozgungor and Guthrie (2004) also included visual representation and analyzed the visual representation based on hierarchy and links appropriate to the experimental passages for that study. Finally, the present study included all the network properties. The result of the present study is discussed in detail in chapter five.
Chapter 4
Research Methodology and Design

4 Introduction

The present study examined the effect of text enhancement on reading comprehension among EFL learners. The questions guiding this study were:

1. Do adjunct questions facilitate learners in recalling what they have read for potential reading comprehension improvement for EFL readers?
2. Does contextual conversation facilitate learners in recalling what they have read for potential reading comprehension improvement for EFL readers?
3. What kind of reading strategies do EFL college students/adolescents use when reading academic materials in English? Is there any correlation between strategies and performance on the reading comprehension tests used in the present study?

4.1 Research Design

This study employed an experimental research design with one control group and two treatment groups — contextual conversation (COC) and adjunct question (AJQ). It examined whether textual enhancement in treatment groups—COC and AJQ — has any effect on gaining meaning from the text. The experiment involved the participants reading two passages and answering the follow-up questions under three different conditions with two treatment groups (AJQ and COC) and one control group. The quantitative data in this study was obtained from the post-reading assessments. The assessments included: pathfinder measures (based on the rating of 28 pairs); reading comprehension questions (multiple-choice questions and fill in the blank, each six questions); familiarity and interest questions (a five-item Likert-type scale, each one question); and a reading strategy questionnaire (30 questions) and a background questionnaire.
4.2 Participants and Setting

The participants in the study were all EFL learners from Iran with the following inclusion criteria:

- Live in Iran,
- Have not lived in an English speaking country for more than six months,
- Were able to read and comprehend the first language (Farsi),
- Were 14 years of age and older,
- Demonstrated English language proficiency of lower-intermediate level or higher,
- Have not been accepted or studied at a graduate level within a university.

It should be mentioned that due to the withdrawal of the schools that had originally agreed to participate in the study, the author had to shift the strategy to collect the data with more flexibility in selecting schools. The data was collected from December 2017 to April 2018. The original participant pool included 181 EFL learners (M=86, F=90, Not reported=5). The participants consisted of 9th grade high school students (N=19), first-year students from two different universities (N=121), and university students/graduates from a private English institute and a mountain climbing class (N=41). An informed consent was obtained from all the participants before initiating the study (Appendices A and B).

Five different schools participated in the present study. Except for the mountain climbing school/courses, the participating schools are among the public and private educational sectors that were described in Chapter 1. In the following section, a brief description of participating schools is provided.

1. Mofid High school is one of the schools in the Mofid Educational Complex. The Mofid Educational Complex includes a total of 12 private schools in K-12 education which are mainly located in the capital city of Tehran. As explained in Chapter 1, K-12 education in Iran consists of primary school, the first cycle of high school which is equivalent to
middle school, and the second cycle of high school which is equivalent to high school. To obtain admission to any Mofid school, the students are required to pass an entrance exam under the National Organization Development of Exceptional talents. The participating school in the present study is the first cycle of high school of the Mofid Educational Complex. The school is a school for boys located in Tehran. English is the only foreign language that is taught in school. Other foreign languages such as French were taught in the past in the school. English language instruction starts at age 12. However, most of the families provide extra English instruction in earlier years by sending their children to private English Institutes. The school offers four hours of English instruction per week. Other than the mandatory textbooks of the Ministry of Education, the school offers additional textbooks such as Tenn2Tenn series (Saslow & Ascher, 2014).

2. Allameh Ghotb Ravandi Institute offers mainly classes in foreign languages. The Institute has four different branches in the capital city of Tehran. The Institute has also been collaborating with some other educational and research universities and organizations. In one of the branches, some courses are offered at university levels. Some of the foreign languages that are offered include English, French, German, Italian, and Chinese. Moreover, the Institute offers courses online for many foreign languages. In addition, the Allameh Ghotb Ravandi Institute has been administering several international standardized tests such as the French Evaluation Test for access to Quebec universities (TEFAQ) and Diploma in French Language Studies (Diplôme d'études en langue française or DELF).

In the branch that participated in the present study, English, French, and German languages are offered. There are about 1,200 students enrolled in different levels from beginner to advanced levels. The main course book for English is Top Notch series (Saslow & Ascher, 2015).

3. Islamic Azad University, Karaj branch is one of the branches of Islamic Azad University (IAU). IAU is considered an Iranian semi-private university system with 31 state university branches across Iran and four branches in the UAE, the United Kingdom, Lebanon, and Afghanistan. IAU is one of the largest higher education systems in the
world. The Karaj branch of Islamic Azad University is located 50 km from the capital city of Tehran. The university includes 11 faculties including science, engineering and social science with approximately 35,000 students. Participants in the present study were selected from the Faculty of Persian Literature and Foreign Languages with a major in English language translation. The medium of instruction for the participants in the study is both English and Farsi.

4. The Sharif University of Technology is a public research university in Tehran. The international campus of the university is located in Kish Island, an island in the Persian Gulf. The Sharif University of Technology is considered the nation’s leading university for science and engineering. The university comprises 15 different departments in science and engineering with approximately 10,000 undergraduate and graduate students. The foreign languages offered at the Sharif University include English, French, German, Spanish and Russian. The participants in the present study consisted of first year undergraduate science or engineering students. As explained in the first chapter, two different English courses are offered: general English and English for Academic Purposes (EAP). The general English course emphasizes the four language skills. Inside Reading series (Burgmeier, 2014) is one of the textbooks for the general English courses. For the EAP course, students mainly read and translate peer-reviewed articles related to their majors.

5. Pakoob is a mountain guide company based in Tehran, Iran. The company offers mountaineering and rock-climbing courses and mountain guidance services. The courses are offered at different levels throughout the year for approximately 200 students. The majority of the participants in the courses are university students or university graduate students because the company mainly advertises in universities in Tehran. A limited number of the participants of the present study were from the Pakoob mountaineering and rock-climbing courses.

To satisfy the inclusion criteria concerning the English language proficiency of at least lower-intermediate, the participants were selected from university level, English language classes, and high-school students with minimum low-intermediate English language proficiency. The participants from the universities have all passed Iranian university entrance exam which
includes a test of English as a foreign language. The participants from the private English Institute were selected from the intermediate and upper-intermediate levels. The students from the high school were also selected from intermediate and higher levels. However, in this private high school, students from a classroom were placed in different English language classes based on the level of their proficiencies. Therefore, all of the participants all were in a similar level of proficiency.

The experiment was conducted either in online or pen and paper modes. For the online mode, JotForm (www.jotform.com) was used. JotForm is a scalable software solution to develop online forms. The participants were instructed to read (online or paper-based) two reading passages and then answer the comprehension tests either. The data was collected during instructional classroom time. The participants spent 60-90 minutes to complete the tasks. Each participant received the equivalent of $5 (CAN) in kind for their participation. The participants received their in-kind gifts in different arrangements such as gift cards for books, annual museum subscription, or tickets to music performances. The compensation was coordinated with the instructors according to the policy and preference of each of the schools that participated.

4.3 Experimental Materials

4.3.1 Reading Passages

The experimental reading materials consisted of two expository passages. One passage was about biology. The other passage was about geology (Appendices C and D). The author wrote the experimental reading materials using general science references and Wikipedia\(^2\). Each passage consisted of three paragraphs (See Table 5).

Further, no pictures were included in either of the passages. Pictures were removed from the texts. The rationale for removing pictures is to examine the effect of adjunct questions on comprehension skills and eliminate other possible text enhancement from the design. Furthermore, different types of pictures may contribute to recall of the text in different ways. For example, in identifying the effect of the pictures on comprehension skills, Waddill and McDaniel

\(^2\) A web-based free encyclopedia.
(1992) demonstrated that detailed pictures enhanced the recall for all skill levels. However, relational pictures (integration or organization of several concepts or idea units) enhanced recall of pictured relational information for highly skilled and moderately skilled comprehenders, but not for less skilled comprehenders. Therefore, the inclusion of different types of pictures in the experimental texts may make it difficult to differentiate the effects of adjunct questions as compared to picture enhancement.

Based on eight readability formulas—including a Flesch–Kinkaid reading level — both passages were “fairly difficult” to read. The passages scored equivalent to U.S. average reading grade levels of grade ten or grade eleven. Therefore, the experimental reading passages were comparable regarding the readability and length (www.readabilityformulas.com). The rationale for employing a readability formula was to create a systematic measurement for the estimation of the difficulty of each text. The readability formulas are a mathematical calculation of specific variables within the passages such as word length and sentence length. Some related studies also employed different readability formula. For example, Ramsay, Sperling & Dornisch (2010) utilized a Flesch–Kinkaid reading level. For high school participants, the level of the readability of the passages was discussed with their language teacher. It should be mentioned that those participants passed a special talent test; therefore, their knowledge of English was significantly higher than average high school students in Iran.

Table 5

*Analysis of the Passages Used for Experimental Material*

<table>
<thead>
<tr>
<th>Passage</th>
<th>Readability Grade level</th>
<th>Total number of words</th>
<th>Total Number of sentences</th>
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<tbody>
<tr>
<td>Geology (A)</td>
<td>10&lt;sup&gt;th&lt;/sup&gt; to 11&lt;sup&gt;th&lt;/sup&gt;</td>
<td>505</td>
<td>31</td>
</tr>
<tr>
<td>Biology (B)</td>
<td>10&lt;sup&gt;th&lt;/sup&gt; to 11&lt;sup&gt;th&lt;/sup&gt;</td>
<td>412</td>
<td>27</td>
</tr>
</tbody>
</table>

To prevent the interference of vocabulary knowledge on adequate reading comprehension (See Lexicon threshold in chapter 2), the definition of terms in English within the text was provided. Furthermore, a separate vocabulary sheet with translation of each word to Farsi was provided to
ensure that the lack of vocabulary knowledge would not impede reading comprehension (Appendix E).

4.3.2 Experimental Conditions

The participants were assigned randomly to three different groups. The three groups consisted of two treatment groups and the control group (Control). The treatment groups consisted of a contextual conversation group (COC) and adjunct question group (AJQ).

For all the groups, each paragraph was presented on a separate page. The definitions of terms were provided at the bottom of the page. The same format was used for both the online and paper-based experiment. The control group did not receive any textual enhancement. For the AJQ group, two questions were embedded at the end of each paragraph; one question targeted the primary information of the given paragraph and the second question the secondary information; for a total of six questions included for each passage. The participants were guided to think about the questions and then check the correct answer on the following page. The same procedure was followed for all three paragraphs (Appendix D).

The contextual conversation group (COC), first read a conversation about the passage. The conversation mainly consisted of the primary and secondary information used in constructing questions used in the AJQ group. After reading the conversation, the COC group read each passage (Appendix C). The AJQ and COC supports were designed to provide comparable information to each treatment group. In other words, in both treatments similar primary information was provided for the participants. In the following, a segment from one of the reading passages is provided in order to demonstrate the way the passages were written in a comparable fashion. Here is the first paragraph of passage A on biology:

The African savanna ecosystem is a tropical grassland with warm temperatures year-round. The savanna is characterized by grasses, trees, and contains a diverse community of animals including plant-eaters. Elephants, zebras, giraffes, and wildebeest are all plant-eaters. There is a huge diversity of plant-eaters; but researchers have questioned exactly how so many of them manage to live near each other with such limited access to food resources. New studies on plant-eaters’ diet analysis show that all large African plant-eaters have surprisingly different diets. In other words, different plant-eaters may eat the same plants; however, their diet relies on different parts of plants.
Here is the COC treatment for the first paragraph of the biology passage:

*Imagine Bob and Alice are on a trip in the African Savannah. They see groups of zebras, wildebeests, giraffes, and elephants.*

_**Bob:**_ I don’t see enough food for all of these plant-eaters. They should all be hungry. Are they?

_**Alice:**_ Oh no. They are not. They don’t eat the same food.

_**Bob:**_ NOT THE SAME FOOD? What do you mean? Aren’t they all plant-eaters?

_**Alice:**_ It may seem so. However, plant-eaters have different diets and eat different parts of plants.

_**Bob:**_ Well, I see all giraffes eat leaves, for example. How do they choose to eat different parts of plants?

The participants were guided to “pause and think” after reading each segment in COC condition.

Here is the AJQ for the first paragraph of the biology passage:

1. What characteristics allow plant-eaters to live together peacefully?
2. What do giraffes eat?

In the next page the answers were provided:

1. What characteristics allow plant-eaters to live together peacefully?

   **African plant-eaters have different diets and eat different parts of plants.**

2. What do giraffes eat?

   **Giraffes eat mainly leaves.**

### 4.3.3 Tests and Questionnaires

Following the reading of each passage, the participants completed reading comprehension tests included Pathfinder Network Scaling, multiple-choice questions, fill in the blank questions, familiarity and interest questions (See Table 6, Appendix F). After finishing the two reading passages, the participants completed two questionnaires: Background Questionnaire and Reading Strategy Surveys (Appendices H and I). The Background Questionnaire questions on level of proficiency were used to compare the three groups (AJQ, COC, and the control) on level of English language proficiency.
Table 6

Overview of the Reading Comprehension Tests and Questionnaires

<table>
<thead>
<tr>
<th>Reading Comprehension Related Tests</th>
<th>Final Questionnaires</th>
</tr>
</thead>
<tbody>
<tr>
<td>(administered after each reading passage)</td>
<td>(administered at the end of the session)</td>
</tr>
<tr>
<td>Pathfinder Network Scaling (28 items)</td>
<td>Background Questionnaire</td>
</tr>
<tr>
<td>Multiple Choice Questions (6 questions)</td>
<td>Reading strategies surveys (SORSMARSI)</td>
</tr>
<tr>
<td>Fill in the blank Questions (6 questions)</td>
<td></td>
</tr>
<tr>
<td>Familiarity Question (1 question)</td>
<td></td>
</tr>
<tr>
<td>Interest Question (1 question)</td>
<td></td>
</tr>
</tbody>
</table>

4.3.3.1 Pathfinder Network Scaling

Eight concepts were selected from each passage. All possible pairwise combinations of the eight concepts (n(n-1)/2=28 total pairs) were provided in the answer sheet (Appendix G) for each experimental passage. The participants rated each pair on a 7-point Likert scale from 1 (not at all related) to 7 (extremely related). The participants were presented with an example (the same example as in Braunschweig & Seaman, 2014) to help them to understand how to rate each pair. For example, flying and birds are strongly related, whereas flying and tree are not related (see Appendix G).

Coherence, similarity, network properties, and network structure for each participant were measured through different steps for each reading passage. First, the participants rated 28 pairs on a scale of one to seven. After collecting the relatedness data, it was transferred to the JRate to create the proximity data for each participant (See Chapter 3 for more details). Next, JPathfinder.jar software was applied to create Pathfiner measures and networks.
4.3.3.2 Multiple-choice Questions and Fill in the Blanks

The reading comprehension tests included multiple-choice test and fill in the blank test. The multiple-choice test consisted of six questions. Three out of the six questions (questions 1, 3, and 5) were related to the primary concepts (hereafter Primary Concept Related multiple-choice questions, PCR questions) and three questions were about secondary information (question 2, 4, and 6). The concepts related to the primary information were included in both AJQ and COC treatments. The multiple-choice test included two different analyses. First, the overall score in the test was analyzed. Second, the PCR questions were analyzed. The fill in the blank measure consisted of six questions. Examples of the multiple-choice questions related to the first paragraph of the Biology reading passage are provided below:

1. The reason some African plant-eaters may live together relatively peacefully when searching for food is because
   A. They all eat the same food and there is enough supply of food.
   B. They have different feeding preferences.
   C. They only eat leaves and stems.
   D. They live in different territories.

2. Which of the following best describes zebras’ diet?
   A. Zebras eat mainly leaves.
   B. Zebras eat nutritious plants.
   C. Zebras eat mainly stems.
   D. Zebras eat mainly fruits.

4.3.3.3 Prior Knowledge and Interest Questions

Prior knowledge and interest measures were administered to identify whether the participants had prior knowledge about the passage and interest in the passages they have read. The prior knowledge and interest questions were used to compare familiarity and interest in the reading passages across the three groups of AJQ, COC, and the control. Participants answered two items on a five-item Likert-type scale.
4.3.3.4 Background Questions

The background questionnaire was administered after students completed the two reading comprehension passages (See Appendix H). The questionnaire also included a self-rating English language proficiency scale and other inclusion criteria such as ‘not’ living in an English-speaking country (See section 4.2, participants and setting).

4.3.3.5 Reading Comprehension Strategy

Students’ awareness of reading strategies was investigated by using the Survey of Reading Strategies (SORS) and the Reading Strategies Inventory (MARS). Both SORS and MARS (See Appendix I) are questionnaires developed by Mokhtari and his colleagues. MARS — developed by Mokhtari and Reichard (2002) — was first developed for native speakers in the US. SORS is an adaptation of MARS for ESL students (Mokhtari & Sheorey, 2002).

