IS THE EFFECT OF PREQUESTIONS ON LEARNING FROM READING PASSAGES DUE TO ATTENTION?
AN EYE-TRACKING STUDY

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ABSTRACT

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Previous studies have shown that asking prequestions is an effective strategy for learning, but there is not enough evidence demonstrating why prequestions lead to a general benefit on learning. Considering this need, the goal of this study was to investigate the effects of prequestions on learning outcomes and to reveal the underlying reasons for this benefit on learning by using eye movement measurements. In order to examine the effects of prequestions, half of the randomly selected participants answered questions before reading the passage (Prequestion Group, n = 12), and the rest were given no prequestions (Control Group, n = 12). This study showed that answering prequestions benefited general learning of both prequestioned and non-prequestioned items. The participants in the Prequestion Group had better post-test scores for the prequestioned items and longer complete fixation time, higher fixation number on the prequestioned items than the Control Group due to top-down attentional processes. In addition, the Prequestion Group had more gaze transitions between the prequestioned items due to the integration processes than the Control group. However, the Prequestion Group had higher post-test scores on the non-prequestioned items, although they showed shorter complete fixation time and less number of fixations on the non-prequestioned items than the Control Group.

Therefore, while attention can explain the effect of prequestions for prequestioned items, attention is not sufficient to explain the impact of prequestions for non-prequestioned items.

Keywords: Prequestion Effect, Eye-tracking, Top-down Attention, Integration Processes, Learning.

ÖZ

OKUMA PARÇALARININ ÖĞRENİLMESİNDE ÖN SORULARIN ETKİSİ DİKKATTEN Mİ KAYNAKLANIYOR? BİR GÖZ İZLEME ÇALIŞMASI

BOSTAN, ESRA
Psikoloji Yüksek Lisans Tezi

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Önceki çalışmalar, önsoru sormanın öğrenme için etkili bir strateji olduğunu göstermiştir, ancak önsoruların neden öğrenme üzerinde genel bir faydaya yol açtığını gösteren yeterli kanıt yoktur. Bu ihtiyaçtan hareketle bu çalışmanın amacı, göz hareketi ölçümlerini kullanarak ön soruların öğrenme çıktılarına etkisini araştırmak ve bu yararın altında yatan nedenleri ortaya çıkarmaktır. Önsoruların etkilerini incelemek için rastgele seçilen katılımcıların yarısı metni okumadan önce soruları yanıtlamış (Önsoru Grubu, $n = 12$) ve geri kalanına ise herhangi bir önsoru verilmemiştir (Kontrol Grubu, $n = 12$). Bu çalışma, önsoruların hem önceden sorulan hem de sorulmayan maddelerin öğrenilmesine fayda sağladığını göstermiştir. Önsoru Grubundaki katılımcıların, yukarıdan-aşağıya dikkat süreçleri nedeniyle Kontrol Grubuna kıyasla, önceden sorulan maddelerde daha yüksek son test puanına, tam sabitlenme süresine ve sabitlenme sayısına sahip oldukları görülmüştür. Ayrıca, Önsoru Grubu, entegrasyon süreçleri nedeniyle, önceden sorulan maddeler arasında Kontrol grubuna göre daha yüksek bakış geçişlerine sahiptirler. Bununla birlikte, Önsoru Grubu, önceden sorulmayan maddelerde Kontrol Grubundan daha düşük tam sabitleme süresi ve

sabitleme sayıları gösterse de bu maddelerde daha iyi son test puanlarına sahip olduğu bulunmuştur. Bu nedenle dikkat, önceden sorulan maddelerde ön soruların etkisini açıklayabilirken, önceden sorulmayan maddelerde önsoruların etkisini açıklamak için dikkat yeterli değildir.

Anahtar Sözcükler: Ön Soru Etkisi, Göz İzleme, Yukarıdan Aşağıya Dikkat, Entegrasyon Süreçleri, Öğrenme.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

SYMBOLS:

ms	: Millisecond
min	: Minute
cm	: Centimeters

ABBREVIATIONS

MMCB	: Multi-Media Comprehension Battery
AOI	: Area of Interest
EMH	: Eye Mind Hypothesis
CTML	: Cognitive Theory Multimedia Learning
OGAMA	: Open Gaze and Mouse Analyzer
ICC	: Intraclass Correlation Coefficient

CHAPTER I

INTRODUCTION

1.1. BACKGROUND OF THE CURRENT STUDY

1.1.1. Testing Effect

Previous studies on learning have shown that several learning strategies can significantly improve students' memory performance. One of the most effective learning strategies is to answer questions about the material that has just been studied (i.e., "testing"). Thus, after testing practice, students can have better memory or transfer performance on tested information than in a restudy condition (i.e., the condition of rereading the study material instead of the test practice). This benefit on memory can be defined as a "*testing effect*".

1.1.2. Pretesting Effect

Recent studies have focused more on whether the effect of answering questions before learning some material (i.e., "pretesting") enhances memory performance. These studies suggest that when participants answer questions about the material before they study that material, they could perform better when they answer the same questions again. This effect on learning is referred to "*pretesting effect*" or "*prequestion effect*" (Carpenter and Toftness 2017; Hausman and Rhodes 2018).

For example, Richland et al. (2009) have examined the effects of prequestions on learning. Their participants read a prose passage about vision and then were tested. Participants in the Prequestion Group tried to answer open-ended questions before reading the passage, whereas participants in the Control Group did not answer any questions before reading. For all participants, post-test was evaluated with the questions previously asked to the Prequestion Group (*i.e., prequestioned materials*) and other questions that both groups had never seen before (*i.e., non-prequestioned*

materials). The results suggested that the participants given prequestions before reading the passage had more correct answers to prequestions repeated in the post-test than the Control Group.

Likewise, studies using various types of pre-test and post-test (e.g., multiple-choice, cued recall, free recall) have shown a significant effect of prequestions on learning from reading passages (Callender and McDaniel 2009; Carpenter 2009; Lima and Jaeger 2020; Mulligan and Picklesimer 2016; Rickards and McCormick 1988; Roediger and Butler 2011; Zaromb and Roediger 2010). These studies suggest that the benefit of learning from prequestions may be limited; namely, the advantage of prequestions is limited to only prequestioned items prior to reading a passage. However, limited studies have shown the general benefit of learning for prequestions and non-prequestions (Carpenter and Toftness 2017; Little and Bjork 2016; Pressley et al. 1990; St. Hilaire et al. 2019). Therefore, it is unclear in the relevant literature what causes the benefits of prequestions.

1.1.2.1. Possible Underlying Reasons of the Prequestion Effect

The pretesting can improve learning due to paying more attention to the material. Recent eye-tracking studies support the relationship between learning and the effect of prequestions that may result from attention (Grant and Spivey 2003; Hyönä et al. 1997 Inamdar and Pomplun 2003; Peterson et al. 2008; Reynolds et al. 1990; Yang et al. 2021). Integrative processes can also explain the impact of prequestions (i.e., integrative prequestions) on learning because increased attention to the material can facilitate the integration of information from prequestions (Jing et al. 2016; Johnson and Mayer 2012; Mason et al. 2015 2016; Wolters and Raffone 2008).

1.1.3. Replicating Study

St. Hilaire et al. (Experiment 2; 2019) examined that integrative prequestions enhance post-test performance for both prequestioned and non-prequestioned materials, indicating a general benefit for learning. They conducted an experiment where they randomly assigned participants to either the Prequestion Group or the Control Group. Participants in the Prequestion Group answered two integrative questions (i.e., prequestions) before reading the passage, and they answered all four integrative questions (i.e., both prequestions and non-prequestions) at the post-test.

However, participants in the Control Group did not answer any questions, and they answered the same four integrative questions during the post-test.

The answers to integrative questions could be explicitly located in the passage, but it was necessary to integrate and combine information from the different paragraphs in the reading passage to answer these questions. In addition, participants in the Prequestion Group, but not the participants in the Control Group, were supported with additional instructions for enhancing performance on integrative prequestions. The authors suggested that additional instructions can be essential for the participants to integrate information successfully.

Firstly, two integrative prequestions were given to the Prequestion Group before reading the material, whereas participants in the Control Group were not asked prequestions. After the pre-test phase, participants in the Prequestion Group were supported with additional instructions to find the answers to the two prequestions while studying the passage. They were informed that the same two questions would be asked again in the post-test. Then, they were also informed that answers to questions were explicitly in the reading passage, but they would be in multiple paragraphs of the reading passage. Immediately after the study phase, the participants assigned to the Prequestion Group were asked to write two prequestions given in the pre-test. Therefore, a manipulation check was conducted to assess whether the participants remembered the prequestions while studying the reading material.

This study shows that answering integrative prequestions improved final test performance on both prequestioned and non-prequestioned material— representing a general benefit of learning. Therefore, integrative prequestions are more likely than other prequestions (i.e., isolating prequestions) to improve learning performance on both prequestioned and non-prequestioned material.

1.1.4. Eye-tracking Technique

Eye-tracking is a widely used technique in reading research. It helps to measure the visual attention directed towards a particular material. Eye tracker records eye movements where the participant looks at the material and how long they look there while reading. In short, it records the eye movements data (e.g., *fixation duration, gaze transition, fixation number*). In eye-tracking studies, fixation duration and fixation number can be used as signs for attentional processes (Bera et al. 2019; Jamet et al. 2008; McCoy-Thomas 2020; Meghanathan et al. 2015; Yang et al. 2021). In addition,

gaze transition is suggested as an indicator for integrative processes (Arndt et al. 2015; Chan 2009; Johnson and Mayer 2012; Mason, Tornatora, et al. 2015; Ponce and Mayer 2014; Wolters and Raffone 2008). Thus, eye-tracking may be one of the most effective methods for assessing visual attention.

According to the *eye-mind hypothesis* (EMH; Just and Carpenter 1980), "*the eye remains fixated on a word as long as the word is being processed. So the time it takes to process a newly fixated word is directly indicated by the gaze duration*" (p. 330). Thus, the eye-mind hypothesis can explain why learners look at prequestioned items longer than others.

For example, more attention can be guided to the familiar information that the participants have seen before while reading a passage compared to unfamiliar information. Therefore, they can perform more fixation numbers and duration on familiar information than unfamiliar information that they have not seen before.

1.2. THE CURRENT STUDY

1.2.1. Goal of the Current Study

The goal of this study was to investigate the effects of prequestions on learning outcomes and to reveal the underlying reasons for this benefit on learning by using eye movement measurements. The eye-tracking technique has the potential to reveal whether the general benefits of prequestions on learning are due to attentional processes (i.e., top-down process)—indicated by fixation duration and numbers of fixation— and integrative processes—indicated by gaze transitions. Consistent with previous studies (Hausman and Rhodes 2018; Hinze et al. 2013; Pressley et al. 1990; St. Hilaire et al. 2019; Thiede et al. 2011), answering prequestions is expected to increase attention to information related to prequestions. Therefore, increasing attention can facilitate learning relevant information to prequestions.

Nevertheless, answering integrative prequestions can increase attention to relevant and irrelevant information to the prequestion; this can lead to longer fixation duration and higher fixation number on prequestioned and non-prequestioned material in the post-test. In addition, previous literature with multimedia learning suggests that integrating relevant information to prequestion provides better memory performance and also leads to higher gaze transitions between the relevant information to prequestions (Mason, L., Pluchino, P., and Tornatora 2016; Mason, Tornatora, et al.

2015; Ponce and Mayer 2014). Therefore, consistent with previous studies, the nature of integrative questions can facilitate learning by integration processes.

1.2.2. Importance of the Current Study

To our best knowledge, there is no study in the literature investigating underlying reasons for the impact of integrative prequestions on learning. Furthermore, the effect of integrative questions on learning has not been associated with attention and integration processes. Therefore, in the current study, the effect of integrative prequestions was investigated using the eye-tracking technique that provides online measures of cognitive processing. The eye-tracker records eye movements during the processing of the material. The eye-tracking technique helps us understand where people are looking and how long they have been looking at that place.

For evaluating eye movements, fixation number and the complete fixation time are evaluated for the effect of the prequestion on attentional processes. In addition, gaze transition measure is examined to investigate the role of integrative processes in the prequestion effect. Due to the nature of integrative questions, answering them requires first finding relevant information to questions from multiple paragraphs in the text and then integrating them. Thus, successful integration of relevant information is expected to enhance learning.