Both SORS and MARS consist of 30 items with a Likert scale 1 to 5 to measure three broad subscales of reading strategies: a) Global Reading Strategies (GLOB subscale, 13 items), b) Problem-Solving Strategies (PROB subscale, 8 items), and c) Support Strategies (SUP subscale, 9 items). GLOB strategies “represented a set of reading strategies oriented toward a global analysis of text” (Mokhtari & Reichard, 2002, p. 252). An example of this subscale is “I have a purpose in mind when I read.” PROB strategies address strategies for solving problems when text becomes difficult to read such as “I try to get back on track when I lose concentration.” According to Mokhtari and Reichard (2002), SUP strategies refer to using outside reference materials, taking notes, and other practical strategies such as “I take notes while reading to help me understand what I read.”

MARS was initially used for the current study. However, for more accurate item analysis of strategies used by EFL students, SORS was used for the remainder of the study. In total 73% of participants used SORS (detail is provided in Chapter 5).

4.4 Experimental Procedures

Participants either consented verbally or in writing to participate in the study. The study was initially designed to be collected online using JotForm, a scalable software solution to develop online forms (www.jotform.com). The pilot study was also conducted by using JotForm software.
(see next section). Part of the data (27 participants from the high school and the mountain climbing classes) were collected online through JotForm software. However, all the forms were transferred to a paper version due to numerous technical difficulties mainly caused by the latest Internet access and filtering policy in Iran. It should be mentioned that the both online and paper modes had comparable layouts and followed the same procedures in terms of the order of presentation of passages, tests, and controlling of access to the reading passages when administering the following up assessments.

Despite the differences in medium between computer-based and paper-based, a comparable layout was used in both versions. For example, both paper-based and computer-based read the same content on each page. Additionally, in both versions, participants were not allowed access to the reading passages during the tests. All participants had access to the Farsi vocabulary sheet both during reading and testing. Hence, the results of both versions were reported on the same scale.

Participants were asked to read each reading passage and then answer the follow-up reading comprehension questions. The participants were told that following the oral instruction, they were to read and try to understand two short passages. The pathfinder assessment was also explained verbally along with the written instruction. This was done by providing a specific example. This same procedure was followed for both the online and paper versions.

All the participants received the geology passage first. The definitions of the terms were provided in English within the passage. Furthermore, a separate vocabulary sheet in Farsi was provided to all participants. As already mentioned, all the participants had access to the Farsi vocabulary sheet during the reading and assessments. The participants were not allowed access to the reading passage during the follow-up tests.

After reading each passage, the reading booklets were removed. All the groups’ answers to the rating questions (coherence and similarity measurements) were followed by multiple-choice tests and fill in the blank questions (Appendix F). In the online version, the page back control mode was activated for the assessment section and the participants did not have access to the reading passage during the assessment.
At the end of the testing session, the participants answered the interest and familiarity questions (See Table 6). When the participants completed the two passages, they responded to the background questionnaire (Appendix H) and the reading comprehension strategy questionnaire (Appendix I). The participants completed the task in 60-90 minutes.

4.5 Scoring

Pathfinder Network Scaling measures were calculated by using JPathfinder, a publicly available tool (See chapter 3 for more details). Network similarity value ranged from 0 to 1. The maximum coherence (consistency within a set of data) was 1.

For the multiple-choice and fill in the blank tests, one point was awarded for every accurate response. For, the reading comprehension strategy inventory of SORS or MARSI, the average for each subscale of the inventory (GLOB, PROB, and SUP) as well as the overall average were calculated for 30 items. These scores were interpreted using the interpretation guidelines provided by Mokhtari, Sheorey, and Reichard (2008) as the following:

- 3.5 or higher = High
- 2.5-3.4 = Medium
- 2.4 or lower = Low

4.6 Pilot Study

4.6.1 Overview of the Pilot study

A pilot study was conducted to enhance the design of the study and to characterize the potential participants. The pilot study was conducted in May 2017. The participants received the equivalent of $5 (CAN) for their participation in the study. The data was collected from one of the science technology universities in Tehran, Iran. In total, 44 first-year students participated in the study. The participants were all EFL learners with the level of English proficiency of upper intermediate and higher. The participants consisted of two groups: treatment and control.
Two passages were used for the pilot study similar to the present study. However, the treatment group only consisted of the adjunct question group. Two questions were inserted in each paragraph in different positions. The first adjunct question was inserted at the beginning of the paragraph (without providing the answer). The same adjunct questions were repeated at the end of the paragraph followed by the second adjunct question. After the second question, the participant received the correct answer to both questions. Each passage included six adjunct questions for three paragraphs. However, the adjunct questions were designed in the format of yes-no questions. The rationale for the yes-no question was to ask a simple question at each paragraph with the strategy of inserting one question at the beginning of the paragraph for bringing the reader’s attention to the main idea of each paragraph.

4.6.2 Assessment and Preliminary Results of the Pilot Study

The pilot study included 45 relatedness questions for coherence and similarity and eight multiple choice questions. It also included two questions in regard to familiarity with the passage and interest in the passage. After completing the two reading passages, the participants were administered a demographic questionnaire which included a self-assessing question on their level of English proficiency.

The preliminary data analysis showed a slightly higher mean for the treatment group. However, the result was not statically significant.

4.6.3 Modification for the Current Study

The communication with the students who participated in the pilot study raised two concerns in terms of the design. First, the participants argued that the design of the adjunct questions was interrupting the reading flow. Second, the participants complained that the relatedness assessment for rating 45 items was too long for a relatively short passage.

To address the issues raised by the participants in the pilot study, the design of the adjunct questions was changed to avoid any interruption in the reading flow in two ways. First, only two adjunct questions were inserted at the end of each paragraph. Second, the question type was modified to wh-questions to avoid possible interruption that any negative answer to a yes-no question may create. Regarding the extensive list for rating in relatedness questions, I reduced the number of terms to seven to create a total number of 28 pairs.
Question analysis of the multiple question items indicated if the question items were too easy or too difficult. On the basis of this analysis, the question items were modified for more balanced question items. The fill in the blank test was added to the assessment.

Finally, I included a second treatment condition to examine the effect of providing the core concept or main ideas of a text prior to a reading activity. The contextual conversation was included in the present study as a second treatment condition. In this way, I was able to examine the effect of two different textual enhancement conditions in the present study.
Chapter 5
Results

5 Introduction

This chapter provides the results of the statistical analyses used to examine the effects of the two interventions on reading comprehension for EFL learners. As noted previously, the interventions included adjunct question (AJQ) and contextual conversations (COC). Adjunct questions were questions added to instructional text that asked about specific text content. COC consisted of a conversation that was included prior to the actual reading passages. This conversation summarized the main points presented in the reading passage.

The experiment involved the participants reading two passages and answering the follow-up questions under three different conditions with two treatment groups (AJQ and COC) and one control group. The quantitative data in this study was obtained from the post-reading assessments. The assessments included: pathfinder measures (based on the rating of 28 pairs); reading comprehension questions (multiple-choice questions and fill in the blank, each six questions); familiarity and interest questions (a five-item Likert-type scale, each one question); and a reading strategy questionnaire (30 questions) and a background questionnaire.

The current chapter includes: (1) descriptive statistics of the participants; (2) analysis of missing data; (3) analysis of the English language proficiency/level; (4) description of the reading comprehension measurements; (5) result of Pathfinder Network Scaling; and (6) analyses of reading comprehension strategies.

5.1 Descriptive Statistics of Participants

The original sample of participants included 181 EFL learners. The participants were recruited from five different settings. The original sample consisted of high school students ($N=19$), first-year students from two different universities ($N=121$), and university students/graduates from a private English institute and a mountain climbing class ($N=41$).
Nine participants were removed from the original sample, leaving a total sample size of $N=172$ participants. Three of those participants from schools (2) and (4) did not meet the inclusion criteria. One had lived in an English-speaking country for more than six months, and two participants reported having studied at a graduate level at a university. Six participants from schools (1), (2), (4) and (5) were removed due to lack of commitment to complete the tests (for example, choosing one random number to answer all the questions). Table 7 summarizes the characteristics of the participants in the study.

Table 7
Participants’ Characteristics

<table>
<thead>
<tr>
<th>School</th>
<th>N</th>
<th>Age range</th>
<th>Age Mean</th>
<th>University Major</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) High school</td>
<td>17</td>
<td>14-16</td>
<td>14.59</td>
<td>NA</td>
</tr>
<tr>
<td>(2) University A</td>
<td>60</td>
<td>18-39</td>
<td>20.84</td>
<td>English</td>
</tr>
<tr>
<td>(3) University B</td>
<td>57</td>
<td>18-23</td>
<td>19.27</td>
<td>Science and engineering</td>
</tr>
<tr>
<td>(4) Private English Institute</td>
<td>29</td>
<td>18-40</td>
<td>29</td>
<td>Miscellaneous</td>
</tr>
<tr>
<td>(5) Mountain climbing class</td>
<td>9</td>
<td>20-31</td>
<td>24.56</td>
<td>Miscellaneous</td>
</tr>
</tbody>
</table>

Note. N=Number, NA=not applicable

Further, the three groups (COC, AJQ, and control) have been analyzed for the age and gender distribution. Table 8 represents age distribution among the three groups.

Table 8
Participants’ Age Distribution

<table>
<thead>
<tr>
<th></th>
<th>Group A (COC)</th>
<th>Group B (AJQ)</th>
<th>Group C (Control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Maximum</td>
<td>40</td>
<td>38</td>
<td>39</td>
</tr>
</tbody>
</table>
Mean                21.18          20.82          21.60
SD                  5.33           4.84           5.32

Note. N= Number, COC= Contextual conversation, AJQ=Adjunct Question, SD=Standard Deviation

Of the 172 participants in the current study, 90 (52.3%) were female, 79 (41.86%) were male, and for 3 (1.74%) participants gender was not reported. Table 9 represents gender distribution among the three groups.

Table 9
Participants’ Gender Distribution

<table>
<thead>
<tr>
<th></th>
<th>Group A (COC)</th>
<th>Group B (AJQ)</th>
<th>Group C (Control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female N</td>
<td>26</td>
<td>30</td>
<td>34</td>
</tr>
<tr>
<td>Male N</td>
<td>32</td>
<td>23</td>
<td>24</td>
</tr>
<tr>
<td>Not Reported N</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Total N</td>
<td>59</td>
<td>55</td>
<td>58</td>
</tr>
</tbody>
</table>

Note. N= Number, COC= Contextual Conversation, AJQ=Adjunct Question

All of the participants were fluent in Farsi (Persian). Additionally, the language proficiency of the participants in a language other than English was also reported. In total, 38 (22%) reported language proficiency in other languages including: German, French, Russian, Spanish, Chinese, Japanese, Korean and Turkish or Turkic. Turkish is the official language spoken in Turkey. Although some Iranians may be proficient in Turkish, these participants who reported Turkish may have intended to refer to Azari Turkic language — an unofficial language spoken mainly in Northwest of Iran. Both Azari Turkic and Turkish are from the same branch of the Turkic family of language. Also, some participants reported Arabic as the other language they have some
proficiency in. However, Arabic (the language of the Quran) is a mandatory subject for Iranian students to learn. Therefore, Arabic as a third language was not reported in the present study.

5.2 Missing values

The first step in analyzing missing values was to determine the percentage of the missing data and the pattern of missing data. As shown in Table 10, the percentage of missing values across variables in the dataset ranged from 1.1% to 10.5%. There were six variables without missing values and only 4% of the total cells were identified as incomplete when the missing values were analyzed.

Table 10

**Percentage of Missing Data**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Missing N</th>
<th>Missing Percentage</th>
<th>Valid N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>9</td>
<td>5.20%</td>
<td>163</td>
</tr>
<tr>
<td>Gender</td>
<td>3</td>
<td>1.70%</td>
<td>169</td>
</tr>
<tr>
<td>English Proficiency</td>
<td>8</td>
<td>4.70%</td>
<td>164</td>
</tr>
<tr>
<td>Familiarity (First passage)</td>
<td>2</td>
<td>1.20%</td>
<td>170</td>
</tr>
<tr>
<td>Interest (First passage)</td>
<td>3</td>
<td>1.70%</td>
<td>169</td>
</tr>
<tr>
<td>Multiple choice (First passage)</td>
<td>0</td>
<td>0.00%</td>
<td>172</td>
</tr>
<tr>
<td>PCR Questions (First passage)</td>
<td>0</td>
<td>0.00%</td>
<td>172</td>
</tr>
<tr>
<td>Fill in the Blank (First passage)</td>
<td>0</td>
<td>0.00%</td>
<td>172</td>
</tr>
<tr>
<td>Similarity (First passage)</td>
<td>3</td>
<td>1.70%</td>
<td>169</td>
</tr>
<tr>
<td>Coherence (First passage)</td>
<td>3</td>
<td>1.70%</td>
<td>169</td>
</tr>
<tr>
<td>Familiarity (Second passage)</td>
<td>11</td>
<td>6.40%</td>
<td>161</td>
</tr>
<tr>
<td>Interest (Second passage)</td>
<td>11</td>
<td>6.40%</td>
<td>161</td>
</tr>
<tr>
<td>Multiple choice (Second passage)</td>
<td>10</td>
<td>5.80%</td>
<td>162</td>
</tr>
<tr>
<td>PCR Questions (Second passage)</td>
<td>10</td>
<td>5.80%</td>
<td>162</td>
</tr>
</tbody>
</table>
Fill Blank (Second passage)  11  6.40%  161
Similarity (Second passage)  12  7.00%  160
Coherence (Second passage)  12  7.00%  160
Support Strategy  18  10.50%  154
Problem Solving Strategy  18  10.50%  154
Global Strategy  18  10.50%  154
Overall mean Strategy  18  10.50%  154

Note. N=Number

Considering the relatively low percentage of the missing data in this dataset, the imputation method was considered adequate to handle this issue and maximize the sample size used in the analyses. The present study applied regression-based imputation and mean substitution to address the missing values. Multiple imputation is a common practice to create a complete set for missing values. In the case of a small proportion of missing data, a complete cases analysis is recommended (Graham, Cumsille, & Elek-Fisk, 2003).

In this study, the multiple imputations were conducted using SPSSv.25. This software allows for the imputation of missing values by regression models that are appropriate to the type of variable being imputed: linear for more or less continuous variables and logistic for ordinal categorical data. The default setting in SPSS produces five imputed datasets and the average of five is computed for the analysis. It should be noted that multiple imputation is recommended when there is a reasonable number of missing values. Although there is not a percentage of the missing data that became problematic, some scholars suggest that more than 10% of missing data are likely to produce biased imputations (Bennett, 2001). The range of missing values for the present study is within the range of the recommended percentage. The multiple imputations were used for all the variables. However, the multiple imputation was applied with some modification for the reading strategies.

The reading strategy was used to characterize the participants of this study rather than to be included in the core of the statistical analysis. Furthermore, two instruments have used for the
reading strategies (See Chapter 4). A total of 18 participants (10%) were reported missing for both SORS and MARSI. Four participants were also removed from reading strategy analysis because of their lack of commitment in completing the questionnaire such as selection of one or two rating scale for all of 30 questions. All the questionnaires with more than five missing values were reported as the missing value. For any entry that had missing values of less than four items, mean substitution of each category was used. Multiple imputation was applied after including the mean substitution. However, for the descriptive and item analysis of reading strategies the data before multiple imputation was reported. Only for the Pearson Correlation and Spearman Correlation analyses of the reading strategies, was multiple imputation data used.

Finally, for the Pathfinder data, both multiple imputation and mean substitution were used. The entries with more than five missing answers were reported as the missing values. For less than five missing in each entry, the middle scale (i.e., scale four) was entered into JRate. Multiple imputation was applied for the statistical analysis.

5.3 Preliminary Analysis

Two preliminary analyses were conducted to ensure that the three groups (COC, AJQ, and control) did not differ greatly from each other on English language proficiency and age differences.

As explained in chapter four, all the participants in the study were selected from students with English language proficiency of low intermediate and higher levels. The indicator of English language level was acquired through the self-assessment questionnaire. The self-assessment questions on language proficiency ranged from 1 to 4, where 1 stood for the beginner, 2 for intermediate, 3 for upper-intermediate and 4 for advanced. The English proficiency in group A (COC) and group B (AJQ) ranged from 2 to 4, and in group C from 1 to 4. Three participants in group C reported English language proficiency for level 1.

To ensure that the three groups did not differ significantly from each other on English language proficiency, a Fisher’s exact test (FET) on English language proficiency was calculated. FET on English language proficiency was not significant (2-sided) $FET(22) = 21.98$, $p = .213$. The result showed there was not a significant difference between the three groups regarding the level of English language proficiency.
Furthermore, the age differences of the three groups were analyzed. The participants’ age in COC group ranged from 14-40, AJQ group ranged from 14-38, and the control group ranged form 14-39. The one-way ANOVA on age was not statistically significant \( F(2, 169) = 0.28, p = .760 \) in COC group \((M=21.31, SD=5.21)\), AJQ \((M=20.86, SD=4.78)\), and the control \((M=21.57, SD=5.28)\). In other words, the three groups did not differ statistically with respect to their age.

### 5.4 Results of Reading Comprehension Tests

The results of the reading comprehension test for each experimental reading passage will be discussed in a different sub-section. Furthermore, for each passage, the results of the multiple-choice questions and the fill in the blank measure will be presented both individually and as a sum of the two measures.