In sum, this study helps to understand the prequestions effect on learning. In addition, it provides an understanding of whether attentional processes are responsible for this effect. Furthermore, it can reveal whether integrative processes facilitate learning performance.

1.2.3. Design of the Current Study

In order to examine the effect of prequestions on learning, retention of the reading passage was evaluated. Participants were assigned randomly to a Prequestion Group in which they would be answered integrative prequestions about a reading passage before studying it or a Control Group in which they would not answer any integrative prequestions before. For both groups, the participants' eye movements (e.g., gaze transition, fixation number, and complete fixation time) were recorded during the reading. After studying the passage, participants in both groups were asked four integrative questions in the post-test session. For the Prequestion Group, two of

these integrative questions were given before as the prequestion (i.e., *prequestioned items*); other questions were never-before-seen questions about the reading passage (i.e., *non-prequestioned items*). For the Control Group, all questions from the passage had not been seen before; namely, all questions were as non-prequestioned items.

Firstly, this design enabled an investigation of the influence of prequestions on learning by comparing post-test performances on the prequestioned and non-prequestioned items for the Prequestion Group and Control Group after the reading passage was studied. It also allowed investigating whether the effect of prequestions on learning was due to attention by comparing the recorded eye movements—fixation number and complete fixation time— on the prequestioned and non-prequestioned items for the Prequestion Group and Control Group while studying the reading passage. Finally, it allowed examining the effect of integrative prequestion on learning due to integration processes by comparing the recorded gaze transition between prequestioned items for the Prequestion Group and Control Group while studying the reading passage.

1.2.4. Predictions of the Current Study Based on Literature

Based on the previous literature, it was expected that participants in the Prequestion Group would have better memory performance on reading material than participants in the Control Group (e.g., Carpenter and Toftness 2017; Frase 1968; Hausman and Rhodes 2018; James and Storm 2019; St. Hilaire and Carpenter 2020). In addition, it was expected that answering prequestions would improve memory for both prequestioned and non-prequestioned items (e.g., St. Hilaire et al. 2019; Little and Bjork 2016; Pressley et al. 1990; Richland et al. 2009).

According to the eye-mind hypothesis (Just and Carpenter 1980) and eye-tracking studies (Grant and Spivey 2003; Inamdar and Pomplun 2003; Yang et al. 2021), it was hypothesized that the complete fixation duration on both prequestioned and non-prequestioned items would be longer in the Prequestion Group than in the Control Group due to attentional processes. In addition, higher fixation numbers on prequestioned items, which include related information to prequestion, and non-prequestioned items, which consist of irrelevant information to prequestion, would be expected in the Prequestion Group compared to the Control Group due to attentional processes (Bayram and Mutlu Bayraktar 2012; Peterson et al. 2008). Finally, it was hypothesized that more gaze transitions between prequestioned items would be

performed for prequestioned items than the non-prequestioned items due to integrative processes(Acarturk and Ozcelik 2017).

1.2.5. Hypotheses

There are four hypotheses of the current study. Three hypotheses are related to eye movements, and one is related to behavioral data.

***Hypothesis 1*:** The effect of prequestions on the learning outcomes for the Prequestion and Control Groups

1a. Learning performance on the prequestioned items would be higher in the Prequestion Group than in the Control Group.

1b. Learning performance on the non-prequestioned items would be higher in the Prequestion Group than in the Control Group.

***Hypothesis 2*:** The effect of prequestions on the gaze transition for the Prequestion and Control Groups

2a. The number of gaze transitions between prequestioned items would be higher in the Prequestion Group than in the Control Group.

Hypothesis 3: The effect of prequestions on the fixation number for the Prequestion and Control Groups

3a. The fixation number on the prequestioned items would be higher in the Prequestion Group than in the Control Group.

3b. The fixation number on the non-prequestioned items would be higher in the Prequestion Group than the Control Group.

Hypothesis 4: The effect of prequestions on the complete fixation time for the Prequestion and Control Groups

4a. The complete fixation duration on the prequestioned items would be longer in the Prequestion Group than in the Control Group.

4b. The complete fixation duration on the non-prequestioned items would also be longer in the Prequestion Group than the Control Group.

CHAPTER II

LITERATURE REVIEW

2.1. TESTING EFFECT

A powerful strategy to improve student learning is to ask questions about the information learned. This strategy is called testing. Studies on human learning and memory have shown that retrieval attempts of information using testing are powerful for learning and long-term memory. This phenomenon for retrieval attempts to improve long-term memory is known as the *"testing effect"* (Karpicke et al. 2009). Also, the testing effect is known as the retrieval practice effect or test-enhance learning effect (Pan and Rickard 2018). Research on the testing effect shows that answering questions after an initial learning material enhances long-term memory performance on the reading passage compared to re-reading, re-studying, or highlighting (Carpenter 2012; Hinze et al. 2013; Karpicke et al. 2009; Roediger and Butler 2011; Roediger and Karpicke 2006b; Rohrer et al. 2010).

However, previous studies have shown that re-reading is a well-liked strategy for students (Millis and King 2001; Rawson and Kintsch 2005; Stine-Morrow et al. 2004). However, some studies have reported that re-reading is usually not effective for learning (Callender and McDaniel 2009; Craik 2016). Furthermore, although most students prefer re-reading, summarizing, or taking notes while preparing for upcoming exams (Amlund et al. 1986; Carrier 2003; Feldt and Ray 1989; Karpicke et al. 2009), many studies have suggested that testing is one of the most effective learning strategy for students to prepare for their upcoming exams (Carpenter and Delosh 2006; Kang et al. 2007; Roediger and Karpicke 2006a).Studies of the testing effect typically consist of a three-stage experimental paradigm: (1) *initial or review study* stage of learned materials (i.e., encoding stage), (2) *training stage in* which learning materials are tested (i.e., retrieval attempts of encoding information), or in which learning materials are restudied for comparison with a control group, (3) *final test* (also known as the critical test) in which materials tested initially are expected to be remembered.

The testing effect has been shown in using a broad range variety of materials, including prose passages (e.g., Butler 2010; Callender and McDaniel 2009; Wheeler et al. 2003), single-word lists (Carpenter et al. 2006; Carpenter and Delosh 2006; Rowland et al. 2014), and paired associates word lists (Carpenter 2009; Pyc and Rawson 2009). Moreover, the testing effect has been assessed with a variety of test types such as multiple-choice and short-answer questions (Butler et al. 2007; Koediger and Marsh 2005; Roediger et al. 2011), with and without feedback after retrieval trials (Carpenter et al. 2006; Moore et al. 2018; Mulligan and Picklesimer 2016; Roediger and Butler 2011), with a variety of retention intervals (Rowland and DeLosh 2015; Wheeler et al. 2003), and with students of various ages (i.e., middle-school-aged, elementary-school-aged, college-aged students; Agarwal et al. 2017; Carpenter et al. 2009; Rohrer et al. 2010) and with various individual differences (Callender and McDaniel 2007; Pan et al. 2015; Sanchez and Wiley 2006).

2.1.1. Benefits of Retrieval Practice (Testing) on Memory

Studies on retrieval practice have shown that answering questions about instructional materials benefits memory performance (Mulligan and Picklesimer 2016; Pan and Rickard 2018; Rohrer et al. 2010). For example, if students are tested about instructional material they just have learned (i.e., if they try to retrieve the information they have learned via testing), information is better transferred to their long-term memory.

A laboratory study by Carpenter (2011) examined the effect of retrieval practice on learning. Participants were randomly assigned either retrieval practice condition or re-study condition (i.e., control group). A series of word pairs were presented to participants for studying. After the initial study, participants in the re-study condition were re-exposed to the same series of word pairs for studying again. However, participants in the retrieval condition were given a cue word from each word pair that encouraged them to remember the target word. After a short delay, both groups were tested with all word pairs list. The participants in the retrieval condition had significantly better retention of word pairs on the final test than participants in the re-study condition. Likewise, many studies have supported these findings using word pairs in laboratory settings. (Carpenter et al. 2006; Coppens et al. 2011; Roediger and Karpicke 2006b; Wilkinson et al. 2019).

In addition, testing has been shown to facilitate the transfer of untested information (i.e., never-before-studied; Carpenter and Kelly 2012; Cho et al. 2017; Kang et al. 2007; Rohrer et al. 2010). For instance, a study about natural-concept learning (Jacoby et al. 2010) reported that testing improves performance in learning to categorize the birds into a specific familial group (i.e., participants tried to categorize birds into their appropriate familial groups, and then they received corrective feedback) compared to the re-study condition (i.e., participants just saw the birds with their family labels). Learning this information benefited from categorizing these birds' families and categorizing never-before-studied birds into their correct familial groups.

According to *transfer-appropriate theory* (TAP; Morris et al. 1977), retrieval practice can facilitate the transfer of learning when the type of processing during retrieval information from memory overlaps the type of processing during encoding. Consistent with TAP, Veltre et al. (2015) found that tested participants had better recall performance than the re-study group when initial and final cues were more similar. They suggested that the testing effect might be due to more overlapping of the final test's retrieval processes with the initial test's retrieval processes.

One important question is about the testing effect; what happens when the final memory test differs from the initial test?. Studies have investigated this effect using the initial test in one type (e.g., cued recall) and the final test in different formats (e.g., free recall). For instance, in several studies using different test formats (e.g., recall vs. recognition), overlapping the initial test with the final test did not improve final test scores compared to non-overlapping conditions (Carpenter and Delosh 2006; Kang et al. 2007). Similarly, some studies (Carpenter et al. 2006; Carpenter 2009) have shown that an initial cued recall test benefits retention of the word-pair list than the additional reading condition, even when the final test is cued recall in the opposite direction— i.e., initial study; A→B (retention word pair); training study, A→? (cued recall same direction); final test, ?→B (cued recall opposite direction —, or free recall format.

Other studies in educational settings have supported that the participants in the testing condition can facilitate learning transfer on different final tests from the initial test formats than the participants in the re-study condition. For example, McDaniel et al. (2007) evaluated the testing effect in a web-based course with additional reading or weekly quizzes. They reported that the testing effect improved learning and memory, even though there was variability between the quizzes (e.g., "All preganglionic axons,

whether sympathetic or parasympathetic, release _____ as a neurotransmitter") and critical tests (e.g., "All _____ axons, whether sympathetic or parasympathetic, release acetylcholine as a neurotransmitter").

Additional studies have supported the benefit of the testing effect even when the memory is assessed after several days (i.e., re-study condition; Butler et al. 2007; Chan and LaPaglia 2011; Overoye et al. 2021; Rowland and DeLosh 2015), or even after a 9-month delay (Carpenter et al. 2009) when compared to a re-study condition. Moreover, sometimes studies have shown that the testing effect can be more robust when memory is tested after a delay than tested immediately after learning material (Coppens et al. 2011; Kornell et al. 2011; Toppino and Cohen 2009). These studies also support that testing can improve learning performance when the final test becomes similar to the initial test (i.e., review phase).

2.1.2. Testing does not Always Enhance Memory

Even though many researchers have reported the benefit of testing trials in both laboratory and classroom settings, recent researchers have suggested that taking a test is not always the most effective learning strategy for each student. Individual differences (e.g., overall class performance, working memory capacity) may affect the impact of testing on memory. (Carpenter et al. 2016) suggested that students' performance, whether it was low or high, had an influence on the effectiveness of retrieval practice. In this study, students were randomly assigned into either the recall condition—in which students were asked to recall the description of five terms— or copy condition—in which the descriptions of five terms were asked to copy. After a one-week delay, students were tested again. However, they divided the students into three groups according to students' overall class performance. The students with the best overall class performance performed better in recall conditions than copy conditions. On the other hand, the students with the worst overall class performance performed better in the copy condition than in the recall condition.

In addition, although previous studies on memory showed that more testing practice could increase errors in retention (Henkel 2004; Roediger et al. 1996), other studies reported reverse findings (Bluck et al. 1999; Bornstein et al. 1998). For these mixed results, Wheeler and Roediger (1992) suggested that a critical factor on the testing effect could be the delay between serial recall trials. If the delay after the first recall trial is short, the probability of correct recall is likely to increase. However, if

the delay after the first recall attempt is long, forgetting may occur (Chan and LaPaglia 2011).