#### 5.4.1 First Experimental Passage Analysis

##### 5.4.1.1 Preliminary Analysis on Interest and Familiarity

For each reading passage, the participants answered two questions in regard to their interest in the passage and familiarity with the passage. The question was a five item Likert-type scale. The scale was as follows: 1 indicated not at all familiar or not at all interested and 5 for really familiar or very interested.

A Fisher’s exact test (FET) was calculated to compare interest in the first passage across the three groups. FET on interest factor was not significant \( FET(14)=15.78, p=.239 \). The result showed there was not a significant difference between the three groups regarding the level of interest in the first experimental passage. Similarly, two-tailed Fisher’s exact test demonstrated that there was not a significant difference in terms of the familiarity with the first passage across the three groups \( FET(12)= 16.20, p=.116 \).

##### 5.4.1.2 Multiple-choice Questions and Fill in the Blank

The results of the multiple-choice questions and fill in the blank are reported both separately and also as the sum of the two tests for passage one (See Table 11). A one-way analysis of variance (ANOVA) was conducted to evaluate if there was a difference between the three groups in their performances on the two reading comprehension tests. The independent variable represented the three groups (COC, AJQ, and control). The dependent variables were multiple-choice test, PCR
questions, fill in the blank, and sum of multiple-choice and fill in the blank tests. Further, Bonferroni post-hoc analyses were used to determine which pairs of the three group means differed. See Table 11 for the mean and standard deviation summary for the first experimental passage.

Table 11

Summary of Mean and Standard Deviation of Reading Comprehension Tests for Passage One

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group A (COC)</th>
<th>Group B (AJQ)</th>
<th>Group C (Control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple-choice Test</td>
<td>4.71 (1.11)*</td>
<td>4.49 (1.10)</td>
<td>3.98 (1.43)</td>
</tr>
<tr>
<td>PCR Questions</td>
<td>2.63 (0.61)*</td>
<td>2.31 (0.72)</td>
<td>2.09 (0.92)</td>
</tr>
<tr>
<td>Fill-in-the blanks</td>
<td>5.10 (1.56)*</td>
<td>4.82 (1.78)</td>
<td>4.09 (2.11)</td>
</tr>
<tr>
<td>Combined Multiple and Fill-in-</td>
<td>4.91 (1.16)*</td>
<td>4.65 (1.18)*</td>
<td>4.03 (1.56)</td>
</tr>
<tr>
<td>the blanks</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. * = statistically significant; PCR = Primary Concept Related Multiple-choice Questions

An alpha level of .05 was used for all analyses. The one-way ANOVA of multiple-choice test revealed a statistically significant main effect \([F(2, 169) = 5.40, p = .005]\) between Group A and the control group. Post- Hoc comparisons using Bonferroni test revealed that only the mean score for the COC treatment \((M = 4.71, SD = 1.11)\) was significantly higher than the mean for the control group \((M = 3.98, SD = 1.43)\).

The one-way ANOVA of PCR showed a statistically significant main effect \([F(2, 169) = 7.75, p = .001]\). Post- Hoc Bonferroni test showed that only the mean score for the COC treatment \((M = 2.63, SD = 0.61)\) was significantly higher than the mean of the control group \((M = 2.09, SD = 0.92)\).
The one-way ANOVA of fill in the blank test showed a statistically significant main effect \([F(2, 169) = 4.79, p = .009]\). Post Hoc Bonferroni procedure test showed that the mean in COC treatment group (\(M = 5.10, SD = 1.56\)) was significantly higher than the control group (\(M = 4.09, SD = 2.11\)).

Finally, the one-way ANOVA of sum of the multiple-choice and fill in the blank test revealed a statistically significant main effect \([F(2, 169) = 6.81, p = .001]\). Post Hoc comparison using Bonferroni test showed that the mean in both treatment groups COC (\(M = 4.91, SD = 1.16\)) and AJQ (\(M = 4.65, SD = 1.18\)) were significantly higher than the control group (\(M = 4.03, SD = 1.56\)).

5.4.2 Second Experimental Passage Analysis

5.4.2.1 Preliminary Analysis on Interest and Familiarity

As explained for the first passage, the participants answered two questions in regard to their interest and familiarity with the second passage. For each question, the participants answered a five items Likert-type scale question where 1 indicated not at all familiar or not at all interested and 5 for really familiar or very interested.

A Fisher’s exact test (FET) was calculated to compare interest in the second passage across the three groups. FET on interest factor was not significant (2-sided) \(FET (30)=29.76, p=.286\). The result showed there was not a significant difference between the three groups regarding the level of interest in the second experimental passage. Similarly, two-tailed FET demonstrated that there was not a significant difference in terms of the familiarity with the second passage across the three groups \(FET (30)= 25.57, p=.724\).

5.4.2.2 Multiple-choice Questions and Fill in the Blank

Similar to the first experimental passage, the results of multiple-choice questions and fill in the blank are reported both separately and also as the sum of the two tests. A one-way ANOVA was conducted to evaluate if there was a difference between the three groups in their performances on the reading comprehension tests. See Table 12 for the mean and standard deviation summary for the second experimental passage.
Table 12

Summary of Mean and Standard Deviation of Reading Comprehension Tests for Passage Two

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group A (COC)</th>
<th>Group B (AJQ)</th>
<th>Group C (Control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple-choice Test</td>
<td>4.22 (1.65)</td>
<td>4.24 (1.80)</td>
<td>3.64 (1.77)</td>
</tr>
<tr>
<td>PCR Questions</td>
<td><strong>2.36 (0.75)</strong>*</td>
<td><strong>2.24 (0.96)</strong>*</td>
<td>1.77 (0.99)</td>
</tr>
<tr>
<td>Fill-in-the blanks</td>
<td><strong>4.98 (1.47)</strong>*</td>
<td><strong>4.65 (1.84)</strong>*</td>
<td>3.74 (2.26)</td>
</tr>
<tr>
<td>Combined Multiple and</td>
<td>4.34 (1.50)</td>
<td>4.42 (1.73)</td>
<td>3.79 (1.93)</td>
</tr>
<tr>
<td>Fill-in-the blanks</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. *=statistically significant; PCR= Primary Concept Related Multiple-choice Questions

An alpha level of .05 was used for all analyses. The one-way ANOVA of multiple-choice test was not statistically significant \(F(2, 169) = 2.20, p = .113\). In other words, the three groups did not differ significantly for the multiple-choice test.

The one-way ANOVA of PCR showed a statistically significant main effect \(F(2, 169) = 6.72, p = .002\). A Post-Hoc Bonferroni test showed that both mean scores for the COC treatments \(M = 2.36, SD = 0.75\) and AJQ treatment \(M = 2.24, SD = 0.96\) were significantly higher than those for the control group \(M = 1.77, SD = 0.99\). Also, there was not a statistically significant difference between the two experimental treatments.

The one-way ANOVA fill in the blank also revealed a statistically significant main effect \(F(2, 169) = 6.80, p = .001\). A Post-Hoc Bonferroni test showed that both mean scores for both treatments, COC \(M = 4.98, SD = 1.47\) and AJQ \(M = 4.65, SD = 1.84\), were significantly higher than ones for the control group \(M = 3.74, SD = 2.26\). Finally, the one-way ANOVA of the combined multiple-choice and fill-in-the-blank tests was not statistically significant \(F(2, 169) = 2.30, p = .103\).
5.5 Result of Pathfinder Networking Scale Analysis

Each experimental passage was analyzed separately for the pathfinder measures (See Chapter 3 for discussion of the Pathfinder Network Scaling). Each experimental passage was analyzed separately for measures of analysis of variance, Pearson Product-moment correlation, and graphical representation of knowledge organization.

5.5.1 First Experimental Passage

By using the proximity data, the similarity and coherence measures were computed (JPathfinder software). As shown in Table 13, the coherence and similarity metric for the treatment groups exhibited higher mean scores than the control group. Specifically, groups A and B have achieved coherence measure of C=0.408 and 0.400 respectively that were by almost a factor of 2 higher than the control group with coherence C= 0.265. Moreover, treatment group A (COC) showed higher similarity, S=0.422, than group B, S=0.387 which was closer to the control group with S= 0.363.

Table 13  
*Pathfinder Measures on Coherence and Similarity for Passage One (Geology)*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Group A (COC)</th>
<th>Group B (AJQ)</th>
<th>Group C (Control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coherence (Mean)</td>
<td>0.408</td>
<td>0.400</td>
<td>0.265</td>
</tr>
<tr>
<td>Coherence (Median)</td>
<td>0.473</td>
<td>0.504</td>
<td>0.304</td>
</tr>
<tr>
<td>Similarity (Mean)</td>
<td>0.430</td>
<td>0.387</td>
<td>0.362</td>
</tr>
<tr>
<td>Similarity (Median)</td>
<td>0.375</td>
<td>0.389</td>
<td>0.343</td>
</tr>
</tbody>
</table>

The one-way ANOVA of coherence and similarity was not statistically significant \([F(2, 169) = 2.52, p = .084]\) and \([F(2, 169) = 2.85, p = .061]\). In other words, the three groups did not differ statistically for the coherence and similarity measures in the first passage.
Furthermore, Pearson correlation coefficients were computed to determine if there were any relationships between the average of the combined reading comprehension tests (i.e., multiple choice and fill in the blank tests) and similarity and coherence variables of passage one. An alpha level of .05 was used for all analysis. A two-tailed test of significance indicated that there was a moderate significant positive relationship between similarity measure and performance on the combined tests on reading comprehension tests, \( r(170) = .456, p < .001 \). The more similar the ratings are to an expert rating, the better the performance is in reading comprehension tests (multiple choice and fill in the blank tests). There was a weak significant positive correlation between the performance on the combined reading comprehension tests and coherence \( r(170) = .250, p = .001 \). Also, there was a moderate significant positive correlation between similarity and coherence \( r(170) = .353, p < .001 \). In general, the results suggested that if students’ ratings were more consistent and more similar to an expert rating, they were likely to perform better in reading comprehension tests.

Graphical networks were analyzed by comparing the network properties and visual representation. For both measures, first the median of the network for each group was generated (using the JPathfinder application). Next, each measure was compared with the expert.

The network property is a feature on the JPathfinder software based on some concepts from graph theory. Three complementary notations for the core/central concept in each knowledge graph can be considered: (a) Maximum Degree, (b) Minimum Eccentricity (denoted by Center in JPathfinder), and (c) Minimum Mean-distance (denoted by Median in JPathfinder). Maximum degree refers to the concept(s) that comprise the largest number of links in a network. Minimum eccentricity refers to the concept/node that comprise the maximum number of (direct or indirect) links between that node and all other nodes in the network (this is equivalent to the notation of chemical distance). In other words, a minimum eccentric concept is located near the center of a network with minimal distance to all other nodes/concepts at the boundary of the graph. A minimum mean-distance refers to a node that has minimum mean distance from all other nodes in the network. It refers to the average distance (number of direct or indirect links) that one has to cover the entire graph. It should be mentioned that depending on the characteristic of a network, it is possible that only one node in a network qualified as the central based on all of the three alternative definitions. However, in many (inhomogeneous) graphs different nodes
would be considered central depending on whether one employs Maximum Degree, Minimum Eccentricity, and Minimum Mean-distance as the notation of centrality. In complex network theory, Maximum Degree is considered as the center or “hub” for graphs in particular in scale-free networks which degree connectivity of graphs satisfies a power-law.

The three concepts of maximum degree, minimum eccentricity, and minimum mean-distance of the expert and the three groups (median network) were generated by JPathfindr software. The network property of each group and the expert are demonstrated in Table 14.

The first experimental passage was about geological processes of constructive forces and destructive forces. As shown in Table 14, the network properties of the expert and group A (COC) were comparable. The network property of the expert and group B (AJQ) demonstrated common terms for the minimum eccentricity and minimum mean-distance concepts. Group B network property included some of the key terms. However, the network property of the control group was very different from the property network of the expert.

Table 14
Pathfinder Measures on Network Properties: Comparison between the Expert, Experimental Groups and the Control Group for Passage One

<table>
<thead>
<tr>
<th>Group</th>
<th>Maximum Degree</th>
<th>Minimum eccentricity</th>
<th>Minimum mean-distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert</td>
<td>Mountain Formation</td>
<td>Mountain Formation</td>
<td>Mountain Formation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Old Mountains</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Volcanic activity</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water and wind</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Erosion</td>
<td></td>
</tr>
<tr>
<td>Median Group A (COC)</td>
<td>Mountain Formation</td>
<td>Mountain Formation</td>
<td>Mountain Formation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Old Mountains</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Volcanic activity</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Constructive forces</td>
<td></td>
</tr>
<tr>
<td>Median Group B (AJQ)</td>
<td>Erosion</td>
<td>Mountain Formation</td>
<td>Mountain Formation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Erosion</td>
</tr>
</tbody>
</table>
Next, the graphical structure of each experimental group and the control group was compared with that of the expert graphical structure (mean of the two experts). This analysis identified any wrong associations and missing links in each group when compared with the expert network (Figures 7, 8, and 9). Wrong association refers to the connection of two terms when they are not related. The missing link refers to a lack of sufficient connection between the terms when compared to the expert’s network. The circle in each figure points to the missing link and the cross out mark represents the wrong association.

The first experimental passage examined constructive and destructive geological forces. For example, the constructive forces were expected to show direct links to earthquake and volcanic activity. Similarly, the destructive forces were expected to show direct links to erosion, water, and wind. Figure 7 shows the comparison between the expert network and the median of group A (COC). The two networks were similar. Only mountain formation and earthquake exhibited missing links when compared with the expert network.

*Figure 7. Comparison of Pathfinder median networks group A (left) and the expert network (right). It demonstrated that the term earthquake did not link directly to the mountain formation.*

The network generated by group B (AJQ) demonstrated some missing links including: mountain formation, constructive forces, water and wind, and old mountains (Figure 8).
The network generated by group C demonstrated both wrong association and missing links (Figure 9). The term volcanic activity showed a wrong association (volcanic activity is a constructive force and not a destructive force). The network generated by the control group demonstrated some missing links including mountain formation, Earthquake, water and wind, and erosion.

Altogether, group A created a more coherent network than the other groups. Both groups A and B demonstrated a few missing links. Group C created a network with both wrong association and missing links. The control group failed to demonstrate an accurate knowledge of the concepts of both destructive and constructive forces.
5.5.2 Second Experimental Passage

Similar to the first experimental passage, the coherence and similarity measures were analyzed for the second experimental passage. As shown in Table 15, the coherence and similarity metric for treatment groups exhibited higher mean than the control group. Groups A and B have achieved coherence measure of \( C = 0.468 \) and \( 0.400 \) respectively which was higher than the control group with coherence \( C = 0.308 \). Moreover, treatment group A (COC) showed higher similarity, \( S = 0.414 \). The similarity of group B (\( S = 0.374 \)) was slightly higher than the control group (\( S = 0.368 \)).

Table 15

Pathfinder Measures on Mean of Coherence and Similarity for Passage Two (Biology)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Group A (COC)</th>
<th>Group B (AJQ)</th>
<th>Group C (Control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coherence (Mean)</td>
<td>0.468</td>
<td>0.400</td>
<td>0.308</td>
</tr>
<tr>
<td>Coherence (Median)</td>
<td>0.613</td>
<td>0.439</td>
<td>0.280</td>
</tr>
<tr>
<td>Similarity (Mean)</td>
<td>0.414</td>
<td>0.374</td>
<td>0.368</td>
</tr>
<tr>
<td>Similarity (Median)</td>
<td>0.438</td>
<td>0.385</td>
<td>0.363</td>
</tr>
</tbody>
</table>

The one-way ANOVA of coherence and similarity was not statistically significant \([F(2, 169) = 2.25, p = .109]\) and \([F(2, 169) = 2.85, p = .254]\). In other words, the three groups did not differ statistically for the coherence and similarity measures in the first passage.

Correlation coefficients were computed to determine if there were any relationships between the average of the combined reading comprehension tests (i.e., multiple choice and fill in the blank tests) and similarity and coherence variables of passage two. The results of the correlational analysis were statistically significant (greater than .50) for all measures. For the combined test,
similarity and coherence were computed respectively as \( r(170) = .553, p < .001 \) and \( r(170) = .593, p < .001 \). Performances for coherence and similarity also were positively correlated, Pearson’s \( r(170) = .610, p < .001 \). In general, the results suggested that if the students’ ratings were more consistent and similar to an expert rating, they were more likely to perform better in reading comprehension tests in the second passage.

Similar to the first passage, the graphical networks were analyzed by comparing the network properties and visual representation. For both network properties and visual presentation, first, the median of the network for each group was generated (using the JPathfinder application). Next, each measure was compared with the expert.

The three concepts of maximum degree, minimum eccentricity, and minimum mean-distance of the expert and the three groups (median network) for the second experimental passage were demonstrated in Table 16. The second experimental passage was about two types of herbivores: ruminants and non-ruminants. The “communication among plant-eaters” is the term common among all the group. The network properties of the group B (AJQ) and the control group were limited to the term of “communication among plant-eaters” except the Maximum degree in the control group. It should be noted that degeneracy of the nodes for minimum eccentricity implies that magnitude of the eccentricity does not fully capture the importance of concepts in a graph and has limited utility; although geometrically might be the most central node within the graph. However, some of this degeneracy observed in Tables 14 and 16 could be related to small size effect, as the experimental passages were very brief, and it made it hard even for experts to distinguish the core and non-core concepts.