2.2. PREQUESTION EFFECT

Answering questions before learning materials can improve learning. This effect is known as the "*prequestion effect"*(St. Hilaire et al. 2019). The prequestion effect, emphasized more recently, can be described as a specific testing effect. Studies of the prequestions typically include a three-stage experimental paradigm: (1) *pre-test stage* in which questions from specific learning material are given to the participants (but this stage is not present for the control group), (2) *studying stage* where all participants studied that material, and (3) *post-test stage* where learning is evaluated with both questions which are asked in the pre-test and other never-seen-before questions. In typically laboratory experiments on prequestions, participants are assigned randomly to either a Prequestion Group, in which prequestions were asked before studying the material, or a Control Group, in which no prequestions are asked and only the material is studied. Prequestions are the questions that are asked before studying, and they are firstly asked the in pre-test and then tested in post-test again. Nonprequestions are also called as never-before-seen questions, and they are asked only in the post-test.

2.2.1. Benefits of Prequestions

2.2.1.1. Answering Prequestions Improves Learning

Previous findings suggested that participants in the Prequestion Group showed significantly higher performance on a delayed post-test than participants in the Control Group, even if the participants answered these questions incorrectly or were not given feedback (Lima and Jaeger 2020; Pan et al. 2020; Peeck 1970; Rickards 1976b 1976b; Sagaria and di Vesta 1978; Shanahan 1985; Watts 1974). For example, Rickards (1976a) showed that asking questions before reading improves memory performance. In their study, all participants read a text on an imaginary African country called Mala. Before reading the text, the open-ended questions (e.g., "What geographical term best describes southern Mala?") were given to the participants in the Prequestion Group, and they tried to answer these questions from the text, whereas the Control Group did

not. After the final test, when all participants were asked to recall the passage, the Prequestion Group remembered the passage better than the Control Group.

Similarly, studies have shown a significant effect of prequestions on learning from reading passages with other types of pre-tests and post-tests— e.g., multiple-choice (Callender and McDaniel 2009; Lima and Jaeger 2020; Roediger et al. 2011); cued recall (Agarwal et al. 2017; Cho et al. 2017; Mulligan and Picklesimer 2016), free recall (Carpenter 2009; Hinze et al. 2013; Martin et al. 2016; McDaniel et al. 2002; Rickards and McCormick 1988; Zaromb and Roediger 2010)

2.2.1.2. Specific and General Benefit of Prequestions

Specifically, recent studies have reported that the participants who answered the prequestions remembered the information in the prequestions better than the information that was not tested (i.e., nonprequestioned information) relative to a control group (Frase 1968; Hausman and Rhodes 2018; James and Storm 2019; Lin et al. 2018; Toftness et al. 2018). This effect on learning is known as the *specific benefit of prequestions*. For instance, Toftness et al. (2018) reported that for the prequestioned materials, participants in the Prequestion Group performed highly on the final test than the participants in the Control Group. However, their performance on the nonprequestions was not better than the Control Group. Therefore, they suggested a positive but limited prequestion effect on learning in the video material. Some studies also reported this effect of prequestions on similar-style video lectures (James and Storm 2019) and actual classroom conditions (Carpenter et al. 2018). These studies suggest that the benefits of pretesting might be limited to those questions that have been seen asked previously.

However, prequestions in under certain circumstances might provide a broad benefit on learning for both information in the prequestions and other information included in the reading material; this is known as a *general benefit of prequestions.* For instance, Little and Bjork (2016) reported that answering multiple-choice prequestions improves learning performance on both related information and non-related information from reading material relative to cued recall pretesting. However, in this study, multiple-choice prequestions had four options and one correct option. The other three incorrect options, designed as competitive alternatives to the correct option, were related to nonprequestions on the final test. Therefore, for multiple-choice questions, learners' attention might be attracted to their correct answers and their

competitive alternatives while reading the passage, especially when feedback on whether the answers are correct or incorrect is given. These results suggest a general benefit of prequestions on reading materials (e.g., Carpenter and Toftness 2017; Pressley et al. 1990; Richland et al. 2009; St. Hilaire et al. 2019).

2.2.2. Does Answering Prequestions Damage Learning of Nonprequestioned Information?

Answering prequestions may have a detrimental effect on learning. Previous studies have compared learning performance on nonprequestioned information for the Prequestion Group and Control Group. Some studies have reported a worse performance on nonprequestioned information (Boyd 1973; Hamaker 1986; Rickards 1976; Sagaria and di Vesta 1978), whereas recent studies have shown the learning benefit of prequestions (Carpenter et al. 2018; Carpenter and Toftness 2017; Little and Bjork 2016; Yang et al. 2021). Generally, this detrimental effect was reported when a passage was read, but not when a video-based material was presented. For example, in a previous study by Peeck (1970), seventy-two undergraduates who studied a 3,000-word reading passage about Greece were tested on the immediate and delayed memory retention task. There were two experimental groups (Prequestion, Guess Group; Prequestion, No-Guess Group) and two control groups (No-Prequestion and Extra Reading time Group, No-Prequestion and No-Extra Reading-time Group) in the study. Participants exposed to prequestions showed a decrement in retention of the irrelevant information to prequestions, while an improvement in retention of the relevant information to prequestions compared to the Control Group (i.e., No-Prequestion and No-extra reading-time Group). Peeck suggested that the detrimental effect might be due to selective attention to relevant information to prequestions.

In addition, this detrimental effect has been reported by another study in educational settings (Sagaria and di Vesta 1978). They investigated the effect of adjunct questions on learner expectations, and they reported that undergraduate students in the Prequestion-treatment Group significantly improved memory only on prequestions. However, answering questions decreased memory on nonprequestions compared to the No-question Group, which did not answer prequestions, reflecting a detrimental effect on learning for nonprequestioned material. Specifically, this detrimental effect was reported when the passage was read but not when the lecture was presented in a video format. One suggestion of this adverse effect of prequestions

on nonprequestioned material is that students in the Prequestion Group can only guide their attention to the pre-questioned material and possibly ignore the nonprequestion materials (Carpenter et al. 2018).

2.2.3. Types of Prequestions on Their Effect on Learning

2.2.3.1. How do Prequestions Asked in Different Question-types Affect Learning?

Previous studies on prequestions usually have used simple questions—i.e., *factual, verbatim, or isolative questions* whose answers are explicitly located in a reading passage and have involved a single fact (e.g., Hamaker 1986; Hausman and Rhodes 2018; Little and Bjork 2016; Rickards 1976a 1976b; St. Hilaire et al. 2019; Thiede et al. 2011; Toftness et al. 2018). Specifically, these studies showed that factual pretesting improved learning compared to other types of pretesting.

For example, a study by Little and Bjork (2016) reported that multiple-choice pretesting, including factual-type questions, significantly improves learning performance on both related information and non-related information relative to the cued recall pretesting. The final test performance revealed the general benefit of prequestions on reading material. As in this study, although factual type prequestions provided learning on questions asked before and never-asked-before (e.g.,video-based reading material; Carpenter and Toftness 2017), sometimes this general benefit may not be found (e.g., video-based material; Toftness et al. 2018). One explanation of this result is that the length of the study material may affect the benefit of prequestions. For instance, Carpenter and Toftness (2017) examined whether the effects of pretesting on learning from brief 2-min video-based text material and found that a taking pretest which included factual questions (e.g., “How many families originally settled on the island of Rapa Nui?”) before learning benefits learning on both repeated and novel factual information (i.e., general benefit of learning).

However, Toftness et al. (2018; Experiment 1) demonstrated that answering factual prequestions about a 22-min video lesson enhances performance only on repeated factual information. Although more extended video materials may require additional processing to include more information, information from shorter video material may be recalled more easily. In contrast to these results in the literature that factual questions benefit learning, Rickards (1976a) showed that verbatim prequestions requiring recall of a sentence from the whole passage were less recalled on the final test than conceptual prequestions that require abstraction of a topic.

Sometimes, studies have used more complex questions than simple ones, providing deeper processes or elaborative processing. These are called *interference*, *higher-order*, *conceptual*, or *integrative questions* in the literature. Answers of higher-order, interference, or conceptual questions were not explicitly located in the passages, and readers needed to make inferences from different parts of the reading text to answer these questions (Hausman and Rhodes 2018; Rickards 1976a). Integrative questions, however, are different from the others, their answers are clearly stated in the reading passage, and their answers do not require new inferences (St. Hilaire et al. 2019).

Giving additional instructions regarding the nature of the test before studying to answer these questions may support the prequestion effect. (e.g., Hinze et al. 2013; Thiede et al. 2011). For example, in the study by Thiede et al. (2011), some participants were informed that they would first read a text, and then their memory would be tested for the specific facts explicitly located in the text (i.e., tested on the factual questions). Other participants were informed that their ability to make inferences from information in different parts of a text would be tested before reading the passage (i.e., tested on the conceptual questions). These two groups were tested on both factual and conceptual questions. The results showed that performance on conceptual questions was better for the participants expecting conceptual questions than for the participants expecting factual questions. Similarly, performance on factual questions was better for the participants expecting factual questions than for the participants expecting conceptual questions.

Moreover, Hausman and Rhodes (2018) suggested that conceptual style prequestions could benefit general learning. They examined whether the conceptual prequestions enhance the learning of prequestion and nonprequestion information. Participants were asked either factual or conceptual types of prequestions before reading passages. In the control condition, participants did not answer any questions. The answers to *factual questions* were directly stated in the text (e.g., “How much of the earth is covered by glaciers during an ice age?”, and the answer was “three” explicitly located in the passage), but answers to conceptual questions were not. For the *conceptual question,* participants were required to make inferences from the information in the reading passage (e.g., “An ice age is a period of time—usually millions or tens of millions of years—when vast glaciers cover as much as a third of the Earth’s land surface.”, the answer was not explicitly stated in the passage). They

suggested that passive reading could lead to find the answers to factual questions, while conceptual questions could lead to active reading. Thus, answering prequestions could enhance learning in both prequestioned and nonprequestioned information, representing a general benefit of learning. This study showed that factual prequestions improved factual learning, whereas conceptual prequestions did not enhance conceptual learning (Experiment 1). However, after answering conceptual prequestions, participants provided correct answers (Experiment 2) or correct or incorrect feedback (Experiment 3). Therefore, after giving corrective feedback, participants' performance was better on the repeated conceptual questions than on the novel conceptual questions. Also, it has been suggested that this effect may be due to memorization, not understanding the conceptual information.

A recent study developed a new approach to the null effect of conceptual prequestions on learning. St. Hilaire et al. (2019) designed *integrative prequestions* that required integrating information explicitly stated in different parts of the text, rather than conceptual prequestions requiring inference from information in different parts of the reading passage. In addition, participants who were asked prequestions were informed about the nature of the study (i.e., answers to questions are in the passage, but in the different parts of the reading passage) to promote the general benefit of learning before studying reading passages (Experiment 2), as in the study by Thiede et al. (2011). They reported that answering integrative prequestions enhanced memory for both prequestioned and nonprequestioned information on the post-test.

As Hausman and Rhodes' study, previous studies have provided that corrective feedback after the pretesting can facilitate learning of conceptual questions (e.g., Latimier et al. 2019; McDaniel et al. 2011; Sana et al. 2020). In addition to this facilitation, the participants' motivation to find the correct answer may increase when the corrective feedback is given after pretesting (Metcalfe 2017).

2.2.4. Underlying Causes of the Effect of the Prequestions on Learning

Although previous studies have shown that prequestions are an effective learning strategy, little is known about the reasons underlying the benefit of prequestions. The effect of prequestions might be due to attentional processes on these items.

2.2.4.1. Attentional Processes

The effect of prequestions has been shown to increase attention by enhancing learning (Hausman and Rhodes 2018; Little and Bjork 2016; Pressley et al. 1990; Reynolds et al. 1990; Richland et al. 2009; St. Hilaire and Carpenter 2020; Thiede et al. 2011; Watts 1974). In addition, the prequestions can activate prior information and focus attention on the material (Pashler et al. 2007).

2.2.4.1.1. Which Attentional Processes are Involved in Learning the Prequestions? Top-down or Bottom-up?

Top-down attention can be defined as a voluntary process in which individuals internally select and focus on a particular location, feature, or object for their current behavioral goals. On the other hand, bottom-up attention is an externally triggered process in which the information to be processed is automatically selected due to the highly salient features of the stimuli. These are known as two different functions of visual attention (Katsuki and Constantinidis 2014). Endogenous cues (e.g., prequestions) can activate top-down processes and include voluntary attention, whereas exogenous cues such as bold or italicized font can activate bottom-up processes and involuntarily grab attention. Previous literature on prequestions has usually shown that the effect of the prequestions on learning is due to *top-down attention* that could improve learning by using prequestions as a cue to guide attention, not bottom-up attention (e.g., Shapiro and Gordon 2012; Wolters and Raffone 2008). Answering questions prior to learning can increase top-down attention to prequestioned material. Thus, increased attention to the prequestioned information from the material can enhance learning on prequestions, but not on nonprequestions (i.e., participants selectively focus attention to prequestioned material that represents the specific benefit of learning during a learning experience; Frase 1968; Rothkopf and Bisbicos 1967; Shanahan 1985).

A recent study supports this suggestion that attention would be focused on the specific information related with the prequestions. St. Hilaire and Carpenter (2020) examined whether the effect of prequestions on prequestioned material was due to selective attention processing of the prequestioned information during a learning experience. They had students ask prequestions before viewing a video-based lecture, during which they filled out a sheet of paper with the prequestions or took notes. A significant prequestion effect was only shown when participants had successfully

recognized and explored answers to the prequestioned items during a video-based lecture (as stated in their notes or sheet of paper). This result suggests that the prequestion effect is based on students' memory on prequestions by guiding attention on prequestioned information (also see Carpenter and Toftness 2007)

In contrast, selective attention to prequestioned material may negatively affect learning non-prequestioned material from a reading passage. A detrimental effect was shown when reading a passage in previous studies (Hamaker 1986; Peeck 1970; Sagaria and di Vesta 1978). However, to our best knowledge, there is no evidence that prequestions do any damage to information from video-based material. Such findings suggest that participants with prequestions would focus their attention on the prequestioned material and possibly ignore the nonprequestion materials; that is, they perform worse memory on non-prequestioned material than a control group.

Sometimes, attention can enhance learning on both prequestioned and nonprequestioned information (e.g., learning of conceptual prequestions). Based on previous studies showing a general benefit of prequestions, it was expected that learners might direct more attention to information nonrelated to prequestions (i.e., nonprequestioned information(Carpenter and Toftness 2017; Little and Bjork 2016). Moreover, the conceptual pretesting has been suggested that participants can be directed to pay more attention to conceptual information than factual information. Therefore, the attentional processes are essential to learning conceptual prequestions (Hausman and Rhodes 2018; St. Hilaire et al. 2019).

Similarly, several studies used conceptual questions, giving participants additional instructions about the nature of the test, provided that they would focus their attention on different information to prequestion (Hinze et al. 2013; Thiede et al. 2011). Furthermore, providing corrective feedback to participants after pretesting may increase attention to prequestioned and nonprequestioned material (Carpenter et al. 2006; Latimier et al. 2019; McDaniel et al. 2011). Conversely, some studies suggested that providing corrective feedback immediately after pretesting might reduce attention to the material (Sana et al. 2020) and support memorization of the corrective feedback rather than learning information (i.e., the shallowing process of information; Kornell and Rhodes 2014).

However, focused attention may be insufficient to explain the effect of prequestions on learning. For example, in a previous study showing a general benefit of prequestions, Little and Bjork (2016) showed that prequestions improved learning

of irrelevant information to prequestions at the post-test, but participants did not spend more time on nonprequestioned information. Furthermore, increased attention to relevant information to prequestions during learning did not have the same effect as the prequestion effect. Similarly, previous studies have supported that attention alone will not be sufficient for learning (Pressley et al. 1990; Richland et al. 2009; Shapiro and Gordon 2012). In these studies, unlike the others, attention was also tested indirectly on learning. These studies support that top-down processes induced by prequestions are more effective on learning than bottom-up processes induced by salient features.

An fMRI study, in which the effect of attention on learning can be observed indirectly, has shown that increased attention to prequestioned information activates the frontal and parietal cortices due to top-down processes (Vestergren and Nyberg 2014). Likewise, another fMRI study by Wing et al. (2013) demonstrated that more attention is paid to prequestioned information than other information compared to a control group. Also, eye-tracking studies can more directly test whether the effect of prequestions on learning is due to attention.

2.2.4.1.2. Eye Tracking Technique

Eye-tracking technology provides an online procedure that allows monitoring of the attention and encoding processes during studying, including "what is attended first and for how long, what is attended next and for how long, how much switching of attention is done between different components of the learning materials, what components are linked together during attentional switching" (Hyönä 2010, p. 174). In addition, using eye-tracking technology allows researchers to make inferences about which elements (e.g., words, illustrations) in the screen are attractive to the learners and how these learners perceive the elements (Duchowski et al. 2003). Moreover, the eye-tracking technique provides methods for indicating how people attend and process information (Djamasbi 2014). It can indirectly measure people's cognition by interpreting eye movements (Miller 2015). Eye-tracking measures can provide insight into ongoing cognitive processes and visual attention during learning (Yang et al. 2021), whereas self-report measures often used to assess attention in past studies cannot capture rapid temporal changes in cognitive processes.

Previous studies have shown that eye-tracking technology is helpful for understanding the reading processes. For example, the differences in processing

between intro, medial, and final sentences about a topic (Ariasi et al. 2017), related and unrelated parts (Kaakinen and Hyönä 2005), and central versus peripheral notions in the reading passage (Yeari et al. 2017) has been investigated using an eye tracker. Andrá et al. (2015) also showed that eye-tracking facilitated understanding what information students pay attention to while solving geometric problems (e.g., Epelboim and Suppes 2001). In eye-tracking studies, two basic measurements are used, fixation and saccade.

2.2.4.1.2.1. Fixation

Fixation describes the condition in which the eye is fixed at one point (Alemdag and Cagiltay 2018). According to the *eye mind hypothesis* suggested by Just and Carpenter (1976), if the eye movements are fixed at one point, attention is directed to that point. Fixation count or *number of fixation* is the frequency of fixations at a specific AOI. *Complete fixation time* indicates the total fixation time. Fixation duration mean is the average fixation duration at each AOIs.

The complete fixation time and the number of fixations can indicate the amount of attention directed to a textual or pictorial AIO. Therefore, fixation information has been used to measure the attention given to the displayed object (Bayram and Mutlu Bayraktar 2012; de Koning et al. 2010; Wang et al. 2014; Yang et al. 2021). In addition, fixation duration and number are considered indicators of cognitive effort in information processing (Krejtz et al. 2013). For example, longer and more fixation on stimuli may reflect a greater processing difficulty.

Several studies have supported the evidence that fixation duration increases as information processing become more effortful (Inamdar and Pomplun 2003; Peterson et al. 2008). Similarly, Van Orden et al. (2001) showed that the number of fixations was strongly related to task performance associated with mental effort. This finding may propose a correlation between fixation number and cognitive effort. Moreover, more fundamental elements of a scene are given more attention representing more fixation and fixation duration than scene elements that are less relevant to the task (Christianson et al. 1991).

Previous eye-tracking studies in multimedia research have shown that fixation numbers are strongly related to complete fixation time. For example, a study (Boucheix and Lowe 2010) examining the effectiveness of different attention patterns on learning, including the spreading color cue and arrow cue, found that visual cues

effectively directed attention. The participants in cued conditions (i.e., given arrow cue or spreading color cue) made more fixations and spent more time on the animated piano mechanism than participants in the no cue condition. However, the participants' learning performance in the spreading color cue condition was better than in the arrow cue. This finding suggests that although different attention patterns successfully direct attention, their effects on learning may be different.

Likewise, Ozcelik et al. (2010) compared a signaling format in which participants directed their attention to particular multimedia material by activating bottom-up processes marked by external cues and a non-signaling format in which participants did not guide their attention to any part of the material. They found that participants had longer total fixation duration and higher fixations on relevant information in the signaled format than in the non-signaled format.

Similarly, in the study by Kaakinen et al. (2002), where animations were used as visual cues, the participants showed that the fixation duration and number of fixations were higher in the related parts with the visual cue than in the unrelated parts. In addition, De Koning et al. (2010) demonstrated that participants in the signaled condition had higher and longer fixations on cued content than non signaled condition.

Recently, an eye-tracking study on prequestions by Yang et al. (2021) demonstrated that participants who viewed video material with interpolated prequestions had a longer fixation duration on prequestioned information for the high achievement motivation group due to allocating more of their attention. Additionally, they performed higher post-test scores than the participants who viewed video material with no prequestions.

These eye-tracking studies showed a positive relation between increased attention and learning performance. However, some studies demonstrated that although visual cues directed more attention to relevant information, participants given visual cues did not perform better for the information presented (de Koning et al. 2010; Kriz and Hegarty 2007).

2.2.4.1.2.2. Gaze Transition

Saccade describes eye movement between fixations, demonstrating a shift in the focus of visual attention (Alemdag and Cagiltay 2018). Additionally, saccade measures include visit count (Zhao et al. 2014), *integrative transitions* (Johnson and

Mayer 2012; Ponce and Mayer 2014), and corresponding transitions (Johnson and Mayer 2012). These represent the integration of information in different locations from viewing objects. Integrative transitions represent the number of times the learner's eye movements switch from one specified AOI to another AOI text during studying.

In addition, when the duration of the saccadic eye movement becomes longer, this may indicate increased cognitive effort (Shojaeizadeh et al. 2019); since saccades are closely related to attentional mechanisms (Bayram and Mutlu Bayraktar 2012; Jamet et al. 2008). They can provide insight into cognitive processes such as understanding language, memory, and decision making. Also, saccadic eye movement is important to control selective attentional processes in visual perception (de Koning et al. 2010; Fiorella and Mayer 2016).

Previous eye-tracking studies have shown that gaze transitions are correlated with learning performance (Johnson and Mayer 2012; Krejtz et al. 2013; Mason et al. 2016). For example, Mason et al. (2013) examined the eye movements of fourth-grade students learning the weather from illustrated science text using multiple eye movement measures. Students' better-learning performance was associated with longer total fixation time on the picture and more integrative transitions between verbal and graphical information. The integration process can be investigated by looking at learners' gaze transitions between text and pictures in the illustrated texts (Acarturk and Ozcelik 2017; Arndt et al. 2015), between different text material (Cerdán and Vidal-Abarca 2008; Chan 2009), and between the information in different parts of the reading text.

2.2.4.1.2.3. How Does an Eye Tracker Work?

First, the eye tracker emits a near-infrared light beam, then this light is reflected in the reader's eyes, then the reflections are captured by the eye tracker's cameras. Finally, through filtering and triangulation, the eye tracker detects where the user is looking at the gaze point and calculates the eye movements data such as the complete fixation duration, fixation number, and the number of gaze transitions.

2.2.4.2. Integrative Processes

In addition to attentional processes, integrative processes might explain why integrative prequestions (representing the general benefit of prequestions) enhance

learning performance. The following sections discuss the potential role of integrative processes for this effect.

2.2.4.2.1. Integrative Processes in Learning from Reading Passages

2.2.4.2.1.1. Do Integration Processes Increase Reading Comprehension?

Re-reading, highlighting, and single-sentence paraphrases are low-level, shallow, and surface learning strategies. These strategies do not require the transformation of knowledge, and they are less strongly related to good comprehension (Cromley et al. 2010a). In contrast, high-level and deep-processing strategies involve generating and answering questions, summarizing, drawing, or constructing concept maps. Therefore, they can be considered knowledge-transforming activities. In addition, they were more strongly related to the comprehension of reading material in a meaningful manner (Fox 2009). Most previous research has evaluated different study strategies' impact by investigating learners' comprehension and memory (Dunlosky et al. 2013; Mason et al. 2013). Studies have used high- or low-level questions from the reading material to investigate their effects on learning.