Table 16
Pathfinder Measures on Network Properties: Comparison between the Expert, Experimental Groups, and the Control Group for Passage Two

<table>
<thead>
<tr>
<th>Group</th>
<th>Maximum Degree</th>
<th>Minimum eccentricity</th>
<th>Minimum mean-distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert</td>
<td>Communication among plant eaters</td>
<td>Communication among plant eaters</td>
<td>Communication among plant eaters</td>
</tr>
<tr>
<td></td>
<td>Non-Ruminant’s diet</td>
<td>Surviving advantage</td>
<td>Surviving advantage</td>
</tr>
<tr>
<td></td>
<td>Nutritious Plants</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Median Group A (COC)</th>
<th>Zebra</th>
<th>Communication among plant eaters</th>
<th>Communication among plant eaters</th>
<th>Communication among plant eaters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Communication among plant eaters</td>
<td>Communication among plant eaters</td>
<td>Communication among plant eaters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surviving advantage</td>
<td>Non-Ruminant’s diet</td>
<td>Ruminant’s diet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Giraffe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Median Group B (AJQ)</th>
<th>Communication among plant eaters</th>
<th>Communication among plant eaters</th>
<th>Communication among plant eaters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Communication among plant eaters</td>
<td>Communication among plant eaters</td>
<td>Communication among plant eaters</td>
</tr>
<tr>
<td></td>
<td>Giraffe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Median Group C (Control)</th>
<th>Communication among plant eaters</th>
<th>Communication among plant eaters</th>
<th>Communication among plant eaters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Communication among plant eaters</td>
<td>Communication among plant eaters</td>
<td>Communication among plant eaters</td>
</tr>
<tr>
<td></td>
<td>Ruminant’s diet</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Next, the graphical representation of the expert network was compared with those of the three groups. This analysis identified any wrong associations and missing links in each group when compared with the expert network for the second passage (Figures 10, 11, and 12). The missing link referred to a lack of sufficient connection between the terms when compared to the expert’s network. The circle in each figure points to the missing link and the cross out mark represents the wrong association. As shown in Figures 10, 11, and 12, the differences between the three groups and the expert were not as distinct as in the first experimental passage.

![Graphical representation](image)

*Figure 10. Comparison of Pathfinder median networks group A (left) and the expert network (right) for the passage two (Biology).*
In contrast with the first passage, the networks created based on the second passage were comparable for the two experimental groups and the control group. There were no wrong associations. Only group C included a missing link for the term low-quality plant.

*Figure 11.* Comparison of Pathfinder median networks group B (left) and the expert network (right) for the passage one two (Biology).

As shown in Figure 12, there is a missing link between the low-quality plants and zebra.

*Figure 12.* Comparison of Pathfinder median networks group C (left) and the expert network (right) for the passage two (Biology).
5.6 Results of Reading Strategies

The data for this study were collected through both Survey of Reading Strategies (SORS, Mokhtari & Sheorey, 2002) and Metacognitive Awareness of Reading Strategies Inventory (MARSI, Mokhtari & Reichard, 2002). Both SORS and MARSI consist of 30 items with a Likert scale of 1 to 5 to measure three broad subscales of reading strategies: a) Global Reading Strategies (GLOB subscale, 13 items), b) Problem-Solving Strategies (PROB subscale, 8 items), and c) Support strategies (SUP subscale, 9 items).

The adaptation of SORS from MARSI (Mokhtari & Sheorey, 2002) consisted of the following adjustment for second language learners: 1) redefining wording to make the items more comprehensible to ESL students for minor modification in five items (for example, “I preview the text” changed into “I take an overall view of the text”); 2) changing two items in the support subscale: two items of “I summarize what I read to reflect on important information in the text” and “I discuss what I read with others to check my understanding.” changed to “When reading, I translate from English into my native language.” and “When reading, I think about information in both English and my mother tongue.” The rest of the 23 items were identical in SORS and MARSI.

The participants in this study were Iranian students who were enrolled in five different institutions. The data from three institutions was collected through SORS and two institutions through MARSI (See Table 17). To report overall reading strategies and subscales, data collected through both MARSI and SORS is used. The overall score and the subscales were interpreted using the interpretation guidelines outlined by Mokhtari, Sheorey and Reichard (2008) for a scale of 1 to 5 as 3.5 or higher = High, 2.5-3.4 = Medium, and 2.4 or lower = Low. As is shown in Table 17, the average of all groups was within the medium range except the high school with slightly higher mean.

Table 17

| Overall Mean Reading Comprehension Strategies Used by Participants in Different Schools |
|---------------------------------|----------|----------|----------|--------|--------|
| School                          | N*       | Minimum  | Maximum  | M      | SD     |
| High school (MARSI)             | 13       | 2.98     | 4.36     | 3.68   | 0.50   |
Moreover, the subscales were reported for different schools. As shown in Table 18, for subscales GLOB and SUP, the means of all schools were in Medium range except for the high school on GLOB subscale which was within a lower range of high according to the guideline used in the study. However, for the problem solving (PROB) subscale, the means of all schools fell within the high range.

Table 18

<table>
<thead>
<tr>
<th>Subscales strategies</th>
<th>School</th>
<th>Minimum</th>
<th>Maximum</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Reading Strategies</td>
<td>High school</td>
<td>2.46</td>
<td>4.54</td>
<td>3.70</td>
<td>0.62</td>
</tr>
<tr>
<td></td>
<td>University A</td>
<td>2.00</td>
<td>4.08</td>
<td>3.26</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td>University B</td>
<td>2.38</td>
<td>4.16</td>
<td>3.18</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td>English Institute</td>
<td>2.00</td>
<td>4.08</td>
<td>3.16</td>
<td>0.52</td>
</tr>
<tr>
<td></td>
<td>Climbing Class</td>
<td>2.85</td>
<td>3.77</td>
<td>3.17</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>Group</td>
<td>Minimum</td>
<td>Maximum</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>--------------------</td>
<td>-------------</td>
<td>---------</td>
<td>---------</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Problem Solving</td>
<td>High school</td>
<td>3.13</td>
<td>4.63</td>
<td>3.90</td>
<td>0.52</td>
</tr>
<tr>
<td>Strategies</td>
<td>University A</td>
<td>2.63</td>
<td>4.63</td>
<td>3.85</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>University B</td>
<td>2.12</td>
<td>4.62</td>
<td>3.59</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>English Institute</td>
<td>2.13</td>
<td>4.63</td>
<td>3.61</td>
<td>0.66</td>
</tr>
<tr>
<td></td>
<td>Climbing Class</td>
<td>3.50</td>
<td>3.88</td>
<td>3.72</td>
<td>0.16</td>
</tr>
<tr>
<td>Support Strategies</td>
<td>High school</td>
<td>2.00</td>
<td>4.44</td>
<td>3.40</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>University A</td>
<td>2.11</td>
<td>4.67</td>
<td>3.04</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>University B</td>
<td>2.44</td>
<td>4.78</td>
<td>3.46</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>English Institute</td>
<td>2.33</td>
<td>4.33</td>
<td>3.30</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td>Climbing Class</td>
<td>1.89</td>
<td>3.44</td>
<td>2.81</td>
<td>0.67</td>
</tr>
</tbody>
</table>

*Note. N=Number, M=Mean, SD=Standard Deviation. Only the bold items are within the high range according to the interpretation guidelines.*

Additionally, the overall average strategy score was reported within the medium range for the experimental groups (See Table 19).

**Table 19**  
*Overall Mean Score of Reading Comprehension Strategies among the Three Groups*

<table>
<thead>
<tr>
<th>Group</th>
<th>Minimum</th>
<th>Maximum</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A (COC)</td>
<td>2.34</td>
<td>4.31</td>
<td>3.33</td>
<td>0.46</td>
</tr>
</tbody>
</table>
Group B (AJQ)  
2.37  
4.31  
3.45  
0.38  

Group C (Control)  
2.64  
4.36  
3.45  
0.41  

*Note.* N=Number, M=Mean, SD=Standard Deviation

### 5.6.1 Item Analysis of SORS

Further, the data was reported for itemized analysis. For that purpose, only the data collected from University A and University B was selected because both University A and B participants used the SORS questionnaire. The results of item analysis showed similar patterns as in other studies with EFL university students.

The overall mean (M=3.40) of University A and B (total N=108) indicated a moderate use of reading strategies according to interpreting score guidelines. The most frequent strategy used among the first-year students at universities A and B was compared in Table 20 and Table 21.

#### Table 20

*University A Most Frequently Used Reading Strategies of SORS*

<table>
<thead>
<tr>
<th>Strategy Number</th>
<th>Strategy</th>
<th>Mean</th>
<th>Strategy subscale</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>When text becomes difficult, I pay closer attention to what I am reading.</td>
<td>4.45</td>
<td>Problem Solving</td>
</tr>
<tr>
<td>25</td>
<td>When text becomes difficult, I reread it to increase my understanding.</td>
<td>4.24</td>
<td>Problem Solving</td>
</tr>
<tr>
<td>9</td>
<td>I try to get back on track when I lose concentration.</td>
<td>4.07</td>
<td>Problem Solving</td>
</tr>
<tr>
<td>28</td>
<td>When I read, I guess the meaning of unknown words or phrases.</td>
<td>4.07</td>
<td>Problem Solving</td>
</tr>
</tbody>
</table>
I adjust my reading speed according to what I am reading.

Both university participants at universities A and B, reported that the most used strategy from subscale Problem-Solving Strategies was PROB14 (*When text becomes difficult, I pay closer attention to what I am reading*). The other commonly used strategy among the two schools was PROB25 (*While reading, if I don’t understand something, I read it again.*). For the university A, the most commonly used strategies were all from subscale of Problem-Solving Strategies. University B reported another subscale of support strategies (SUP13) (*I use reference materials—e.g., dictionary—to help me understand what I am reading.*).

<table>
<thead>
<tr>
<th>Strategy Number</th>
<th>Strategy</th>
<th>Mean</th>
<th>Strategy subscale</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>When text becomes difficult, I pay closer attention to what I am reading.</td>
<td>4</td>
<td>Problem Solving</td>
</tr>
<tr>
<td>7</td>
<td>I read slowly and carefully to make sure I understand what I am reading.</td>
<td>3.94</td>
<td>Problem Solving</td>
</tr>
<tr>
<td>10</td>
<td>I underline or circle information in the text to help me remember it.</td>
<td>3.94</td>
<td>Support</td>
</tr>
<tr>
<td>13</td>
<td>I use reference materials (e.g., a dictionary) to help me understand what I read.</td>
<td>3.92</td>
<td>Support</td>
</tr>
<tr>
<td>25</td>
<td>When text becomes difficult, I reread it to increase my understanding.</td>
<td>3.90</td>
<td>Problem Solving</td>
</tr>
</tbody>
</table>
5.6.2 Reading Strategy Correlations with the Reading Comprehension Tests

Finally, Spearman correlation was computed to determine if there were any relationships between self-reported strategy used when reading academic materials and the average scores of reading comprehension tests (i.e., multiple choice and fill in the blank tests) for combined passages. The correlation is calculated in three different levels: overall strategies, subscales, and among the three groups.

There was no significant correlation between the performance on the combined reading comprehension tests and the overall strategy use $r=.054$, $N=172$, $p=.478$. This suggests that the overall strategies used by the students was not an indicator of their performance on the reading comprehension tests.

However, further analysis revealed interesting results for the correlation between combined reading comprehension tests and the subscales of reading strategies. There was no significant correlation between the performance on the combined reading comprehension tests and the Global Subscale $r=.089$, $N=172$, $p=.246$. In contrast, there was a weak significant positive relationship between the Problem-Solving subscale and performance on the combined reading comprehension tests, $r=.232$, $N=172$, $p=.002$. Also, there was a weak significant negative relationship between the Support subscale and performance on the combined reading comprehension tests, $r=-.189$, $N=172$, $p=.013$.

The Spearman correlation between the combined reading comprehension tests and the subscales among the three groups did not produce any statistically significant result except for the subscale of Problem-Solving. There was a weak significant positive relationship between the Problem-Solving subscale and the combined reading comprehension tests only for AJQ group, $r=.366$, $N=55$, $p=.006$. 
6 Introduction

Reading is an important predictor of excellence in school and success in the workplace. Increased access to digital media has provided numerous opportunities to promote reading literacy for many students including language learners. However, harnessing such an abundant resource for reading in order to improve reading comprehension performance has remained one of the challenges for educators.

This study examined the effectiveness of using two different interventions to improve reading comprehension competencies. The two interventions were the contextual conversation (COC) and adjunct questions (AJQ) within the context of expository reading passages. The COC group first read a conversation about each passage and then read the passage. After reading the conversation, the COC group read each passage. The AJQ intervention involves a standard adjunct question strategy that asks about specific text content (a “what” question).

Both of the interventions were designed to assist in extracting meaning from text and encourage extensive reading. Both contextual conversations and adjunct questions are easy to integrate into any form of digital environment. In other words, both of the interventions are examples of digital scaffolding technologies that have the potential to support reading comprehension skills with the goal of moving learners toward greater self-regulation.

This closing chapter summarizes the main results of the current research and provides interpretation of the data collected and analyzed in the course of the study. The chapter is divided into three main sections: (1) interpretation of the data; (2) limitations and recommendations for future studies; and (3) toward scalable and adaptable technology-based interventions.
6.1 Interpretation of the results

6.1.1 Effectiveness of interventions: COC and AJQ

The present study examined to what extent the two interventions (COC and AJQ) facilitated learners’ recall of the text for potential improvement in reading comprehension competency. The data was analyzed in different steps including analyzing each experimental passage individually using a variety of assessment measures. The post-reading assessment included multiple-choice test, fill-in-the-blank test, and Pathfinder Network Scaling. The multiple-choice test results include two different analyses. First, the overall score in the test was analyzed. Second, the PCR questions that were related to the primary information in both interventions, were analyzed. Further, the combined results of the multiple-choice and fill in the blank tests were also measured.

The mean results of the reading comprehension tests in both intervention groups were higher than the control group in all measures (See Tables 11 and 12). However, only some measures were statistically significant when compared to the control group. In the first passage, the COC results were statistically significant for all measures including the overall multiple-choice test, PCR questions, fill in the blank test, and combined multiple-choice and fill in the blank tests. In the second passage, the COC results were statistically significant for PCR questions and fill in the blank test measures. The AJQ results, on the other hand, were statistically significant only for combined multiple-choice test and fill in the blank test in passage one and PCR questions and fill in the blank test measures in passage two.

The results of the present study showed that both interventions supported reading comprehension competency to some extent. However, COC was more effective for the participants in this study. When the results of the COC are compared with studies examining pre-reading interventions, it seems that pre-reading interventions which involved more engagement and deeper processing are more effective for L2 readers. The rationale for the pre-reading intervention is based on directing readers’ attention to more relevant textual information and appropriately activating readers’ background knowledge.

However, the results in the adjunct question intervention were less facilitative than contextual conversation. It can be argued that the adjunct questions may have interrupted the flow of
reading and increased the workload for the participants in this study. In other words, the adjunct questions group may have devoted some cognitive resources in executing a new strategy in the present study. A second possible explanation is that adjunct questioning strategies are less effective for those participants who have already acquired some mastery of reading comprehension skills. The participants in the present study were mainly university students. Therefore, they have already developed some reading skills-based strategies.

Some of the results in the AJQ group should be interpreted cautiously. The result of the combined multiple-choice test and fill in the blank test measure was statistically significant in the first experimental passage. However, the significant result could be a cumulative effect of two measures; i.e., for each multiple-choice test and fill in the blank test measures were not strong enough. However, the result is amplified when the measures are combined. It further has been argued that adjunct questions that are placed within the text typically improve comprehension for L1 readers, particularly when those adjunct questions are similar to, or are related to, the final questions used for assessment (Hamaker, 1986). Such an argument was not fully supported in the present study. If that was the case, it would have been expected that in both experimental passages, participants would have performed better in PCR questions. However, for this measure, the participants in AJQ outperformed the control group only in the second passage. Furthermore, group A (COC) performed better than the adjunct question group in both experimental passages in that measure. Therefore, the effect of related questions in adjunct questions and final assessments were peripheral according to the results of the present study.

The results of the Pathfinder Network Scaling are consistent with other reading comprehension measures in the present study. The mean scores of similarity and coherence measures were higher in treatment groups than the control group. Although those measures were not statistically significant, both treatment groups displayed a more organized passage according to the graph representation than the control group. However, the COC group displayed fewer missing links than the AJQ group and the network properties of the COC were more similar to the network properties of the expert for both passages. Therefore, the COC intervention was more facilitating than AJQ as assessed by the Pathfinder measures.