Moreover, several studies have reported that high-level questions are more effective than low-level questions for reading comprehension (Cerdán et al. 2009; Cerdán and Vidal-Abarca 2008; Rouet et al. 2001), although other studies have reported no significant differences between participants in both high-level questions condition and low-level questions condition (Rouet et al. 2001). For example, Cerdán et al. (2009) investigated the effects of low- and high-level questions and reading the text before answering questions on performance. In the study, answering high-level questions allowed students to review and connect more related parts of information (as in the integrative type questions), whereas students in the low-level question (as in the isolative type questions) condition focused only on locating isolated textual parts. They reported that participants who answered high-level questions outperformed on the deeper comprehension test than those who answered low-level questions. They suggested that processing more difficult tasks increase deep comprehension. Also, high-level questions facilitate deeper text comprehension, and low-level questions facilitate superficial comprehension. They also suggest that high-level questions require more effort to the reading passage due to integration processes. These integration processes might lead to a deep level of comprehension.

However, Rouet et al. (2001) reported no significant difference in the summary task that required a summary of reading passage between high-level question and low-level question groups. For this study, it was suggested that the nature of the material could lead to a discrepancy. The previous literature showed that high-level and low-level questions, integrative types, and isolative types (St. Hilaire et al. 2019) are the same types of questions.

To sum up, answering high-level or integrative questions requires integrating related information, reflecting deep comprehension, whereas low-level or isolative questions—located on the isolated textual part— reflect surficial comprehension. Also, it was reported that high-level questions lead to the general benefit of learning, but low-level questions lead to the specific benefit of learning.

2.2.3.2.2. Integrative Processes in Multimedia Learning

According to the cognitive theory of multimedia learning (CTML; Mayer 2014), integration processes are important for learning from pictorial texts after selecting and organizing related information. CTML suggests three cognitive processes assumptions, which are *dual-channel assumption, limited capacity assumption, and active processing assumption*, and five cognitive processes—(1) related words are selected from text, (2) related images are selected from illustrations, (3) the selected words are organized into a coherent verbal structure, (4) the selected images are organized into a coherent visual structure, and (5) the visual and verbal structures are integrated with prior knowledge— were defined for the multimedia learning.

Studies have shown that learners' ability to integrate text and picture information improves learning performance (Johnson and Mayer 2012; Krejtz et al. 2013; Mason et al. 2015). These studies examined whether learners are successful in mentally integrating from text and pictures due to design principles— for example, spatial, contiguity, and signaling principles (Mayer 2014b)— that provided indirect evidence of the integration process, which is an example of cognitive process in the multimedia learning (Arndt et al. 2015).

Moreover, in eye-tracking studies, learners' eye movements between parts of a text and their relevant picture were analyzed to provide direct evidence of the integration processes (Hannus and Hyönä 1999; Johnson and Mayer 2012; Mason et al. 2016; Ponce and Mayer 2014). Therefore, these integrative transitions of eye

movements from the text to picture and picture to text are suggested to reflect participants' attempts to integrate relevant information.

2.2.3.2.2.1. Integrative Process as a Learning Strategy

In multimedia literature, sometimes studies using the eye-tracker technique have focused on the effectiveness of *learning strategies* resulting from *integrative processes* on learning. For example, Hannus and Hyönä (1999) have investigated the eye movements of students while learning illustrated textbook passages to examine how learners divided their attention between text and illustrations in the two groups (i.e., high ability and low ability groups). They reported that high-ability students spent more time studying relevant parts of text and pictures and more gaze transitions between relevant parts of text and pictures on the scientific textbook passage than low-ability students. They have suggested that high-ability learners focus on related information and engage in more integrative processes due to their more mature learning strategies.

Further, several studies suggest that these integration processes can be more effective if supported by appropriate guidelines (Mason et al. 2016a; Mason, Pluchino, et al. 2013 2015). Moreover, integrating the relevant words and their relevant illustration during learning would increase reading comprehension and learning the material (Cromley 2009; Cromley et al. 2010b).

Previous research by Mason et al. (2015) investigated the effects of integration processes text and illustrations on learning using a different learning strategy—modeling integrative gaze transition. They have examined the effectiveness of eye-tracking technology with modeling integration processes in the educational context. The benefit of video-based modeling was combined with eye tracker technology. Participants in the EMME (Eye Movement Modeling Example) condition showed more integration processing and better verbal and graphical recall performance than participants who did not observe the model's gaze replay (No-EMME condition). Interestingly, observing a model's eye movements contributed to deeper learning on the pictorial text for students with low reading comprehension ability was also reported (Mason et al.,2016).

Similarly, Mason et al. (2013) reported that the transfer of knowledge at posttests, readers who viewed a text with the labeled illustration performed better than the readers who did not view the text with the labeled illustration. Moreover, eye-

tracking studies suggested that more time spent on relevant parts of diagrams leads to a better understanding of diagrams due to integration processes (Canham and Hegarty 2010; Sanchez and Wiley 2006).

Ponce and Mayer (2014) have examined the effect of the study activities (i.e., note-taking, filling in a graphic organizer) on cognitive processing using an eye-tracker. Participants' comprehension of the reading material was tested while learning in one of three conditions: note-taking, graphic-organizers groups, and the read-only group conditions. It was suggested that students use a linear learning strategy, a cognitive process of adding information to memory in the note-taking groups, and a generative learning strategy, which is a cognitive process of selecting, reorganizing, and integrating information in the graphic organizer group. The note-taking and graphic organizers are well-known text comprehension activities reported by the National Institute of Child Health and Human Development (2000).

Also, Ponce and Mayer have reported that students in the graphic-organizer group exhibited more gaze transition of the related text and graphic illustration of a passage. In addition, they outperformed on the reading comprehension test than the participants in the note-taking and read-only groups due to using generative learning strategies. Sometimes, note-taking has been reported as an efficient learning strategy (Barnett et al. 1981; Bohay et al. 2011). For example; the study by Barnett et al. (1981)—which reported that note-taking strategy facilitates encoding and storing of information in LTM—, the study by Bohay et al. (2011)— which found that the processes of note-taking provide deeper levels of comprehension, the study by Kiewra (1985)— which suggested that the process of reviewing notes improves students' performance. Although, some studies demonstrate that students get incomplete notes and do not touch on critical points on their notes (Peverly et al. 2003).

CHAPTER III

METHOD

3.1. PARTICIPANTS

Twenty-four participants (14 female, ten male) voluntarily participated in the current study. Their ages were between 18 and 35 (M = 25.67, SD = 4.50). While selecting the participants, it was paid attention that they are Turkish native speakers. The experiment involved two between-subject groups. For the Prequestion Group, prequestions were given to participants before the post-test session. For the Control Group, no prequestions were given to participants before the post-test session. Participants were randomly assigned to the Prequestion (n = 12) or the Control Group (n = 12).

3.2. APPARATUS

Eye movements were recorded with an "Eye Tribe Tracker" with a 60 Hz sampling rate. It was reported that the accuracy of the eye tracker is about 0.50 degrees, the latency is < 20 ms at 60 Hz, and the spatial resolution is 0.1 degrees. The eye tracker was integrated into a 20-inch monitor with a resolution of 1600×900 pixels. The viewing distance between the monitor and participants was approximately 60 cm.

In addition, the *OGAMA software* was used for eye movement analysis. The software application designed to record and analyze gaze and mouse data in parallel is called the *Open Gaze And Mouse Analyzer- "OGAMA"* (Voßkühler et al. 2008). To detect fixation, a dispersion-type algorithm is used in the OGAMA. The fixations' calculation defaults are determined as follows: the minimum number of 5 samples, maximum distance in 20 pixel , and fixation detection ring size of 31 pixels. Also, 16 calibration point were determined for a good eye calibration.

3.3. MATERIALS

3.3.1. Instructional material

The study material was a reading passage about the braking system, called *Car Brake Passage* (Mayer and Gallini,1990). The reading passage was adapted to the Turkish version as "*Araba Frenleri Metni*" (See Appendix1). The passage includes a 573-word reading passage. The reading passage provides information about three different types of vehicular braking systems: mechanical brake, hydraulic brake, and air brake system, and their mechanical structure and functions. The reading passage was organized as two pages in Microsoft Office Word file because information related to prequestion items and non-prequestioned items is separated as much as possible from the other parts of the passage to larger areas were needed to create AOIs. However, these two pages were placed side by side and presented as a single image on a 21-inch monitor so that participants could see the whole text simultaneously (see Figure1).

Fren, hareketli bir nesneyi yavaşlatan veya durduran bir aygıttır. Çoğu frende sürtünme üretmek için dönen bir tekerleğe -veya bağlı bir üniteye- baskı yapan, fren balatası veya fren pabucu adı verilen bir parça bulunur. Bu sürtünme tekerleğin enerjisini ısıya dönüştürerek, tekerleği yavaşlatır veya durdurur. Araçlar ve endüstriyel makineler geniş bir fren çeşitliliğine sahiptir. Bu metin araçlarda kullanılan belli başlı frenleri anlatır. Araçlar üç temel fren türü ile donatılmıştır: (1) Mekanik frenler, (2) Hidrolik frenler ve (3) Hava frenleri.

Mekanik frenler, bir veya iki balatası tekerleğe doğru baskı yapan fren kollarına veya kablolara sahiptir.

Çoğu bisiklette her tekerlek için bir tane olmak üzere, fren kalıperi adı verilen iki mekanik fren bulunur.

Her frende, tekerlek jantının her iki tarafında birer tane olmak üzere iki küçük lastik balata bulunur. Balatalar uzun bir kablonun ucuna bağlanan mekanik bir cihaza monte edilmiştir. Kablonun diğer ucu gidondaki bir kola bağlanmıştır.

Mekanik frenlerde, sürücü bu kolu sıktığında kablo üzerindeki kuvvet tekerleğin dışına doğru balataları baskılar.

Otomobiller acil durum freni ya da el freni adı verilen başka bir tür mekanik fren ile donatılmıştır. Ayrıca bu fren park freni olarak da bilinir, çünkü park edilmiş bir arabanın kaymasını önlemeye yardımcı olur. Sürücü bir kol sistemi olan acil durum frenini kullandığında, rotlar ve kablolar arka tekerleklerin pabuçlarına veya balatalarına baskı uygular.

Hidrolik frenler, balatalara veya pabuçlara fren basıncı uygulamak için fren hidroliği sıvısı adı verilen özel bir sıvı kullanır.

Çoğu otomobil hidrolik frenleme sistemine sahiptir. Bu sistemin temel parçaları, fren pedalının yanında bulunan merkez silindir adı verilen bir bölme; her tekerlekte en az bir tekerlek silindiri; bu merkez silindiri tekerlek silindirine bağlayan fren hatları adı verilen borulardan oluşur. Silindirler ve fren hatları fren sıvısı ile doludur.

Hidrolik frenlerde, merkez silindirin içinde ileri geri kayabilen bir piston bulunur.

Basit bir hidrolik sistemde, fren pedalı, bir rot veya başka bir mekanik bağlantı aracılığıyla bu pistonu kontrol eder.

Sürücü pedala bastığında, merkez silindirin içindeki piston sıvıya basınç uygular ve kısa bir mesafe ileri doğru kayar. Fren sıvısı bu basıncı fren hatlarından geçirerek tekerlek silindirlerindeki pistonları ileri doğru itmeye zorlar. Tekerlek silindirleri ileri doğru hareket ettikçe, balatalara veya pabuçlara fren basıncı uygular.

Hidrolik sistemlerde, tekerlek silindirleri ya disk frenlerin ya da kampanalı frenlerin içine monte edilmiştir. Çoğu arabanın ön tekerleklerinde disk freni ve arka tekerleklerinde kampanalı fren bulunur.

Disk frenler, aracın aksına tutturulmuştur ve genellikle dökme demirden yapılmış bir diske sahiptir. Tekerlek diske bağlanmıştır. U şeklindeki bir kaliper düzeneği diskin bir parçasını kaplar fakat diskle beraber dönmez. Bu düzenek, her biri bir piston ve diskin her iki tarafında birer tane olmak üzere iki fren balatası içeren bir veya iki tekerlek silindiri içerir. Fren balataları ısıya dayanıklı bir malzeme ile kaplı yassı metal parçalardır.

Disk frenler, fren uygulandığında balatalar diskin içine doğru bir basınç uygular.

Kampanalı frenler aksa sabitlenmiş genellikle demir döküm kampanaya sahiptir. Tekerlek kampanaya bağlanmıştır. Kampananın içinde ısıya dayanıklı malzeme ile kaplanmış iki yarı dairesel fren pabucu bulunur. Fren pabuçları kampanayla beraber dönmez. Pabuçlar arasında tekerlek silindiri bulunur. Silindir her biri bir pabuca dayanan, zıt yönlerde itme hareketi gerçekleştiren iki pistona sahiptir.

Kampanalı frenler, fren uygulandığında, pabuçlar diskin dışına doğru basınç uygular.

Hava frenleri, kompresör adı verilen bir makine tarafından sağlanan basınçlı havayı kullanır. Çoğu otobüs, ağır kamyon ve trende hava frenleri vardır.

Sürücü ya da makinist fren uyguladığında, bir depolama ünitesi, basınçlı hava salar.

Bu hava balatalara veya pabuçlara fren basıncı uygulayan bir pistonu veya diyagramı iter. Otobüslerde ve kamyonlarda otomobillerdeki gibi disk freni ve kampanalı fren bulunur.

Ancak trenlerde pabuçlar tekerleğin dışına doğru baskı uygular.

Figure 1. A screen of the original study material was presented to participants during the study.

3.3.2. Pre-test

Hilaire and colleagues developed the integrative questions based on the reading material about car brakes (2019). *The integrative questions* were adapted to the

Turkish version as *"bütünleştirici sorular"* (See Appendix 3). In the current study, there are four integrative-type questions as in the previous study. It consists of two questions, each worth 2 points, and the other two questions, each worth 3 points. All questions are open-ended. The pre-test included two integrative questions determined as prequestions (i.e., prequestioned items)—one with two points and three (see Appendix 2). The total score that can be obtained from the pre-test was 5 points.

3.3.3. Post-test

The post-test includes a total of four integrative questions about the reading passage; two integrative questions have been seen in the pre-test (i.e., prequestions), and the two new integrative questions have been never seen (i.e., non-prequestions). The answers to integrative questions were in multiple paragraphs within the reading passage. Information related to these questions was explicitly placed in the reading passage, but the answers to these questions were never explicitly located in one paragraph within the passage. Thus, participants needed to combine information from different paragraphs from the reading passage to answer the integrative questions. For the Prequestion Group, two of the post-test questions were presented as prequestioned items, and the other two were presented as non-prequestioned items. For the Control Group, all post-test questions were presented as non-prequestioned items. The total post-test score was 10 points.

3.3.4. MMCB

The Turkish version of the Multi-Media Comprehension Battery was used in the current study to evaluate an individual's structure abilities. The Multi-Media Comprehension Battery (MMCB; Gernsbacher and Varner 1988), which efficiently assesses a general structure (mental representation) building ability, was adapted to the Turkish version as *Çoklu-Ortam Kavrama Bataryası.* The Multi-Media Comprehension Battery has six stories of three modalities; two stories are presented as a written modality, two stories are given as an auditory modality, and the last two stories are presented as a pictorial modality in the original study. However, since these three modalities are highly correlated with one modality, only the written modality has been used in many previous studies (e.g., Arnold et al. 2016; Bui and McDaniel 2015; Callender and McDaniel 2007 2009; Lin et al. 2018; Martin et al. 2016).

Callender and McDaniel (2007) have adapted the written modality of MMCB as a *fully test-based version of MMCB that was adapted for the computer*, which required reading four stories and answering 12 multiple-choice questions immediately at the end of each story. They found that the MMCB written modality's reliability is .77 using split-half reliability. Therefore, the written modality of the MMCB was used in the current study with Gernsbacher and McDaniel's permission. In addition, the psychometric properties of the Turkish version of this scale were investigated.

The Turkish version of MMCB has four stories that are "*Mike Hooter ve Missisipi'deki Akıllı Ayılar*", "*Ev İşleri ile İlgilenen Koca", "En Değerli Varlık*", "*Bal Toplayıcısının Üç Oğlu*", respectively. The four stories range in length from 413 to 666 words. Each story includes 12 multiple-choice questions, and there are 48 questions in total. Each question has five options and is worth 1-point. The questions corresponding to each story are answered immediately after reading the story. The total 48 questions score that the participants will get at most 48 points and at least 0 points.

3.4. DESIGN AND PROCEDURE

In the current study, there were two groups, and participants were randomly assigned to the *Prequestion Group* and *Control Group*. The study was conducted in single sessions, and each participant was tested individually in a classroom. Participants were seated approximately 60 cm away from the computer screen. The eye tracker was placed under the computer screen to detect their eye movements, and the reading material was presented through a computer screen. Pre-test and post-test were presented as a sheet of paper. Also, the MMCB was presented via the computer following the post-test session.

For the *Prequestion Group* (n = 12), participants were asked prequestions (i.e., prequestioned items) before the reading material, and all questions— two prequestioned items and two non-prequestioned items— were asked following the post-test session. For the *Control Group* (n = 12), the participants were asked the same two prequestions and the other two questions only on the post-test because no prequestions were given to the Control Group before the study material. All participants were verbally informed that they would read a passage at the beginning of the experiment, and then their memory of the reading passage would be tested. Additionally, the instructions—participants will do throughout the experiment—were presented in writing before starting the experiment.

During the *prequestion phase*, participants in the Prequestion Group were asked two prequestions, and 2 minutes were given to them for answering the prequestions. Also, they were encouraged to guess; however, any feedback and any correct answers were not given to prequestions. Before starting the study phase (reading passage), an eye calibration practice also was done with an eye tracker for each participant in the Prequestion Group and Control Group.

Before the calibration phase, all participants sat approximately 60 cm away from the computer screen. During the *calibration phase*, the participants in each group were presented with 16 calibration locations. Participants were asked to follow a black spot with a red in the center on the computer screen. It took approximately 20-25 seconds for each participant to complete their calibration process. After the eye calibration was accepted as good, it was taken care not to move the eye-tracker. Thus, the calibration was repeated when the eye calibration was poor or moderate during the calibration phase.

Following a successful calibration, the participants in the Control Group immediately passed to the study phase (reading the study material). However, after completing the successful calibration phase, participants in the Prequestion Group were provided additional instructions to find the answers to questions, but not the participants in the Control Group. Answering the integrative-type questions required more effort than answering other questions whose answers are located explicitly in one part of the reading material; therefore, additional instructions are critical for successful recognition.

Firstly, participants in the Prequestion Group were informed that before reading material, they would again answer two same questions—which were asked in the pre-test— on the post-test again. They were also informed that answers to the integrative questions would be located in multiple paragraphs. Then, participants in the Prequestion Group were instructed to tell the prequestions they had been asked before the post-test session. This instruction was used as a manipulation check to determine whether they remembered the prequestions.

In the *study phase*, "Araba Frenleri Metni" was presented in the OGAMA application via computer to both groups, and the eye tracker recorded eye movements (e.g., complete fixation durations, gaze transitions) on the overall text and each area of interest (AOI) during the reading material for each participant.

The reading material screen was organized to include three types of AOI's: (1) prequestioned items' AOIs—which include information related to prequestioned items that are tested in the post-test, (2) non-prequestioned items' AOIs—which consist of information related to non-prequestioned items that are also tested in the post-test —, (3) remaining AOIs—includes untested information in the post-test, that is related to neither prequestioned items nor non-prequestioned items (see Figure 2).

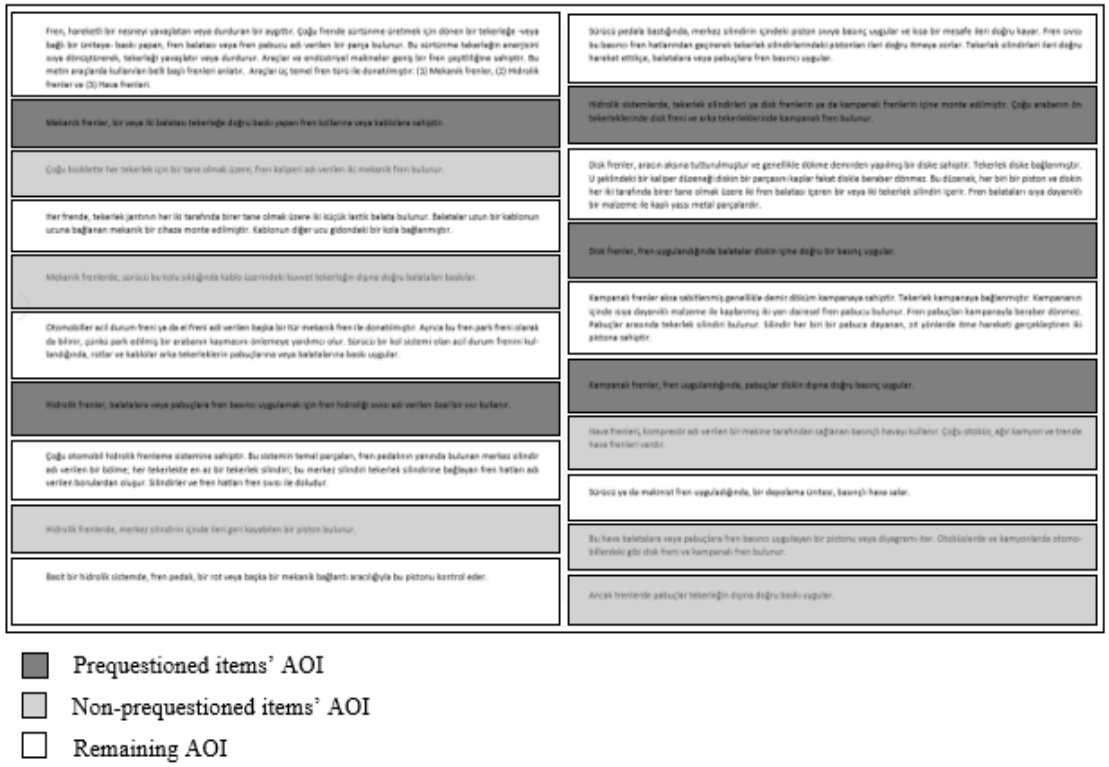

Figure 2 . A screen of the study material on how AOIs are determined on the computer screen.

Notes. (1) Prequestioned items' AOIs include information related to prequestions. The prequestions were tested in both pretest and posttest. (2) Non-prequestioned items' AOIs include information related to non-prequestions. The non-prequestions did not appear as prequestions, and they were tested only in the posttest. (3) Remaining AOIs— which include information neither related to prequestions nor non-prequestions but include information about the reading material—are the remaining areas of the study material.

During the reading passage, the eye tracker recorded the eye fixations of the participants. The fixation number, fixation duration mean, complete fixation time, and gaze transition measures for each AOI were calculated. The gaze transitions were computed for only prequestioned items (i.e., prequestions), not non-prequestioned items. Firstly the gaze transitions between first prequestioned items' AOIs—transitions between AOIs, which are included information about one of the

prequestions—and the gaze transitions between second prequestioned items' AOIs—transitions between AOIs, which are included information about other prequestion—were computed, separately. Finally, these gaze transitions were summed up, and total gaze transitions between each prequestion AOI's were found. However, *fixation numbers, fixation duration means, and complete fixation times* were computed separately for the prequestioned items' AOIs, non-prequestioned items' AOIs, and remaining AOIs.

After participants finished the reading material, they were given a distractor task in which they listed cities in Turkey for 2 minutes. Immediately after the distractor task, the participants completed the post-test session, which included questions from the reading material, and the participants were given unlimited time to complete the post-test. This session took about 5 min for all participants.

MMCB stories were presented to all participants via a computer screen following the post-test session. First, all participants read the first story and then answered immediately 12 multiple-choice questions on the first story. Then, the same procedure was applied for the rest three stories. All of the procedures were completed in approximately 50 min.

3.5. VALIDITY AND RELIABILITY

In order to test the inter-rater reliability of the post-test for the prequestioned items and the non-prequestioned items, a reliability analysis was conducted. First, a second independent rater scored the 25% of the post-test selected randomly. Then, the inter-rater agreement was examined by using the Intraclass Correlation Coefficient (ICC). The intraclass correlation coefficient was .98 for the post-test score, indicating a high agreement among raters.

MMCB was translated from English to Turkish. Then, two Ph.D. students at the University of California, Riverside, back-translated these materials from Turkish to English. This battery was applied to 161 psychology students at Cankaya University via Google Forms. To our knowledge, there is no scale to evaluate the reading comprehension skills or the structure-building ability of university students or adults in Turkey. Therefore, validity analysis could not be performed. Split-half reliability analysis was used for reliability analysis, and 'Spearman-Brown Coefficient' was found as .92, which is an acceptable value for reliability.