The findings in this study, on facilitating reading comprehension performances via COC intervention, are consistent with previous research in pre-reading interventions. It is suggested
that when the background knowledge is activated appropriately, it facilitates the process of extracting meaning from the text. For this reason, some pre-reading strategies appear to be more effective than others. Among the different pre-reading strategies, those that built more appropriate schemata for readers were more facilitative than those with a lack of global activation. For example, pictorial context and pre-questioning were more effective than vocabulary pre-teaching (Taglieber, Johnson, & Yarbrough, 1988; Mihara, 2011). The results of the present study on establishing some background knowledge are consistent with similar findings in studies on text summary (Tudor, 1988) and comprehension questions (Mihara; 2011; and Alemi & Ebadi, 2010).

The results of the present study did not confirm the outcomes of some L1 research that standard adjunct questions facilitated reading comprehension performances (Callender & McDaniel, 2007, for low-comprehenders; Dornisch & Sperling, 2008). On the other hand, the studies in L2 showed that standard adjunct questioning was less facilitative for L2 learners. In a series of studies conducted in L2 with a similar design, it was demonstrated that adjunct questioning is a less effective strategy for improving L2 reading comprehension skills (Brantmeier, Callender, & McDaniel, 2011; Brantmeier, Callender, Yu, & McDaniel, 2012; Brantmeier, Callender, & McDaniel, 2013; Callender, Medina, & Brantmeier, 2013; Medina et al., 2017). The adjunct question did not produce any statistically significant result in any of those studies. As elaborated in Chapters 2 and 4, the design in the present study was different from the previous L2 studies. In those studies, only two adjunct questions were inserted in the texts and participants in those studies were required to pause and think about the questions or write down the answers to the adjunct questions (See Table 4, Chapter 2). In the present study, instead, six adjunct questions were inserted within the texts and the answers to the adjunct questions were provided. Therefore, it is possible, that the present study was less interruptive by providing the answer to the adjunct questions. As a result, the results of the study were statistically significant for a few measures.

Although the mean measure of coherence and similarity measures were not statistically significant, consistent with the Ozgungor and Guthrie (2004) study, the AJQ displayed a relatively well-structured organization of the passage. In fact, both treatment groups displayed a better organization of the passage according to the graph representation than the control group.
Overall, comparing the COC and AJQ groups indicated that a contextual conversation may be a more potent strategy than an adjunct question strategy for EFL learners. Enhancing readers’ background knowledge by pre-reading interventions was beneficial for EFL readers. It can be suggested that the contextual conversation was a more engaging intervention and resulted in better comprehension.

6.1.2 Reading Strategies

The reading strategy questionnaire administered in the present study was intended to explore the awareness and perceived use of reading strategies of the participating Iranian students in general and to characterize the type of strategies used by the two groups of university students. The data was analyzed according to the interpretation guidelines outlined by Mokhtari, Sheorey and Reichard (2008) for a scale of 1 to 5 as 3.5 or higher = High, 2.5-3.4 = Medium, and 2.4 or lower = Low. However, mean of any scale at low high (i.e. 3.5) has been interpreted as moderate.

The mean of individual strategy items ranged from a high of 4.36 to a low of 2.34 among all participants (overall Mean=3.41), indicating a medium use of reading strategies, according to established interpretation guidelines. Among the three subscales of global strategies, problem-solving and support strategies, the participants reported using problem-solving with higher frequencies (M=3.72) followed by support and global strategies (M=3.25).

Further, two groups of participants from two universities were selected for more in-depth analysis for reading strategies. The rationale for choosing only the two groups from the universities for in-depth analysis was that both University A and B participants used the SORS questionnaire. The two groups included 117 students from two different universities. Overall, the Iranian students from the two participating universities in the present study reported using reading strategies with medium frequency (Overall SORS mean=3.39). In studies reviewed in chapter two on reading strategies, all L2/EFL readers demonstrated a medium or moderate use of reading strategies (Sheorey & Baboczky, 2008; Sheorey, Kamimura, & Freiermuth, 2008; Jafari & Shokrpour, 2012; Tavakoli, 2014). Consistent with previous research, Iranian college students demonstrated a medium overall use of reading strategies. It is interesting that the medium or moderate range that was reported in the present study was also consistent with the range reported for L1 college students (Sheorey & Mokhtari, 2008). Shorey and Mokhtari (2008) conducted a study to compare L1 and L2 strategies used among college students. They reported that L2/EFL
college students had acquired a rather adequate strategy development in L1 that is transferred to L2 as well.

The data was further analyzed according to the SORS subscales. The participants from both universities reported Problem-solving as the most subscale strategy used (Mean=3.72). The most used subscale has been reported differently in L2 studies (Sheorey & Baboczky, 2008; Sheorey, Kamimura, & Freiermuth, 2008; Jafari & Shokrpour, 2012; Tavakoli, 2014). For example, Japanese students reported “problem-solving” categories as the most used subscale (Sheorey, Kamimura, & Freiermuth, 2008). The two other studies on Iranian college students reported “support” subscale as the most subscale used (Jafari & Shokrpour, 2012; Tavakoli, 2014).

The most frequently used strategy for both university participants was from subscale Problem-Solving Strategies, PROB14 (When text becomes difficult, I pay closer attention to what I am reading). This strategy was also reported as most frequently used by Japanese students (Sheorey, Kamimura, & Freiermuth, 2008). The other commonly used strategy among the two schools was PROB25 (While reading, if I don’t understand something, I read it again.). Re-reading was also reported as one of the most frequently used strategies by Hungarian students (Sheorey & Baboczky, 2008).

In general, in the present study, Iranian EFL university students’ reading strategy usage displays rather strategic reading behaviors that are comparable with L1 college university students (See Shorey & Mokhtari, 2008). In other words, they perceive themselves to be strategic readers when they read academic passages in English. Based on the most frequently used strategies, it can be argued that Iranian university students participating in the present study demonstrated they prefer to read the passages more carefully when it becomes difficult (PROB14), reread it (PROB25) or read slowly (PROB7), guess the unknown words (PROB28) and try to get back on track when they lose concentration (PROB9). They also preferred to use reference materials such as a dictionary (SUP13) and underline or circle information in the text (SUB10).

It can be concluded that typical Iranian university students are rather strategic readers when they read a text in English. They read carefully or reread when needed. They also use rather appropriate support to boost their comprehension such as guessing strategies and dictionaries. All of these strategies are crucial when they read English for Academic Purposes (EAP).
Finally, the correlations between the reading strategies and reading comprehension test yielded mixed results. Since the overall strategies were not correlated with the reading comprehension tests, it can be argued that the participants in the present study may not benefit from any strategy training. However, the statistically significant positive correlation of the Problem-solving may indicate that the participants in this study may benefit from some strategy training with the emphasis on the problem-solving subscale. Further, the correlation between Problem-solving strategy and reading comprehension test in AJQ might imply that students with stronger Problem-solving subscale strategy might benefit more from the AJQ intervention. In other words, the Problem-solving reading strategies might have been boosted by AJQ intervention. However, such a claim requires further investigation.

6.2 Limitations and recommendations for future studies

The findings of this study must be interpreted in light of several limitations with regard to the research design and the research instruments used. The data needed to be collected during regular class hours, and the researcher was only given a limited class period to conduct the study. Due to time constraints, several modifications were implemented to the original design of the study.

First, no standard English reading assessment (such as Gates-MacGinitie Reading Tests, MacGinitie, & MacGinitie, 1989) was administered. Instead, self-assessed English language proficiency questions were included in the background questionnaire. Future studies can examine the effect of the interventions in the learners with different levels of English language proficiency. It is possible that either adjunct questions or contextual conversation have a differential effect on students with different levels of English language proficiency.

Second, to measure interest in and familiarity with the experimental reading passages, only two questions were included in the post-reading assessments. Including more questions focusing on the participants’ familiarity and interest would have allowed further analysis based on the effectiveness of the type of interventions among participants with different levels of interest and familiarity.

Third, the interventions and assessments were administered without any prior training. It is possible that some training may have resulted in a different performance by students.
Specifically, training in use of the “adjunct question” strategy might have resulted in better performance. Cognitive overload may represent an important constraint for second or foreign language learners. It is also possible that strategy training might decrease some of the expected cognitive load resulting in improved performance for second language learners. Future studies can examine the impact of training on the effectiveness of both adjunct questions and contextual conversations. Some training may improve the effectiveness of both contextual conversation and adjunct questions. Alternatively, future studies can explore a pre-test and post-test design over an extended intervention training for effectiveness of the interventions for L2 learners.

Moreover, future studies can consider implementing some changes in the Pathfinder Network Scaling procedure. Due to the time constraints, two rather short passages were designed for the present study. Although the present study provided a simple example prior to the assessment to clarify the rating procedures, some students expressed their concerns in regard to vagueness of rating for some specific terms. For example, the two terms “ruminant” and “non-ruminant” are related to each other. However, according to the information in the reading passage the two terms are expected to be rated the lowest score on the relatedness scale. For this reason, the Pathfinder Network Scaling is more suitable for passages with terms that are distinct from each other with fewer overlaps or where the concepts have a natural hierarchical structure. Therefore, it would be advisable for future research to examine the pathfinder scaling during an extended time period for longer passages and include some training to illustrate the procedure more clearly. It should be mentioned that for a long passage and large number of rating decisions, the rating process should be conducted in different sessions to prevent fatigue. Finally, since there was a positive correlation between the average of the combined reading comprehension tests (i.e., multiple choice and fill in the blank tests) and Pathfinder similarity and coherence measures in both experimental passages, Pathfinder network scaling can be used as an assessment tool to measure reading comprehension competency.

Future studies could also investigate optimal frequencies of adjunct questions as well as placing adjunct questions prior to or after targeted information. For instance, the present study examined placing adjunct questions after the targeted information in a rather short passage. It would be interesting to investigate the effect of adjunct questions in a longer passage in a similar design to the present study (when the answers to the questions are provided in a longer passage).
Investigating standard adjunct questions in different positions (prior to or after targeted information) and different frequencies would provide valuable information in order to discover the optimal settings to produce systematically enhanced results for implementing such intervention.

It should be mentioned that the current study explored the reading comprehension strategies with a focus on factual (literal) information in the text. Therefore, the design of the present study was intentionally constructed to tap the literal rather than inferential information. Future studies, however, can explore both factual and inferential questions. Additionally, it would be interesting to investigate if the interventions have the same results with experimental materials that are presented online or in a paper-based format similar to the present study. The current study collected data for the pilot study and the limited number of participants in an online format. Hence, there was no analysis of the two different versions.

The findings of the present study suggest that many L1 and L2 students, regardless of their academic levels, benefit from interventions assisting them to acquire information from expository texts. Those interventions can include inserting adjunct question within a passage and providing a contextual conversation prior to a reading passage. Both strategies are easy to execute. Teachers can easily implement both adjunct questioning and contextual conversation interventions into the instructional materials in an educational context. Both adjunct questioning and contextual conversation interventions can be integrated into potential electronic environments for digital scaffolding to improve reading comprehension literacy.

Considering the findings of the present study, the adjunct question strategy can be regarded as an effective but not a sufficient support for EFL learners studying expository texts. Both adjunct question and contextual conversation strategies can be beneficial for EFL students with English language proficiency of intermediate and higher. Teachers can implement both contextual conversation and adjunct question strategies as an additional textual support. Such strategies have the potential to assist students to improve their performance for more complex instructional materials. It is important to introduce students to a wide array of effective strategies. In fact, such strategies can be useful additions to students' existing strategic repertoires to best match the task demands and their skills in the area of study. Finally, the SORS questionnaire can provide a snapshot of students’ overall reading strategies which is valuable information for both teachers
and students. The teachers can play a key role in increasing student’s awareness of how to become strategic readers.

6.3 Toward scalable and adaptable technology-based intervention

Over the past two decades, we have witnessed the biggest technology transformation of all time. This is mostly driven by digital technology which has benefited from four interrelated underlying exponentially growing forces: (a) Moors law: exponential increase in hardware performance which surpassed the critical threshold of capability more than a decade ago; (b) big data: exponential explosion of digital data; (c) artificial intelligence: exponential growth of capital and human intelligence investment in developing efficient machine learning algorithms in the past five years; (d) combinatorial technology integration: an exponential number for possible ways of integrating various digital technologies into new hardware and software platforms and applications. These combined forces have led to a cascade of industrial revolutions in many different sectors of the economy. This includes scalable digitizing of information organization and acquisition led by Google, scalable digital advertisement bidding by Google, digitizing of retail industry led by Amazon, a complete transformation of social network technology led by Facebook, digital access to entertainment by Netflix and Google, crowdsourcing of local transportation and accommodation by Uber, Lyft, and Airbnb.

Surprisingly, the effects of such digital technology transformations have been relatively muted in education; nevertheless, there have been considerable investments in online e-learning platforms. These includes Coursera, Udacity, Udemy for both massive and other online course offering and enrolments in college level courses, and various educational games mainly focused on elementary education. Some of the potential future technologies for reading comprehension and writing were introduced in an edited book by Crossley and McNamara (2017). Some of the examples of those technologies include educational computer-administrated tests to assess comprehension and strategies (Magliano, Ray, & Millis, 2017), such as CSAL Auto Tutor (Graesser et al., 2017), and Palette technologies for improving content comprehension for ELLs (Burstein & Sabatini, 2017). However, newly launched programs are not always well received for many different reasons. For example, recently many students and their parents requested to opt-out from Summit Learning, a California-based charter management organization (Bowles,
Summit learning, a personalized learning system, emphasizes individualized learning and project-based learning (Mass & Lake, 2018).

There are many reasons why recent changes have not yet been revolutionary in the field of education. One of the major issues is a lack of large-scale studies that could promote a fuller understanding of underlying mechanisms that could improve the various aspects of education. Due to inherent limitations in collecting data in school settings, there have not been large scale studies on the real impact of possible digital mechanisms on education in a fundamental way.

The study presented in this thesis has provided an important step towards the characterization of digital scaffolding as a reading comprehension intervention mechanism. However, in order to develop scalable digital scaffolding technologies, there are many possible ways that this study can be extended and implemented.

Certain limitations that were outlined in section 6.2 could be overcome with adopting more advanced concepts and techniques from mathematics and computer science, in particular complex network theory and machine learning. For example, Pathfinder software package has certain limitations with respect to data structure and formatting and lacks an open source library. An open source approach to Pathfinder networks with user-friendly documentation is required to make necessary adjustments and generalization of certain graph theorectic subroutines and evaluation of distance metrics (such as coherence and similarity) based on particular needs in a given study. More generally, open source projects for educational software platforms will allow integration with other resources such as Python NetworkX (http://networkx.github.io/) for more generic graph/network analysis and Google TensorFlow libraries (https://www.tensorflow.org/) for machine learning prototyping and development. Such an integrated educational toolbox could allow dynamic and individual-based learning to become a reality. For example, the optimal frequencies of adjunct questions, as well as the optimal placing of such interventions, can be dynamically adapted for each individual learner with deep reinforcement learning (Sutton & Barto, 1998; Mnih et al., 2015). Such generalizations are necessary to scale up these interventions for a large number of materials and a large number of participants. Novel task-orientated software platforms and algorithms are needed for future scalable computer-assisted learning systems.
One of the best examples of technology-based reading software that has already been implemented on a large scale is TurboTax (https://turbotax.intuit.com/). This commercial software platform has been highly successful across social, economic, age, sex, and ethnicity backgrounds of participants. It enhances reading comprehension for highly complex tax laws and regulations sufficiently to improve engagement for the arguably highly unattractive subject matter of tax regulations. Moreover, the software platform is adaptive; based on the answers to previous questions, the software guides the user through different pathways of forms and tax materials. In more recent versions, the TurboTax software is also interactive via AI-assisted online chatbots. However, this software platform is not intended for educational purposes. It is designed to assist a user to complete a particular task (i.e., filling your tax return) with significantly less effort than the paper-based alternatives. Similarly, Google query/search suggestions, or smart phone typing suggestions, or other chatbot interventions do not necessarily enhance the knowledge of individuals but definitely can assist a user to complete a particular task with a higher level of engagement and success.

One main question would be whether it is possible to design scalable software platforms for educational purposes that assist students/users from a wide range of backgrounds to accomplish an educational task. If yes, does that imply that actual knowledge acquisition has been enhanced, and how can it be measured? To address such questions for future digital scaffolding platforms, one may need to develop a general algorithmic approach based on recent technological developments in statistical learning (Albert & Barabási, 2002), deep learning (Goodfellow, Bengio, & Courville, 2016), Natural Language Processing (Jurafsky & Martin, 2009) for automatic term/concept extraction, automatic knowledge graph construction (Hastie, Tibshirani, & Friedman, 2009; Paulheim, 2017) and complex network theory (Van Steen, 2010) approaches for similarity and coherence evaluations. Also, combination of those technologies with reinforcement learning approaches (Sutton & Barto, 1998; Mnih et al., 2015) can be used to develop future individual-based online intervention and assessment paradigms.

Overall, reading is a critical skill in any educational system. Any scalable technology-based effort to improve reading literacy is a long-term investment for the future of students. The awareness of computer-assisted strategies and their success may not necessarily translate into exclusive use of such strategies and they might often have to be amended by traditional school settings. However, they can be considered as steps in promoting extensive reading with the goal
of developing metacognitive awareness and self-regulation for future generations of readers who will have abundant access to digital media and individually optimized reading platforms.


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Appendices

Appendix A: Consent

Information Letter and Consent Research Project (participant)

Dear participants,

My name is Minoo Ardeshiri. I am currently a doctoral candidate at the University of Toronto, Canada, in the Department of Curriculum, Teaching and Learning in Language and Literacies Education Program. My Supervisor is Professor Jim Cummins (his contact info is provided at the end of this letter).

You are invited to participate in my research project. The purpose of this research is to improve reading comprehension skills for English Language Learners (ELLs) and English as a Foreign (EFL) learners. The following is a brief description of what you will be involved in during this research if you consent to participate.

- You will participate in a reading activity. You will read different expository texts in English. All of the data will be collected online.
- Your reading activity and follow up questionnaire takes approximately 90 minutes (for ADHD participants up to 120 minutes).
- Upon completing the study, you will receive compensation equal to $5. You will receive an in-kind gift card only if you complete the activities.

There are no foreseeable risks to participating in this research project. On the contrary, you may learn more skills to improve your reading comprehension. Your identity will not be revealed in any documents or future publications. I will replace the participants’ name with a code to ensure confidentiality.

This research study you are participating in has been approved by the Office of Research Ethics of the University of Toronto (the contact info is provided at the end of this letter). The research study you are participating in may be reviewed for quality assurance to make sure that the required laws and guidelines are followed. If chosen, (a) representative(s) of the Human Research Ethics Program (HREP) may access study-related data and/or consent materials as part of the review. All information accessed by the HREP will be upheld to the same level of confidentiality that has been stated by the research team.

Please be aware that your participation is completely voluntary and that you can withdraw anytime without penalty by contacting the researcher and notifying her of your wish to withdraw. Should you decide to withdraw from the study, the collected data will not be used. Once research findings are reported or published, the participants’ data will not be able to withdraw from the study. The result of this study will be compiling into my doctoral thesis and
further will be used for paper publication. If requested, you will receive update about future publications of this study.

By participating in this study, you will contribute to reading comprehension research which is an important component for academic success. Many English learners experience difficulties in catching up academically because of the demands of the curriculum and the pressures faced by teachers to provide an effective learning environment for all students. Furthermore, many students get distracted as a result of their access to technology including social media, video games, etc. Thus, technological interventions that assist them to focus on reading comprehension skills could contribute to improving their reading comprehension performance. The findings of this study have the potential to contribute to the design of future personalized learning programs.

Should you choose to accept to participate, please sign the following consent letter by clicking the accept bottom at the end of the form. You will receive an electronic or hard copy of the information letter accordingly.

Sincerely,

Minoo Ardeshiri

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m.ardeshiri@mail.utoronto.ca or (310) 405-2786

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The Office of Research Ethics of the University of Toronto can be reached at ethics.review@utoronto.ca or 416-946-3273.
Appendix B: Consent (Farsi Version)

رضایت نامه

تقویت درک مطلب برای زبان آموزان

شرکت کندگی گرامی,

نام من میتوان ارشدیری است. در حال حاضر دانشجوی مقطع دکترای رشته آموزش زبان انگلیسی و برنامه ریزی درسی دانشگاه تورنتو در کانادا هستم. استاد راهنماً من دکتر جیم کامینز هستند (اطلاعات تمام ایشان درانتهای این رضایت نامه درج شده است).

از شما دعوت می‌کنم در پروزه تحقیقاتی ام شرکت نمایید. هدف من از این تحقیق، بهبود مهارت های درک مطلب برای زبان آموزان است. در ادامه اینکه را در طی این تحقیق به شما ارائه خواهند ارائه شده. این ارائه در طول خواهد گذشته.

شما در کنار فعالیت خواندن شرکت نموده و متون مختلف مربوط به درک مطلب به زبان انگلیسی را می‌خوانید. داده‌ها به صورت آنلاین جمع آوری خواهند شد.

شما چندین متن درخصوص درک مطلب به زبان انگلیسی را خوانید و پرسید به سوالات مربوطه پاسخ می‌دهید که حدود 90 دقیقه طول خواهد کشید.

جهت قدردانی برای شرکت شما در این پروزه تحقیقاتی، تنها پس از اتمام کار، کارت هدیه (مبلغ 15 هزار تومان) تقدیم می‌شود.

این تحقیق مربوط به درک مطلب در زبان انگلیسی بوده و هیچگونه مشکلی برای شما ایجاد نمی‌کند. نام و نام خانوادگی هیچکی از شرکت کنندگان مشخص نخواهد شد بلکه اساسی با یک کد جایگزین می‌گردد.

(The Office of Research Ethics)

این پروزه تحقیقاتی توسط دانشگاه تورنتو نهاد گردیده است. دفتر تحقیقاتی دانشگاه تورنتو

(The Human Research Ethics Program)

امکان دسترسی به اطلاعات جمع‌آوری شده از کلیه تحقیقات را دارد و ممکن است این تحقیق را بطور محرمانه برسی نماید.

پایدر می‌رسانم که شرکت شما در این تحقیق کاملاً داوطلبانه بوده و درصوتی انسانی ثبت شده است. درصوتی که پس از پایان این پروزه وانتش در نتایج حاصله، تمایل به انتشار داشته باشید در آن زمان امکان پذیر نخواهد بود. این نتایج حاصل از این تحقیق در رساله دکتری من گرد اوری خواهند شد و درصوتی تمایلی می‌توانم مقاله منتشر شده را برای انتشار نمایم.
کمک شیانتی به یوهوش های مرتبط با خواندن و درک مطلب خواهد نمود که در واقع از مباحث مهم موفقیت های درسی مشابه می‌رود. بسیاری از افرادی که زبان انگلیسی را فرا می‌آورند مشکلاتی را در طی مراحل پایه‌گیری تجربه می‌کنند که ناشی از عدم برنامه ریزی مؤثر می‌باشد. علیرغم این که برنامه برای اندوزه‌گیری فناوری‌های زمان، مانند پزشکی های کامپیوتری، موبایل و... تمرکز دانش آموزان را چهل پایه‌گیری به مخاطرات اندکت است. بنابراین هر تکنولوژی جدیدی که برای تمرکز دانش آموزان در هنگام خواندن متن و درک مطلب مفید واقع شود؛ عامل مهمی در بهبود برنامه ریزی درسی در تمام مقاطع خواهد بود.

چنانچه با شرکت خود در این پروژه تحقیقاتی موافق هستید، لطفاً اطلاعیه‌ای ایجاد در امضاء کنید.

مینو اردشیری دانشجوی دانشگاه تورنتو

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Appendix C: Experimental Passages for Group A (Contextual Conversation, COC)

Passage One: Geology

Geological Destructive and Constructive Forces

*Imagine Bob and Alice travel to Mount Everest in South Asia. They look at Mount Everest, the Earth’s highest Mountain. Now, read their conversation:*

**Bob:** Look at Mount Everest, Alice. Wow, the highest mountain! It must be a really old mountain.

**Alice:** Oh no. Higher mountains (like Everest) are more recently formed on Earth. Old mountains such as the Appalachian Mountains in North America are lower mountains.

**Bob:** You mean that the old mountains are not high. Why?

**PAUSE......THINK**

**Alice:** Yes, older mountains are not high. When mountains form, they are subjected to erosion.

**Bob:** I see. You mean that the mountains’ surfaces change because of the rain?

**Alice:** Yes. The changes are because of weather (water and wind) and gravity.

**Bob:** Interesting. What do we call these changes?

**Alice:** We call them destructive forces.

**Bob:** Are volcanic activities destructive forces, too? They destroy everything, right?

**Alice:** Actually, volcanic activities are not destructive forces. Instead, they are constructive forces.

**Bob:** Why are they constructive?

**PAUSE......THINK**

**Alice:** Because the volcanic activities result in the formation of mountains.
Bob: In this way, an earthquake is also a constructive force, right?

Alice: Absolutely. Do you know what types of mountains are formed by these constructive forces?

Bob: I can think of volcanic mountains.

Alice: That is correct. There are 3 types of mountains: volcanic mountains, fold mountains and block mountains.

Bob: What type of mountain is Mount Everest?

Alice: Mount Everest is a fold mountain. Now you know about constructive and destructive forces that constantly change mountains.

Now read the following text:
Geological Destructive and Constructive Forces

Despite our tendency to consider Earth as static, Earth is dynamic, and it is constantly changing. All of the changes that affect the Earth’s surface are either constructive or destructive. Constructive forces affect the Earth’s surface by building it up while forming new crust and landforms like mountains and islands. Constructive forces include crustal deformation (e.g., earthquakes) and volcanic eruption. Destructive forces affect the Earth's surface by breaking down landforms through the processes of weathering and erosion. In the following, the constructive and destructive forces will be elaborated by providing examples of mountain formations and mountain erosions.

---

geological: relating to the study of the earth's physical structure

static: unchanging

crust: the outer layer of the Earth

deformation: changing shape

erosion: the process by which soil and rock particles are worn away

elaborate: explain
Mountains are formed through various constructive forces. Mountains are divided into three different categories based on how they are formed: volcanic mountains, fold mountains, and block mountains. All of these are the result of Earth's crust, where compressional forces push surface rock upward creating a landform higher than the surrounding features. **Volcanic mountains** are formed when molten rock deep within the earth (magma) erupts to the surface. When the magma reaches the surface, it often builds a volcanic mountain. An example of a volcanic mountain is Mount Fuji in Japan. **Fold mountains** occur as a result of the effects of folding on layers in the upper part of the Earth’s crust. Fold mountains are the most common type of mountains. Zagros mountains in Iran and Mount Everest (the highest mountain in the world) in South Asia are examples of fold mountains. **Block mountains** are caused by cracks in the Earth’s crust where rocks can move past each other as a result of geological activities such as an earthquake. Mount Blanc in France is an example of a block mountain.

---

**compress**: press together

**molten**: liquid

**erupt**: break out suddenly

**occur**: take place

**crack**: break

**Earth’s crust**: the outer layer of the Earth
Due to constructive forces, mountains are changed over time. All mountains are affected by destructive forces such as weathering (water and wind) and gravity. For example, gravity pulls rocks and sediments downhill; similarly, strong winds pick up dust and wear away exposed rock surfaces. On the other hand, the water from rivers and rainfalls leaks slowly underground and cuts through the rocks and carries away debris from the mountains to the lowlands. The water, in its many forms, is considered the main agent of erosion on mountains. The extent of weathering and erosion in shaping the mountains will be explained by comparing the oldest mountains and the highest mountains. The oldest mountains on earth are the Appalachian Mountains (fold mountains) in North America, which formed approximately 480 million years ago. The Appalachians’ highest point reaches up to only 2,037 meters. However, it is argued that the Appalachian may have reached elevations similar to those of Mount Damavand in Iran (5,600 meters) before naturally occurring erosions. On the other hand, Mount Everest – Earth's highest mountain— reaches up to 8,848 meters. However, Mount Everest is considered young, and it is estimated to be only 60 million years old. Therefore, it can be argued that older mountains are not expected to be tall because weather and erosion continually reshape the mountain forms.

sediments: material deposited by water or wind

exposed: having no protection from bad weather

debris: remains

elevation: height above
African Plant-eaters

Imagine Bob and Alice are on a trip in the African Savannah. They see groups of zebras, wildebeests, giraffes, and elephants.

Bob: I don’t see enough food for all of these plant-eaters. They should all be hungry. Are they?

Alice: Oh No. They are not. The y don’t eat the same food.

Bob: NOT THE SAME FOOD? What do you mean? Aren’t they all plant-eaters?

Pause.............Think

Alice: It may seem so. However, plant-eaters have different diets and eat different parts of plants. Bob: Well, I see all giraffes eat leaves, for example. How do they choose to eat different part of plants?

Alice: Good point. Did you know that the feeding preferences of the plant-eaters are related to their digestive systems?

Bob: They don’t have the same digestive systems?

Alice: No. Based on their digesting system, the plant-eaters are divided into ruminants and non-ruminants. Ruminants (such as wildebeests) have special stomach and re-chew their food. Ruminant select leafier parts of plants and receive higher nutrition from food. Non-ruminants (such as zebras) eat low quality stems and receive low nutrition.

Bob: In this way, ruminants have an advantage over nun-ruminants because they obtain higher nutrition from food.

Pause.............Think
Alice: Excellent point. In fact, ruminants survive better if there is not enough supply of food.

Bob: OK. But how do they find food?

Alice: They follow the pattern of local rainfall in their migration to search for new food.

Bob: Do some of them migrate together?

Alice: Yes, some of the plant-eaters migrate together. It is interesting that plant-eaters communicate at some level during migration to find safe paths and source of water.

Now read the following text:
African Plant-eaters

The African savanna ecosystem is a tropical grassland with warm temperatures year-round. The savanna is characterized by grasses, trees, and contains a diverse community of animals including plant-eaters. Elephants, zebras, giraffes, and wildebeest are all plant-eaters. There is a huge diversity of plant-eaters; but researchers have questioned exactly how so many of them manage to live near each other with such limited access to food resources. New studies on plant-eaters’ diet analysis show that all large African plant-eaters have surprisingly different diets. In other words, different plant-eaters may eat the same plants; however, their diet relies on different parts of plants. Some plant-eaters, such as giraffes, prefer to eat leaves. Other plant-eaters, such as zebras, eat stems or plants near ground level.

*tropical: a region with a hot and humid climate*

*characterize: describe*

*diverse: very different*

*rely: depend on*
The plant-eaters are divided into two types according to their digestive systems: “ruminants” and “non-ruminants”. Ruminants have a more complex stomach structure. They regurgitate their food to re-chew it. Ruminants (such as wildebeests and giraffes) eat leafier and more nutritious parts of plants. Therefore, ruminants obtain higher nutrition through digestion. However, non-ruminants— with a simple stomach structure— eat low-quality stems. For this reason, non-ruminants (such as zebras) obtain lower nutrition through digestion and require eating large quantities of plants. Most importantly, ruminants have an advantage over non-ruminants when there is a shortage of food supply. Because ruminants receive higher nutrition from food, they are capable of surviving better when there is not enough food available for plant-eaters.

---

digestive system: the process by which the body organs (such as stomach) change food into a form that the body can use as energy.

regurgitate: bring up food

stem: the straight part of a plant that grows above the ground

survive: stay alive
All African plant-eaters continuously search for new sources of food. For this reason, the African plant-eaters migrate by following the rainfall to search for new sources of food. It may seem that the African plant-eaters migrate in a random fashion. However, there is a particular pattern in their migration. It is interesting that intercommunication among plant-eaters occurs in relation to water resources or dangerous situations. For example, wildebeests and zebras migrate together. Wildebeests are very responsive to rain and can sense it falling up to 25km away. Thus, wildebeests often lead other animals to water and fresh grazing. On the other hand, zebras have better memories regarding migration routes and recall previous dangerous places and safe areas. In conclusion, different diet selection, different structure of stomach, and patterns of migration can explain how it is possible that so many large plant-eating animals can coexist on an African Savanna.

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*migrate*: travel

*intercommunication*: two-way communication

*responsive*: react quickly

*grazing*: the vegetation available for plant-eaters

*co-exist*: live together
Appendix D: Experimental Passages for Group B (Adjunct Question, AJQ)

Passage one: Geology

Geological Destructive and Constructive Forces

Despite our tendency to consider Earth as static, Earth is dynamic, and it is constantly changing. All of the changes that affect the Earth’s surface are either constructive or destructive. Constructive forces affect the Earth's surface by building it up while forming new crust and landforms like mountains and islands. Constructive forces include crustal deformation (e.g., earthquakes) and volcanic eruption. Destructive forces affect the Earth's surface by breaking down landforms through the processes of weathering and erosion. In the following, the constructive and destructive forces will be elaborated by providing examples of mountain formations and mountain erosions.

---

destructive: causing change

**geological:** relating to the study of the earth's physical structure

**static:** unchanging

**crust:** the outer layer of the Earth

**deformation:** changing shape

**erosion:** the process by which soil and rock particles are worn away

**elaborate:** explain
Think about the following questions and check your answers on next page:

1. What are the two primary changes that occur to the Earth’s surface?

2. What are examples of constructive processes that affect the Earth’s surface?
Check your answers:

1. **What are the two primary changes that occur to the Earth’s surface?**
The changes happen to the Earth surface are constructive forces or destructive forces.

2. **What are examples of constructive processes that affect the Earth’s surface?**
Earthquake and volcanic activity
Mountains are formed through various constructive forces. Mountains are divided into three different categories based on how they are formed: volcanic mountains, fold mountains, and block mountains. All of these are the result of Earth's crust, where compressional forces push surface rock upward creating a landform higher than the surrounding features. **Volcanic mountains** are formed when molten rock deep within the earth (magma) erupts to the surface. When the magma reaches the surface, it often builds a volcanic mountain. An example of a volcanic mountain is Mount Fuji in Japan. **Fold mountains** occur as a result of the effects of folding on layers in the upper part of the Earth’s crust. Fold mountains are the most common type of mountains. Zagros mountains in Iran and Mount Everest (the highest mountain in the world) in South Asia are examples of fold mountains. **Block mountains** are caused by cracks in the Earth’s crust where rocks can move past each other as a result of geological activities such as an earthquake. Mount Blanc in France is an example of a block mountain.