CHAPTER IV

RESULTS

Firstly, the normality assumptions for all variables were tested. A Kolmogorov-Smirnov test was used to test whether a set of data came from a normal distribution. The normality values of the eye movements and the behavioral measurements variable are presented in **Table 1** and **Table 2**, respectively. The results suggest that some variables showed a "normal distribution". For example, the post-test score for the prequestioned items was normally distributed in the Prequestion Group (D (12) = 0.165, p = 0.200) and the Control Group (D (12) = 0.191, p = 0.200), and the percentage of fixation number on the prequestioned items' AOIs was also normally distributed in the Prequestion Group (D (12) = 0.133, p = 0.200) and the Control Group (D (12) = 0.101, p = 0.200).

Table 1. Tests of Normality for the Control Group and Prequestion Group on the Behavioral Measurements

	Group					
	Control			Prequestion		
	Kolmogorov-Smirnov[a]			Kolmogorov-Smirnov[a]		
Variable	*Statistic*	*df*	*Sig.*	*Statistic*	*df*	*Sig.*
Pretest score	.	.	.	.357	12	.000
Posttest score for the prequestioned items	.191	12	.200*	.165	12	.200*
Posttest score for the non-prequestioned items	.197	12	.200*	.220	12	.114
Overall posttest score	.232	12	.073	.138	12	. 200*
MMCB score	.186	12	.200*	.157	12	.200*

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table 2. Tests of Normality for the Control and Prequestion Groups on the Eye Movements Measurements

Variables	Group					
	Control			Prequestion		
	Kolmogorov-Smirnov[a]			Kolmogorov-Smirnov[a]		
	Statistic	*df*	*Sig.*	*Statistic*	*df*	*Sig.*
Gaze transitions between the first prequestioned item's AOIs	.530	12	.000	.226	12	.093
Gaze transitions between the second prequestioned item's AOIs	.339	12	.000	.160	12	.200*
Overall gaze transitions between the prequestioned items' AOIs	.291	12	.006	.169	12	.200*
Fixation number on the prequestioned items' AOIs	.286	12	.008	.206	12	.169
Fixation number on the non-prequestioned items' AOIs	.248	12	.040	.166	12	.200*
Fixation number on the remaining AOIs	.226	12	.092	.182	12	.200*
Complete fixation time on the prequestioned items' AOIs	.245	12	.045	.154	12	.200*
Complete fixation time on the non-prequestioned items' AOIs	.275	12	.013	.130	12	.200*
Complete fixation time on the remaining AOIs	.244	12	.047	.231	12	.076
Fixation durations mean on the prequestioned items' AOIs	.319	12	.001	.149	12	.200*
Fixation durations mean on the non-prequestioned items' AOIs	.246	12	.043	.151	12	.200*
Fixation durations mean on the remaining AOIs	.268	12	.018	.235	12	.067
Percentage of fixation number on the prequestioned items' AOIs	.101	12	.200*	.133	12	.200*
Percentage of fixation number on the non-prequestioned items' AOIs	.234	12	.070	.207	12	.166
Percentage of fixation number on the remaining AOIs	.297	12	.004	.118	12	.200*
Percentage of complete fixation time on the prequestioned items' AOIs	.132	12	.200*	.162	12	.200*
Percentage of complete fixation time on the non-prequestioned items' AOIs	.274	12	.013	.175	12	.200*
Percentage of complete fixation time on the remaining AOIs	.298	12	.004	.119	12	.200*

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

However, some variables showed a “non-normal distribution”. For example, the total gaze transition between the prequestioned items’ AOIs was not normally distributed for the Control Group(D (12) = 0.291, p = 0.006), the complete fixation time on the non-prequestioned items’ AOIs was not normally distributed for the Control Group (D (12) = 0.275, p = 0.013). Therefore, a non-parametric test, the Mann-Whitney U test, was performed to determine the effect of prequestions on each dependent variable.

4.1. BEHAVIORAL MEASUREMENTS

For all behavioral measurements, the descriptive statistics are shown in **Table 3**. The following sections present the pre-test, post-test, and structure-building ability analyses.

4.1.1. Pre-test Score

In the Prequestion Group, the participants’ answers on the prequestions showed low accuracy (M = 0.33, SD = 0.44). This finding means that participants usually performed incorrect or incoherent answers to prequestions during the pre-test phase. Also, this reveals that they had little knowledge of the study material.

4.1.2. Post-test Score (Hypothesis 1a,1b)

As explained previously, the prequestioned items were initially asked during the pre-test and then again during the post-test, and the non-prequestioned items were asked only on the post-test for the Prequestion Group. However, the Control Group did not answer any questions before, and both prequestioned and non-prequestioned items were asked only in the post-test.

Results of the Mann-Whitney U test indicated that prequestion effect was significant on the post-test score for the prequestioned items (U = 14, p = .001, r = -0,14), the post-test score for the non-prequestioned items (U = 25.5, p = .006, r = -0,12), and overall post-test score (U = 13.5, p = .0010, r = - 0,14). Participants in the Prequestion Group scored significantly higher on the post-test for the prequestioned items (M = 3.17, SD = 0.91) than the Control Group (M = 1.79, SD = 0.50). This result reveals a specific benefit of learning on the prequestioned items. Therefore, Hypothesis 1a was supported.

Additionally, participants who answered prequestions performed significantly better on the post-test for the non-prequestioned items (M = 2.21, SD = 0.62) compared to the Control Group (M = 1.37, SD = 0.64). Thus, Hypothesis 1b was supported. Hence, answering integrative prequestions increased performance on the post-test for not only prequestioned items but also non-prequestioned items. This represents a general benefit of prequestions on learning. Likewise, the overall post-test performance was significantly greater for participants in the Prequestion Group (M = 5.37, SD = 1.48) than the participants in the Control Group (M = 3.17, SD = 0.96), which revealed a significant prequestion effect.

A Wilcoxon signed-rank test was also conducted to evaluate the performance differences between pre-test and post-test for the Prequestion Group. Participants' performance was better on the post-test (M = 3.17, SD = 0.91) than the pre-test (M = 0.33, SD = 0.44) for the prequestioned items, Z= -3,074, p = .002. This result shows that participants in the Prequestion Group scored significantly better on the post-test for prequestioned items.

4.1.3. Structure Building Ability

The participants' structure-building ability scores showed no significant difference between both the Prequestion Group (M = 31.08, SD = 4.50) and the Control Group (M = 30.17, SD = 3.79), U = 71.5, p = .728, r = -0,001.The descriptive statistics are shown in **Table 3**.

Table 3. Mean and Standard Deviations for the Control and Prequestion Groups on the Behavioral Measurements

Variables	Group			
	Control		Prequestion	
	M	*SD*	*M*	*SD*
Pre-test performance	-	-	.33	.44
Post-test performance for the prequestioned items	1.46	.40	3.08	.76
Post-test performance for the non-prequestioned items	1.21	.72	2.00	.60
Overall post-test performance	2.67	.91	5.08	1.18
MMCB score	30.50	3.48	30.75	4.29

4.2. EYE MOVEMENT MEASUREMENTS

4.2.1. Gaze Transition (Hypothesis 2a)

As explained previously, the gaze transitions were calculated only for the prequestioned items but not non-prequestioned items. Therefore, the gaze transitions on the prequestioned items were compared between the Prequestion Group and the Control Group.

The results revealed that the prequestion effect was significant on the gaze transitions between the first prequestioned item's AOIs (U = 35.5, p = .012, r = -0,10), the gaze transitions between the second prequestioned item's AOIs (U = 29.5, p = .014, r = -0,11), and total gaze transitions between all prequestioned items' AOIs (U = 23.5, p = .004, r = -0,12)**.** Participants in the Prequestion Group performed more gaze transitions between the first prequestioned items' AOIs (M = 1.42, SD = 1.62) compared to the Control Group (M = 0.17, SD = 0.57). Table 4 presents descriptive statistics for the eye movement measurements.

Similarly, they showed higher gaze transitions between the second prequestioned items' AOIs (M = 4.67, SD = 3.57) relative to the Control Group (M = 1.25, SD = 1.54).The participants' total gaze transitions between all prequestioned items' AOIs were higher in the Prequestion Group (M = 6.08, SD = 4.57) than in the Control Group (M = 1.25, SD = 4.25). Thus, Hypothesis 2a was supported.

4.2.2. Fixation Number

The prequestion effect was significant on the participants' fixation number for the non-prequestioned items' AOIs (U = 12, p = .001, r = -0,03) and the remaining AOIs (U = 24, p = .006, r = -0,12). Participants in the Prequestion Group had significantly less fixation number on the non-prequestioned items' AOIs (M = 161.08, SD = 57.26) relative to the Control Group (M = 316.58, SD = 158.72), and on the remaining AOIs (M = 415.92, SD = 132.68) compared to the Control Group (M = 644.75, SD = 250.20).

Nevertheless, participants' fixation numbers on the prequestioned items' AOIs showed no significant difference between the Prequestion Group (M = 334.50, SD = 131.058) and the Control Group (M = 310.50, SD = 180.26).

4.2.2.1. Percentage of Fixation Number (Hypothesis 3a,3b)

The fixation numbers can differ between participants. Therefore, the percentage of fixation number on the AOIs was used to reduce variance in this eye fixation variable due to individual differences.

The analysis results revealed that the prequestion effect was significant on the percentage of fixation number for the prequestioned items' AOIs (U = 19, p = .002, r = -0,13) and the non-prequestioned items' AOIs (U = 13, p = .001, r = -0,14).The percentage of fixation number of participants in the Prequestion Group was higher on the prequestioned items' AOIs (M = 0.36, SD = 0.09) compared to the Control Group (M = 0.23, SD = 0.04). Thus, Hypothesis 3a was supported.

In contrast, the percentage of fixation number of the participants in the Prequestion Group was lower on the non-prequestioned items' AOIs (M = 0.17, SD = 0.03) relative to the Control Group (M = 0.25, SD = 0.05), U = 13, p = .001. However, Hypothesis 3b was not supported. The percentage of fixation number of participants on the remaining AOIs did not differ significantly between the Prequestion Group (M = 0.46, SD = 0.11) and the Control Group (M = 0.51, SD = 0.7), U = 52.5, p = .259, r = -0,05.

4.2.3. Complete Fixation Time

The prequestion effect was significant on the complete fixation time for only the non-prequestioned items' AOIs (U = 15, p = .001, r = -0,13). Hence, participants in the Prequestion Group performed shorter complete fixation time on the non-prequestioned items' AOIs (M = 44043.42, SD = 16704.46) relative to the Control Group (M = 90304.17, SD = 46062.56).

Participants in the Prequestion Group did not have statistically significant complete fixation time difference on the prequestioned items' AOIs (M = 95512.42, SD = 35339.77) compared to the Control Group (M = 86477.33, SD = 53191.57), U = 53, p = .27, r = -0,05). Likewise, participants' complete fixation time on the remaining AOIs was not significantly different in the Prequestion Group (M = 145184.33, SD = 95824.28) than the Control Group (M = 173432.17, SD = 63076.94), U = 41, p = .073, , r = -0,07.

4.2.3.1. Percentage of Complete Fixation Time (Hypothesis 4a,4b)

In addition to the fixation number, the complete fixation time can also differ between participants. Hence, the percentage of complete fixation time on the AOIs was used to reduce the complete fixation time in variance due to individual differences.

For the percentage of complete fixation time, the prequestion effect was found significant on the prequestioned items' AOIs (U = 31, p = .018, r = -0,10) and non-prequestioned items' AOIs (U = 7.5, p = .000, r = -0,15). In the Prequestion Group, the percentage of complete fixation time was higher on the prequestioned items' AOIs (M = 0.35, SD = 0.13) compared to the Control Group (M = 0.24, SD = 0.05). Therefore, Hypothesis 4a was supported.

In contrast, the percentage of complete fixation time in the Prequestion Group was lower on the non-prequestioned items' AOIs (M = 0.16, SD = 0.04) relative to the Control Group (M = 0.25, SD = 0.05). Thus, Hypothesis 4b was not supported. Further, the percentage of complete fixation time on the remaining AOIs showed no significant difference between the Prequestion Group (M = 0.48, SD = 0.16) and the Control Group (M = 0.50, SD = 0.07), U = 60.5, p = .505, r = -0,03.