---

**compress**: press together

**molten**: liquid

**erupt**: break out suddenly

**occur**: take place

**crack**: break

**Earth’s crust**: the outer layer of the Earth
Think about the following questions and check your answers on next page:

3. What are the three types of mountains?

4. What is the highest mountain in the world and which type of mountain it is?
Check your answers:

3. **What are the three types of mountains?** Volcanic mountains, fold mountains and block mountains

4. **What is the highest mountain in the world and which type of mountain it is?** Mount Everest is the highest mountain in the world, and it is a fold mountain.
Due to constructive forces, mountains are changed over time. All mountains are affected by destructive forces such as weathering (water and wind) and gravity. For example, gravity pulls rocks and sediments downhill; similarly, strong winds pick up dust and wear away exposed rock surfaces. On the other hand, the water from rivers and rainfalls leaks slowly underground and cuts through the rocks and carries away debris from the mountains to the lowlands. The water, in its many forms, is considered the main agent of erosion on mountains. The extent of weathering and erosion in shaping the mountains will be explained by comparing the oldest mountains and the highest mountains. The oldest mountains on earth are the Appalachian Mountains (fold mountains) in North America, which formed approximately 480 million years ago. The Appalachians’ highest point reaches up to only 2,037 meters. However, it is argued that the Appalachian may have reached elevations similar to those of Mount Damavand in Iran (5,600 meters) before naturally occurring erosions. On the other hand, Mount Everest — Earth's highest mountain— reaches up to 8,848 meters. However, Mount Everest is considered young, and it is estimated to be only 60 million years old. Therefore, it can be argued that older mountains are not expected to be tall because weather and erosion continually reshape the mountain forms.

---

**sediments**: material deposited by water or wind

**exposed**: having no protection from bad weather

**debris**: remains

**elevation**: height above
Think about the following questions and check your answers on next page:

5. Which mountains are older -- lower mountains or higher mountains?

6. What are the reasons for erosion in mountains?
Check your answers:

5. Which mountains are older --lower mountains or higher mountains?
Lower mountains (such as the Appalachian Mountains in North America) are older and higher mountains (such as Mount Everest) are younger.

6. What are the reasons for erosion in mountains?

Weathering, such as, Water, wind, and gravity.
The African savanna ecosystem is a tropical grassland with warm temperatures year-round. The savanna is characterized by grasses, trees, and contains a diverse community of animals including plant-eaters. Elephants, zebras, giraffes, and wildebeest are all plant-eaters. There is a huge diversity of plant-eaters; but researchers have questioned exactly how so many of them manage to live near each other with such limited access to food resources. New studies on plant-eaters’ diet analysis show that all large African plant-eaters have surprisingly different diets. In other words, different plant-eaters may eat the same plants; however, their diet relies on different parts of plants. Some plant-eaters, such as giraffes, prefer to eat leaves. Other plant-eaters, such as zebras, eat stems or plants near ground level.

*tropical:* a region with a hot and humid climate

*characterize:* describe

*diverse:* very different

*rely:* depend on
Think about the following questions and check your answers on next page:

1. What characteristics allow plant-eaters to live together peacefully?

2. What do giraffes eat?
Check your answers:

1. **What characteristics allow plant-eaters to live together peacefully?**
   African plant-eaters have different diets and eat different parts of plants.

2. **What do giraffes eat?**
   Giraffes eat mainly leaves.
The plant-eaters are divided into two types according to their digestive systems: “ruminants” and “non-ruminants”. Ruminants have a more complex stomach structure. They regurgitate their food to re-chew it. Ruminants (such as wildebeests and giraffes) eat leafier and more nutritious parts of plants. Therefore, ruminants obtain higher nutrition through digestion. However, non-ruminants— with a simple stomach structure— eat low-quality stems. For this reason, non-ruminants (such as zebras) obtain lower nutrition through digestion and require eating large quantities of plants. Most importantly, ruminants have an advantage over non-ruminants when there is a shortage of food supply. Because ruminants receive higher nutrition from food, they are capable of surviving better when there is not enough food available for plant-eaters.

digestive system: the process by which the body organs (such as stomach) change food into a form that the body can use as energy.
regurgitate: bring up food
stem: the straight part of a plant that grows above the ground
survive: stay alive
Think about the following questions and check your answers on next page:

3. What is the main advantage of ruminants compared to non-ruminants?

4. What is an example of non-ruminant plant-eaters?
3. **What is the main advantage of ruminants compared to non-ruminants?**
   Ruminants (such as wildebeests) survive better if there is not enough supply of food. Ruminants have special stomach and re-chew their food. Ruminant select leafier parts of plants and receive higher nutrition from food. Non-ruminants (such as zebras) eat low quality stems and receive low nutrition.

4. **What is an example of non-ruminant plant-eaters?**
   Zebra
All African plant-eaters continuously search for new sources of food. For this reason, the African plant-eaters migrate by following the rainfall to search for new sources of food. It may seem that the African plant-eaters migrate in a random fashion. However, there is a particular pattern in their migration. It is interesting that intercommunication among plant-eaters occurs in relation to water resources or dangerous situations. For example, wildebeests and zebras migrate together. Wildebeests are very responsive to rain and can sense it falling up to 25km away. Thus, wildebeests often lead other animals to water and fresh grazing. On the other hand, zebras have better memories regarding migration routes and recall previous dangerous places and safe areas. In conclusion, different diet selection, different structure of stomach, and patterns of migration can explain how it is possible that so many large plant-eating animals can coexist on an African Savanna.

---

*migrate*: travel

*intercommunication*: two-way communication

*responsive*: react quickly

*grazing*: the vegetation available for plant-eaters

*co-exist*: live together
Think about the following questions and check your answers on next page:

5. What is the main migratory pattern of plant-eaters?

6. What is the characteristic of communication among plant-eaters during migration?
5. **What is the main migratory pattern of plant-eaters?**
   They follow local rainfalls. After it rains in new areas, plant-eaters will arrive.

6. **What is the characteristic of communication among plant-eaters during migration?**
   They communicate with each other during migration to choose safer paths and to find water sources.
## Appendix E: Vocabulary Sheet in L1

### Passage 1 (Geology)

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<td>surface</td>
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<tr>
<td>static</td>
<td>ثابت</td>
</tr>
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<td>volcanic</td>
<td>طبیعت انگیزی</td>
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### Passage 2 (Plant-eater)

<table>
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<td>characterize</td>
<td>مشخص کردن</td>
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<tr>
<td>co-exist</td>
<td>هم هستی</td>
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<tr>
<td>diet</td>
<td>رژیم غذایی</td>
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<td>digestive system</td>
<td>سیستم گوارشی</td>
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<tr>
<td>diverse</td>
<td>متنوع</td>
</tr>
<tr>
<td>graze</td>
<td>گیرنده</td>
</tr>
<tr>
<td>ground level</td>
<td>میدان</td>
</tr>
<tr>
<td>intercommunication</td>
<td>ارتباط متقابل</td>
</tr>
<tr>
<td>leave</td>
<td>بیرون</td>
</tr>
<tr>
<td>low quality</td>
<td>کیفیت پایین</td>
</tr>
<tr>
<td>memory</td>
<td>حافظه</td>
</tr>
<tr>
<td>migrate</td>
<td>مهاجرت</td>
</tr>
<tr>
<td>non-ruminant</td>
<td>غیر شکارکننده</td>
</tr>
<tr>
<td>nutritious</td>
<td>غنی</td>
</tr>
<tr>
<td>Plant-eater</td>
<td>غذای گیاهی</td>
</tr>
<tr>
<td>regurgitate</td>
<td>بازگرداندن</td>
</tr>
<tr>
<td>rely</td>
<td>وفادار</td>
</tr>
<tr>
<td>responsive</td>
<td>واکنش</td>
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<tr>
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<td>شکارکننده</td>
</tr>
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<td>savanna</td>
<td>سوانه</td>
</tr>
<tr>
<td>stem</td>
<td>ساقه</td>
</tr>
<tr>
<td>stomach</td>
<td>سوخت</td>
</tr>
<tr>
<td>survive</td>
<td>زنده بقای</td>
</tr>
<tr>
<td>tropical</td>
<td>پوستایی</td>
</tr>
</tbody>
</table>
Passage One: Geology

**Assessment /Geo**

**A. Rate the pairs (28 pairs)**
**B. Multiple choice questions (6 questions)**
**C. Fill in the blanks (6 questions)**
**D. Prior knowledge and Interest (2 questions)**

**A. Rate the pairs:**

**Direction:** For this assessment, you will be asked to rate word pairs about the passage you read. You should rate the relatedness (correlation) of each pair by marking one of the response options for each pair. The response options range from:

1 = Not at all related  
7 = Extremely related.

First, let's start with an example to clarify this test. Look at the following words:

- Flying
- Tree
- Bird
- Leaves

How do you rate relatedness between the following pairs?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flying</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>Birds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaves</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>

Next, check the relatedness rating for the example words:
<table>
<thead>
<tr>
<th>Flying</th>
<th>Birds</th>
<th>7</th>
<th>They are strongly related.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flying</td>
<td>Tree</td>
<td>1</td>
<td>They are not related.</td>
</tr>
<tr>
<td>Flying</td>
<td>Leaves</td>
<td>2</td>
<td>Slightly related</td>
</tr>
<tr>
<td>Birds</td>
<td>Tree</td>
<td>6</td>
<td>Very related. Not all birds live on the trees</td>
</tr>
<tr>
<td>Birds</td>
<td>Leaves</td>
<td>4</td>
<td>Related. However, birds make their own nests.</td>
</tr>
<tr>
<td>Leave</td>
<td>Tree</td>
<td>6</td>
<td>Very related. But some trees lose their leaves in fall.</td>
</tr>
</tbody>
</table>

Now “Go back to the answer sheet” and rate the word pairs from the passage. Remember, you should rate only according to the information provided in the passage.

Rate the first thing that comes to your mind and move to the next item to rate.

**B. Multiple Choice Questions**

Choose the correct answer. Only one answer is correct.

1. According to the passage, which of the following statements is “true” regarding changes in the Earth’s surface?

   A. Both constructive and destructive forces cause the changes to the Earth’s surface.
   B. The changes in the Earth’s surface only occur during mountain formation.
   C. The changes to the Earth’s surface occur less frequently today than they once did.
   D. The most important changes to the Earth’s surface occur during volcanic activities.

2. Which of the following best describes destructive forces?
   A. It breaks down landforms.
   B. It forms new mountains.
   C. It changes the earth’s surface because of weather factors.
   D. Both (a) and (c)

3. The three types mountains are:
   A. Fold mountains, block mountains, and crust mountains
   B. Fold mountains, volcanic mountains, and earthquake mountains
   C. Fold mountains, block mountains, and volcanic mountains
D. Block mountains, volcanic mountains, and rock mountains

4. Which type of mountain is considered the most common?
   A. Fold Mountains
   B. Block Mountains
   C. Volcanic Mountains
   D. Earthquake Mountains

5. Which of the following can be inferred from the passage about the Appalachian Mountains?
   A. At present, the Appalachian Mountains and Mount Damavand have the same height.
   B. At present, Appalachian Mountains are higher than Mount Damavand.
   C. The Appalachian Mountains height has not changed since its formation about 480 million years ago.
   D. The Appalachian Mountains were probably as high as Mount Damavand 480 million years ago.

6. What is the main cause of mountain erosion?
   A. Gravity
   B. water factors
   C. volcanic activities
   D. wind

C. Fill in the blanks

Direction: Write the letter from the following list to complete each sentence.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>water</td>
</tr>
<tr>
<td>b</td>
<td>shorter</td>
</tr>
<tr>
<td>c</td>
<td>volcanic activity</td>
</tr>
<tr>
<td>d</td>
<td>constructive forces</td>
</tr>
<tr>
<td>e</td>
<td>taller</td>
</tr>
<tr>
<td>f</td>
<td>destructive forces</td>
</tr>
</tbody>
</table>

1. Mountain formation is as a result of ……………….. .
2. ……… is an example of constructive forces.
3. The forces that cause mountains become smaller is referred to as ………….
4. Old mountains expected to be ………… as a result of erosion.
5. ………………is an example of destructive forces.
6. Recently formed mountains are expected to be………….. .

D.  Prior knowledge and Interest

Direction: Please rate your Familiarity and Interest to the topic of the passage you read.

Part A. Please rate your familiarity to the topic of the text you have just read.

Not at all familiar
Not very familiar
Somewhat familiar
Very familiar
Really familiar

Part B. Please rate your interest in the topic of the text you have just read.

Not at all interested
Not very interested
Somewhat interested
Very interested
Passage Two: Biology

**Assessment/Bio**

A. Rate the pairs (28 pairs)
B. Multiple choice questions (6 questions)
C. Fill in the blanks (6 questions)
D. Prior knowledge and Interest (2 questions)

**A. Rate the pairs:**

**Direction:** For this assessment, you will be asked to rate word pairs about the passage you read. You should rate the relatedness (correlation) of each pair by marking one of the response options for each pair. The response options range from:

1= Not at all related
7= Extremely related.

First, let's start with an example to clarify this test. Look at the following words.

![Word pairs]

How do you rate relatedness between the following pairs?

<table>
<thead>
<tr>
<th></th>
<th>Flying</th>
<th>Tree</th>
<th>Bird</th>
<th>Leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flying</td>
<td>Birds</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Flying</td>
<td>Leaves</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

Next, check the relatedness rating for the example words:
| Flying | Birds | 7 | They are strongly related. |
| Flying | Tree  | 1 | They are not related.      |
| Flying | Leaves| 2 | Slightly related           |
| Birds  | Tree  | 6 | Very related. Not all birds live on the trees |
| Birds  | Leaves| 4 | Related. However, birds make their own nests. |
| Leave  | Tree  | 6 | Very related. But some trees lose their leaves in fall. |

Now “Go back to the answer sheet” and rate the word pairs from the passage. Remember, you should rate only according to the information provided in the passage.

Rate the first thing that comes to your mind and move to the next item to rate.

**B. Multiple Choice Questions**

Choose the correct answer. Only one answer is correct.

1. The reason some African plant-eaters may live together relatively peacefully when searching for food is because
   - E. They all eat the same food and there is enough supply of food.
   - F. They have different feeding preferences.
   - G. They only eat leaves and stems.
   - H. They live in different territories.

2. Which of the following best describes zebras’ diets?
   - E. Zebras eat mainly leaves.
   - F. Zebras eat nutritious plants.
   - G. Zebras eat mainly stems.
   - H. Zebras eat mainly fruits.

3. Which of the following plant-eaters are more likely to survive if there is a shortage of food supply?
   - A. Non-ruminants
   - B. Ruminants
   - C. Both ruminants and non-ruminants
   - D. Only wildebeests
4. Which of the following is a characteristic of “non-ruminants”?  
   A. They obtain lower nutrition through digestion.  
   B. They regurgitate their food to re-chew it.  
   C. They have a complex stomach structure.  
   D. They obtain higher nutrition through digestion.

5. According to the passage, which of the following is “true” about migratory habits of the African plant-eaters?  
   A. The plant-eaters have “no” special pattern in migration.  
   B. Giraffes will arrive first in a new area.  
   C. Plant-eaters do “not” communicate with each other during migration to a new place.  
   D. Rain is the main factor that affect the migration of the plant-eaters.

6. Which of the following explains the role of “wildebeests” for finding a new source of food?  
   A. Wildebeests and elephants travel together to find new sources of food.  
   B. Wildebeests are responsible for finding safe paths.  
   C. Wildebeests are responsible for finding water sources.  
   D. Wildebeests are traveling alone to find the new source of food.

E. Fill in the blanks  
   **Direction:** Write the letter from the following list to complete each sentence.

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>b</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>digestive system</td>
</tr>
<tr>
<td>b</td>
<td></td>
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<td></td>
<td>c</td>
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<tr>
<td></td>
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<td>c</td>
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<td>d</td>
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<td>d</td>
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<td>e</td>
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<td>nutritious plants</td>
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<td>e</td>
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<td>f</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>communication</td>
</tr>
</tbody>
</table>

1. ……………….. are divided into ruminants and non-ruminants according to their stomach structures.  
2. The reason that ……………..survive better is related to their nutritious diet.
3. ………..among plant-eaters help them to migrate more efficiently to find safer paths.

4. Zebras prefer to eat mainly……………..

5. Zebras and giraffes have different diets because they have different …………

6. Giraffes prefer to eat mainly……………..

F. Prior knowledge and Interest

Direction: Please rate your Familiarity and Interest to the topic of the passage you read.

Part A. Please rate your familiarity to the topic of the text you have just read.

Not at all familiar

Not very familiar

Somewhat familiar

Very familiar

Really familiar

Part B. Please rate your interest in the topic of the text you have just read.

Not at all interested

Not very interested

Somewhat interested

Very interested

Really interested
Appendix G: Answer Sheets

Passage One: Geology

Your Code: ____________________________

A. Rate the pairs

<table>
<thead>
<tr>
<th></th>
<th>Constructive Forces</th>
<th>Destructive forces</th>
<th></th>
<th>Earthquake</th>
<th>Volcanic activity</th>
<th>Erosion</th>
<th>Mountain formation</th>
<th>Water and wind</th>
<th>Old mountains</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

B. Multiple Choice Question:

1. A B C D
2. A B C D
3. A B C D
4. A B C D
5. A B C D
6. A B C D

C. Fill in the blanks (Use the letter from the table):

1. __________ 2. __________ 3. __________ 4. __________ 5. __________ 6. __________

D. Familiarity and Interest:

(A) Familiarity: ____________________________  (B) Interest: ____________________________
Passage Two: Biology

Your Code: ________________

**Answer Sheet/Bio**

A. Rate the pairs:

<table>
<thead>
<tr>
<th></th>
<th>Not related</th>
<th>Very related</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Non-ruminant’s diet</td>
<td>Ruminant’s diet</td>
</tr>
<tr>
<td>2</td>
<td>Non-ruminant’s diet</td>
<td>low quality plants</td>
</tr>
<tr>
<td>3</td>
<td>Non-ruminant’s diet</td>
<td>Nutritious plants</td>
</tr>
<tr>
<td>4</td>
<td>Non-ruminant’s diet</td>
<td>Surviving advantage</td>
</tr>
<tr>
<td>5</td>
<td>Non-ruminant’s diet</td>
<td>Zebra</td>
</tr>
<tr>
<td>6</td>
<td>Non-ruminant’s diet</td>
<td>Giraffe</td>
</tr>
<tr>
<td>7</td>
<td>Non-ruminant’s diet</td>
<td>Communication among plant-eaters</td>
</tr>
<tr>
<td>8</td>
<td>Ruminant’s diet</td>
<td>low quality plants</td>
</tr>
<tr>
<td>9</td>
<td>Ruminant’s diet</td>
<td>Nutritious plants</td>
</tr>
<tr>
<td>10</td>
<td>Ruminant’s diet</td>
<td>Surviving advantage</td>
</tr>
<tr>
<td>11</td>
<td>Ruminant’s diet</td>
<td>Zebra</td>
</tr>
<tr>
<td>12</td>
<td>Ruminant’s diet</td>
<td>Giraffe</td>
</tr>
<tr>
<td>13</td>
<td>Ruminant’s diet</td>
<td>Communication among plant-eaters</td>
</tr>
<tr>
<td>14</td>
<td>Low quality plants</td>
<td>Nutritious plants</td>
</tr>
<tr>
<td>15</td>
<td>Low quality plants</td>
<td>Surviving advantage</td>
</tr>
<tr>
<td>16</td>
<td>Low quality plants</td>
<td>Zebra</td>
</tr>
<tr>
<td>17</td>
<td>Low quality plants</td>
<td>Giraffe</td>
</tr>
<tr>
<td>18</td>
<td>Low quality plants</td>
<td>Communication among plant-eaters</td>
</tr>
<tr>
<td>19</td>
<td>Nutritious plants</td>
<td>Surviving advantage</td>
</tr>
<tr>
<td>20</td>
<td>Nutritious plants</td>
<td>Zebra</td>
</tr>
<tr>
<td>21</td>
<td>Nutritious plants</td>
<td>Giraffe</td>
</tr>
<tr>
<td>22</td>
<td>Nutritious plants</td>
<td>Communication among plant-eaters</td>
</tr>
<tr>
<td>23</td>
<td>Surviving advantage</td>
<td>Zebra</td>
</tr>
<tr>
<td>24</td>
<td>Surviving advantage</td>
<td>Giraffe</td>
</tr>
<tr>
<td>25</td>
<td>Surviving advantage</td>
<td>Communication among plant-eaters</td>
</tr>
<tr>
<td>26</td>
<td>Zebra</td>
<td>Giraffe</td>
</tr>
<tr>
<td>27</td>
<td>Zebra</td>
<td>Communication among plant-eaters</td>
</tr>
<tr>
<td>28</td>
<td>Giraffe</td>
<td>Communication among plant-eaters</td>
</tr>
</tbody>
</table>

B. Multiple Choice Question:

1. A B C D
2. A B C D
3. A B C D
4. A B C D
5. A B C D
6. A B C D

C. Fill in the blanks (Use the letter from the table):

1. 
2. 
3. 
4. 
5. 
6. 

D. Familiarity and Interest:

(A) Familiarity ...........................................

(B) Interest ..............................................
## Appendix H: Background Questionnaire

Your Code: ___________ /  

**Background Questionnaire**

<table>
<thead>
<tr>
<th>Gender</th>
<th>☐ male</th>
<th>☐ female</th>
</tr>
</thead>
</table>

| Age | ........................... |

### Level of Education (choose high school or university)

<table>
<thead>
<tr>
<th>High school</th>
<th>University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have you graduated?</td>
<td>☐ Yes ☐ No</td>
</tr>
<tr>
<td>If not, what is your grade?</td>
<td>...........................</td>
</tr>
<tr>
<td>What is your most recent English score for an English subject at school (e.g., 16/20)?</td>
<td>...........................</td>
</tr>
<tr>
<td>Your major?</td>
<td>...........................</td>
</tr>
<tr>
<td>Have you graduated?</td>
<td>☐ Yes ☐ No</td>
</tr>
<tr>
<td>If not, which year are you?</td>
<td>...........................</td>
</tr>
<tr>
<td>What is your University Entrance exam (Konkur) percentage for English language (e.g., 40%)?</td>
<td>...........................</td>
</tr>
<tr>
<td>What is your most recent English score for an English subject at school (e.g., 16/20)?</td>
<td>...........................</td>
</tr>
</tbody>
</table>

### What do you think your English language proficiency is in the following categories?

<table>
<thead>
<tr>
<th></th>
<th>Beginner</th>
<th>Intermediate</th>
<th>Upper intermediate</th>
<th>Advanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading Comprehension</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Listening</td>
<td></td>
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<tr>
<td>Writing</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speaking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Have you ever taken any extra English classes? (e.g., private English school)? ☐ Yes ☐ No
If yes, for how many years? ...........................
What is your English level at the private English School? (e.g., intermediate, advanced) ...........................
What is your latest English score at the private English School? (e.g., 85/100)

Do you know any other language(s) besides Farsi and English? ☐ Yes ☐ No
If yes, what is it? ...........................

Have you ever lived in an English-speaking country? ☐ Yes ☐ No
If so, where? ........................... For how long? ...........................

If you are not graduated, we may inquire your scores/grade from your instructor. All information will be held in strict confidentiality. Names will never be used in communicating findings. Do you consent?
☐ Yes ☐ No
Appendix I: SORS and MARS

Survey of Reading Strategies (SORS)

SURVEY OF READING STRATEGIES
Kouider Mokhtari and Ravi Sheorey, 2002

The purpose of this survey is to collect information about the various strategies you use when you read school-related academic materials in ENGLISH (e.g., reading textbooks for homework or examinations; reading journal articles, etc.). Each statement is followed by five numbers, 1, 2, 3, 4, and 5, and each number means the following:

'1' means that 'I never or almost never do this'.
'2' means that 'I do this only occasionally'.
'3' means that 'I sometimes do this'. (About 50% of the time.)
'4' means that 'I usually do this'.
'5' means that 'I always or almost always do this'.

After reading each statement, circle the number (1, 2, 3, 4, or 5) which applies to you. Note that there are no right or wrong responses to any of the items on this survey.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Never</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I have a purpose in mind when I read.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>2. I take notes while reading to help me understand what I read.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>3. I think about what I know to help me understand what I read.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>4. I take an overall view of the text to see what it is about before reading it.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>5. When text becomes difficult, I read aloud to help me understand what I read.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>6. I think about whether the content of the text fits my reading purpose.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>7. I read slowly and carefully to make sure I understand what I am reading.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>8. I review the text first by noting its characteristics like length and organization.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>9. I try to get back on track when I lose concentration.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>10. I underline or circle information in the text to help me remember it.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>11. I adjust my reading speed according to what I am reading.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>12. When reading, I decide what to read closely and what to ignore.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>13. I use reference materials (e.g., a dictionary) to help me understand what I read.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>14. When text becomes difficult, I pay closer attention to what I am reading.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>15. I use tables, figures, and pictures in text to increase my understanding.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>16. I stop from time to time and think about what I am reading.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>17. I use context clues to help me better understand what I am reading.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>18. I paraphrase (restate ideas in my own words) to better understand what I read.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>19. I try to picture or visualize information to help remember what I read.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>20. I use typographical features like bold face and italics to identify key information.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>21. I critically analyze and evaluate the information presented in the text.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>22. I go back and forth in the text to find relationships among ideas in it.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>23. I check my understanding when I come across new information.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>24. I try to guess what the content of the text is about when I read.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>25. When text becomes difficult, I re-read it to increase my understanding.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>26. I ask myself questions I like to have answered in the text.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>27. I check to see if my guesses about the text are right or wrong.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>28. When I read, I guess the meaning of unknown words or phrases.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>29. When reading, I translate from English into my native language.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>30. When reading, I think about information in both English and my mother tongue.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
</tbody>
</table>
**SCORING GUIDELINES FOR THE SURVEY OF READING STRATEGIES**

**Student Name:** __________  **Date:** __________

1. Write the number you circled for each statement (i.e., 1, 2, 3, 4, or 5) in the appropriate blanks below.
2. Add up the scores under each column and place the result on the line under each column.
3. Divide the subscale score by the number of statements in each column to get the average for each subscale.
4. Calculate the average for the whole inventory by adding up the subscale scores and dividing by 30.
5. Use the interpretation guidelines below to understand your averages.

<table>
<thead>
<tr>
<th>Global Reading Strategies (GLOB Subscale)</th>
<th>Problem Solving Strategies (PROB Subscale)</th>
<th>Support Reading Strategies (SUP Subscale)</th>
<th>Overall Reading Strategies (ORS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. _______ 7. _______ 2. _______</td>
<td>GLOB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. _______ 9. _______ 5. _______</td>
<td>PROB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. _______ 11. _______ 10. _______</td>
<td>SUP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. _______ 14. _______ 13. _______</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>8. _______ 16. _______ 18. _______</td>
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<tr>
<td>12. _______ 19. _______ 22. _______</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>15. _______ 25. _______ 26. _______</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. _______ 28. _______ 29. _______</td>
<td></td>
<td></td>
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<tr>
<td>20. _______ 30. _______</td>
<td></td>
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<tr>
<td>21. _______</td>
<td></td>
<td></td>
<td></td>
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<td>23. _______</td>
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<td></td>
<td></td>
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<tr>
<td>24. _______</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. _______</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

____ GLOB Score / 13  ______ PROB Score / 8  ______ SUP Score / 9  ______ Overall Score / 30

____ GLOB Average  ______ PROB Average  ______ SUP Average  ______ Overall average

**KEY TO AVERAGES:** 3.5 or higher = High 2.5 - 3.4 = Medium 2.4 or lower = Low

**INTERPRETING YOUR SCORES:** The overall average indicates how often you use reading strategies when reading academic materials. The average for each subscale shows which group of strategies (i.e., Global, Problem Solving, or support strategies) you use most often when reading. It is important to note, however, that the best possible use of these strategies depends on your reading ability in English, the type of material read, and your reading purpose. A low score on any of the subscales or parts of the inventory indicates that there may be some strategies in these parts that you might want to learn about and consider using when reading (adapted from Oxford 1990, pp. 297-300).

Metacognitive Awareness of Reading Strategies Inventory
(MARSI) Version 1.0
Kouider Mokhtari and Carla Reichard © 2002

DIRECTIONS: Listed below are statements about what people do when they read academic or school-related materials such as textbooks, library books, etc. Five numbers follow each statement (1, 2, 3, 4, 5) and each number means the following:

- 1 means “I never or almost never do this.”
- 2 means “I do this only occasionally.”
- 3 means “I sometimes do this.” (About 50% of the time.)
- 4 means “I usually do this.”
- 5 means “I always or almost always do this.”

After reading each statement, circle the number (1, 2, 3, 4, or 5) that applies to you using the scale provided. Please note that there are no right or wrong answers to the statements in this inventory.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>STRATEGIES</th>
<th>SCALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLOB</td>
<td>1. I have a purpose in mind when I read.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>SUP</td>
<td>2. I take notes while reading to help me understand what I read.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>GLOB</td>
<td>3. I think about what I know to help me understand what I read.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>GLOB</td>
<td>4. I preview the text to see what it’s about before reading it.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>SUP</td>
<td>5. When text becomes difficult, I read aloud to help me understand what I read.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>SUP</td>
<td>6. I summarize what I read to reflect on important information in the text.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>GLOB</td>
<td>7. I think about whether the content fits my reading purpose.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>PROB</td>
<td>8. I read slowly but carefully to be sure I understand what I’m reading.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>SUP</td>
<td>9. I discuss what I read with others to check my understanding.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>GLOB</td>
<td>10. I skim the text first by noting characteristics like length and organization.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>PROB</td>
<td>11. I try to get back on track when I lose concentration.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>SUP</td>
<td>12. I underline or circle information in the text to help me remember it.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>PROB</td>
<td>13. I adjust my reading speed according to what I’m reading.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>GLOB</td>
<td>14. I decide what to read closely and what to ignore.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>SUP</td>
<td>15. I use reference materials such as dictionaries to help me understand what I read.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>PROB</td>
<td>16. When text becomes difficult, I pay closer attention to what I’m reading.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>GLOB</td>
<td>17. I use tables, figures, and pictures in text to increase my understanding.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>PROB</td>
<td>18. I stop from time to time and think about what I’m reading.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>GLOB</td>
<td>19. I use context clues to help me better understand what I’m reading.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>SUP</td>
<td>20. I paraphrase (restate ideas in my own words) to better understand what I read.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>PROB</td>
<td>21. I try to picture or visualize information to help remember what I read.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>GLOB</td>
<td>22. I use typographical aids like bold face and italics to identify key information.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>GLOB</td>
<td>23. I critically analyze and evaluate the information presented in the text.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>SUP</td>
<td>24. I go back and forth in the text to find relationships among ideas in it.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>GLOB</td>
<td>25. I check my understanding when I come across conflicting information.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>GLOB</td>
<td>26. I try to guess what the material is about when I read.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>PROB</td>
<td>27. When text becomes difficult, I re-read to increase my understanding.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>SUP</td>
<td>28. I ask myself questions I like to have answered in the text.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>GLOB</td>
<td>29. I check to see if my guesses about the text are right or wrong.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>PROB</td>
<td>30. I try to guess the meaning of unknown words or phrases.</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

Metacognitive Awareness of Reading Strategies Inventory
SCORING RUBRIC

Student Name: ___________________ Age: _______ Date: _________________
Grade in School: □ 6th □ 7th □ 8th □ 9th □ 10th □ 11th □ 12th □ College □ Other

1. Write your response to each statement (i.e., 1, 2, 3, 4, or 5) in each of the blanks.
2. Add up the scores under each column. Place the result on the line under each column.
3. Divide the score by the number of statements in each column to get the average for each subscale.
4. Calculate the average for the inventory by adding up the subscale scores and dividing by 30.
5. Compare your results to those shown below.
6. Discuss your results with your teacher or tutor.

<table>
<thead>
<tr>
<th>Global Reading Strategies (GLOB Subscale)</th>
<th>Problem-Solving Strategies (PROB Subscale)</th>
<th>Support Reading Strategies (SUP Subscale)</th>
<th>Overall Reading Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. _______</td>
<td>8. _______</td>
<td>2. _______</td>
<td>GLOB _______</td>
</tr>
<tr>
<td>3. _______</td>
<td>11. _______</td>
<td>5. _______</td>
<td></td>
</tr>
<tr>
<td>4. _______</td>
<td>13. _______</td>
<td>6. _______</td>
<td>PROB _______</td>
</tr>
<tr>
<td>7. _______</td>
<td>16. _______</td>
<td>9. _______</td>
<td></td>
</tr>
<tr>
<td>10. _______</td>
<td>18. _______</td>
<td>12. _______</td>
<td>SUP _______</td>
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<td>14. _______</td>
<td>21. _______</td>
<td>15. _______</td>
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<td>17. _______</td>
<td>27. _______</td>
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<td>19. _______</td>
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<td>22. _______</td>
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<td>26. _______</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>29. _______</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

____ GLOB Score ______ PROB Score ______ SUP Score ______ Overall Score
____ GLOB Mean ______ PROB Mean ______ SUP Mean ______ Overall Mean

KEY TO AVERAGES: 3.5 or higher = High  2.5 – 3.4 = Medium  2.4 or lower = Low

INTERPRETING YOUR SCORES: The overall average indicates how often you use reading strategies when reading academic materials. The average for each subscale of the inventory shows which group of strategies (i.e., global, problem-solving, and support strategies) you use most when reading. With this information, you can tell if you are very high or very low in any of these strategy groups. It is important to note, however, that the best possible use of these strategies depending on your reading ability in English, the type of material read, and your purpose for reading it. A low score on any of the subscales or parts of the inventory indicates that there may be some strategies in these parts that you might want to learn about and consider using when reading (adapted from Oxford 1990: 297-300).