4.2.4. Fixation Duration Mean

The Mann-Whitney U test was performed to examine whether there is significant prequestion effects on the fixation duration means. For the Prequestion Group, the participants' fixation duration means was not significant on the prequestioned items' AOIs (M = 284.87, SD = 51.93) compared to the Control Group (M = 274.31, SD = 54.25), U = 56, p = .378, r = 0,04. For the non-prequestioned items' AOIs, the participants' fixation duration means showed no significant difference between the Prequestion Group (M = 255.58, SD = 32.41) and the Control Group (M = 286.35, SD = 49.38), U = 40, p = .065, r = -0,08.

Likewise, the participants' fixation duration means in the Prequestion Group was not significantly different on the remaining AOIs (M = 286.14, SD = 52.31) relative to the Control Group (M = 269.69, SD = 42.65), U = 57, p = .386, r = -0,04.

Table 4. Mean and Standard Deviations for the Control and Prequestion Groups on the Eye Movements Measurements

	Group			
	Control		Prequestion	
Variables	*M*	*SD*	*M*	*SD*
Gaze transitions between the first prequestioned item's AOIs	.17	.58	1.42	1.62
Gaze transitions between the second prequestioned item's AOIs	1.08	1.56	4.67	3.58
Total gaze transitions between the prequestioned items' AOIs	1.25	1.55	6.08	4.25
Fixation number on the prequestioned items' AOIs	310.5	180.26	334.5	131.06
Fixation number on the non-prequestioned items' AOIs	316.58	158.72	161.08	57.27
Fixation number on the remaining AOIs	644.75	250.21	415.92	132.69
Complete fixation time on the prequestioned items' AOIs (ms)	86477.33	53191.58	95512.42	35339.78
Complete fixation time on the non-prequestioned items' AOIs (ms)	90304.17	46062.56	44043.42	16704.46
Complete fixation time on the remaining AOIs (ms)	173432.17	63076.94	145184.33	95824.28
Fixation durations mean on the prequestioned items' AOIs (ms)	274.31	54.26	284.88	51.93
Fixation durations mean on the non-prequestioned items' AOIs (ms)	286.36	49.39	255.58	32.41
Fixation durations mean on the remaining AOIs (ms)	269.7	42.66	286.14	52.32
Percentage of fixation number on the prequestioned items' AOIs	.24	.05	.36	.10
Percentage of fixation number on the non-prequestioned items' AOIs	.25	.06	.17	.04
Percentage of fixation number on the remaining AOIs	.51	.07	.46	.12
Percentage of complete fixation time on the prequestioned items' AOIs	.24	.06	.35	.13
Percentage of complete fixation time on the non-prequestioned items' AOIs	.26	.06	.16	.05
Percentage of complete fixation time on the remaining AOIs	.50	.08	.48	.17

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CHAPTER V

DISCUSSION

The goal of the current study was to investigate whether the effect of prequestions on learning was due to enhanced attention to integrative prequestions by using eye movement measurements. For this, a group of participants was asked prequestions before they studied the material (i.e., the Prequestion Group), and eye movements were recorded to understand how the participants' attention was directed while participants were studying material. After that, participants were tested with a post-test that included prequestions and non-prequestions that had never been seen before. Finally, the results were compared to a Control Group, which was asked no prequestions.

5.1. BEHAVIORAL MEASUREMENTS

5.1.1. MMCB

Participants' structure-building ability scores were assessed to control whether there was an individual difference between groups. Participants' structure-building ability was evaluated by the MMCB. This battery was used only to assess whether individual differences between groups. After analysis, it was found that there is no significant structure ability scores difference between the Prequestion Group and Control Group. This result could mean that the two groups have similar features, and any individual difference in the structure building ability was not found, as expected (e.g., St. Hilaire et al.,2019).

5.1.2. Post-Test

5.1.2.1. Post-test Findings

The learning outcomes showed that participants in the Prequestion Group had higher post-test scores for prequestioned items, indicating the specific benefit of

prequestions. Moreover, the results revealed that participants in the Prequestion Group also had higher post-test scores for non-prequestioned items, replicating the general benefit of prequestions in the previous studies for non-prequestioned items. To sum up, consistent with the prior literature about prequestions, the advantage of the prequestion effect was found on both the prequestioned items and non-prequestioned items in the post-test— indicating both the specific and general benefit of prequestions.

5.1.2.2. Compatibility of the Post-test Findings with Literature

The specific benefit of the prequestion, in which learning only on related prequestioned information, has been replicated in prior studies that have used reading material (Carpenter et al. 2018; Frase 1968; Hausman and Rhodes 2018; James and Storm 2019; St. Hilaire et al. 2019; St. Hilaire and Carpenter 2020; Toftness et al. 2018). Although the specific benefit of prequestions on learning materials has been consistently shown, the general benefit of prequestion has been demonstrated in limited studies.

Consistent with our findings, Carpenter and Toftness (2017) found both specific and general benefits of prequestions on video-based learning material— video materials are not controlled by learners and are presented continuously. This is because learners were able to focus attention on both prequestioned information and non-prequestioned information within the video material during the presenting video, and they could not selectively attend to prequestioned items during the video. This result may suggest video-based materials can be more effective than reading materials when given after prequestions for the general benefit of learning.

Along similar lines, a previous study by Little and Bjork (2016) reported that answering multiple-choice prequestions improves the learning of both information of prequestions and other information from the reading passage compared to a Control Group. Their finding represents a general benefit of learning. However, in this study, multiple-choice prequestions had four options and one correct option, the other three incorrect options, which are designed competitive alternatives to the correct option, were appeared as related to non-prequestions on the final test. Therefore, these competitive alternatives of correct answers may guide participants' attention on both the information of the prequestion and alternatives while studying material, especially when corrective feedback is given on whether the answers are correct or incorrect.

St. Hilaire et al. (2019) showed that answering isolative prequestions improved memory performance on the prequestioned item, but integrative prequestions did not facilitate memory for both prequestioned and non-prequestioned items (Experiment 1). However, answering integrative prequestions enhanced later memory for prequestioned and non-prequestioned items from the reading passage with additional instructions that support the integration of information (Experiment 2), as replicated in the current study. While isolative questions are simple questions whose answers are explicitly located in one part of the reading passage, answering integrative questions requires combining information from different parts. Integrative questions, however, can require more effortful processing than isolative questions. Therefore, they also suggested additional instructions(i.e., participants were informed about the purpose of the study and the nature of the test.) to enhance the general benefit of learning related to non-prequestioned information before participants begin to study reading material. Finally, they found that answering integrative prequestion enhanced learning of both prequestioned and non-prequestioned items due to additional instructions for learning the reading material.

One interpretation of these results is that the benefit of prequestioned items could be thought of as spill-over attention to the whole material. Also, the nature of multiple-choice questions with competitive alternatives, as in Little and Bjork's (2016) study, the compare-contrast nature of the integrative questions, as in St. Hilaire et al. 's (2019) and our study, and given corrective feedback after pretesting, as in Hausman and Rhodes' (2018) and Thiede et al.'s (2011) studies, may lead to the processing of the whole material by guiding attention to both pre-questioned and unquestioned items. Therefore, integrative pretesting may be recommended as an effective educational tool to increase attention to the whole learning material

In addition, these findings might suggest that the general benefit of learning occurs when participants increase their attention to the non-prequestioned information. For instance, by using video-based study material (Carpenter and Toftness 2017), by increasing the relationship of prequestioned information with their competitive alternatives (i.e., non-prequestioned information; Little and Bjork 2016) by using an integrative type of prequestions with additional instructions (St. Hilaire et al. 2019), by presenting attractive keywords related to prequestioned information (Richland et al. 2009), by assessing comprehension ability of the material as it is read (Pressley et

al. 1990), learners' attention can be guided to both previously asked and unquestioned information.

Also, a significant effect of prequestions may be due to top-down attention; this is because prequestions as an endogenous cue to guide attention would activate top-down processes, not bottom-up processes activating salient cues. The previous study on pretesting, which reported initial test and their answers function as endogenous cues to direct attention toward tested information and away from untested information during the posttest, supports this suggestion (Gordon et al. 2015). Similarly, several studies showing the specific effect of prequestions (Pan et al. 2020; St. Hilaire and Carpenter 2020) have shown that participants answering prequestions (i.e., factual prequestions) guide their attention to prequestioned information; therefore, this directed attention to these prequestions only facilitated the learning of prequestioned information, not other information.

However, the current study suggests that the general effect of prequestions might be guided attention to both prequestioned and non-prequestioned due to the nature of integrative questions. The question types used in the studies may have affected the guiding attention to the whole material. As mentioned earlier, the answers to factual questions are in one location in the material, whereas the answers to integrative questions are in different locations of the material. Thus, attention might be guiding attention to one point where only that question is located for factual prequestions, and attention might be directed to more points for integrative prequestions while searching for the answer.

Additionally, a study by Richland et al. (2009), examining the association between the effect of testing and attention, reported that the group in which prequestions are presented as a cue before studying performed better on a post-test than the group in which important details in the text in a bold or italicized font are presented as a cue in a text during studying (e.g., Little and Bjork 2016; Pressley et al. 1990; Richland et al. 2009). These studies suggest that top-down processes induced by prequestions would be more effective on learning than bottom-up processes induced by salient features (i.e., characteristic fonts, italic or bold). In the current study, integrative prequestions would guide visual and spatial attention as a cue, helping them focus on both related and unrelated information strategically and voluntarily following a post-test; therefore, increased attention to information enhanced general learning of prequestions.

Contrastly, some studies have shown the disadvantage of the prequestion effect on non-prequestioned information from reading material (e.g., Peeck 1970; Rickards 1976; Sagaria and di Vesta 1978). The current study, however, showed no disadvantages of the prequestion effect. It is possible that as the selective processing hypothesis predicts that participants who answered prequestions might directly focus their attention on prequestioned information and ignore or skim unrelated information to prequestions—non-prequestioned information— within the text material relative to a Control Group. This might be resulting in impaired learning for unrelated information from prequestions. Reading materials may be suitable for participants to quickly ignore or skip irrelevant information to the prequestions, but video materials are not suitable for easily ignoring information unrelated to the prequestions.

5.2. EYE MOVEMENT MEASUREMENTS

5.2.1. Gaze Transition

5.2.1.1. Gaze Transition Findings

In addition to behavioral measurements, participants' eye movements were also recorded when participants were studying material. After investigating the relationship between prequestions and attention in the relevant literature, eye movements were recorded using an eye tracker to examine how integrative type questions affect attention processes.

In the light of the information in the relevant literature about prequestions, it was hypothesized that the number of gaze transitions between the prequestioned items might be higher due to the integration processes in the Prequestion Group compared to the Control Group. Thus, the integrative type of prequestions in the current study might be thought to require the integration of related information. The results supported the hypothesis, which expects a significant benefit of prequestions in the gaze transitions between prequestioned items. Furthermore, the results support this hypothesis such that participants in the Prequestion Group exhibited higher gaze transitions between prequestioned items than the Control Group.

5.2.1.2. Compatibility of the Gaze Transition Findings with Literature

The findings of previous multimedia research (Cromley 2009; Cromley et al. 2010), supporting that the integration of relevant text and pictorial elements improves text comprehension and learning performance, are consistent with current findings. In

addition, the cognitive theory of multimedia learning (e.g., Arndt et al. 2015; Johnson and Mayer 2012; Mason, L., Pluchino, P., and Tornatora 2016; Mason, Pluchino, and Tornatora 2015) supported the current findings. For example; Hannus and Hyönä (1999), who demonstrated more gaze transition (back-and-forth looking) between text parts and its related illustration for high-ability students, Ponce and Mayer (2014), who showed more total gaze transitions (right-left and top-bottom) between the related parts of a text, and Mason and colleagues (2015), who reported multiple gaze shifts between text parts to corresponding picture parts were due to integrative processing, supported the finding of the current study. These findings, including our own, might suggest that integrative processes can be more effective in holistic learning, and more gaze transitions might be more successful in deep learning, not only for illustrated text but also for prose text (e.g., Ponce and Mayer 2014).

Another possible interpretation of the finding, more gaze transition in Prequestion Group, could be explained by the *"maintenance, attentional process, integration"* function of working memory (Wolters and Raffone 2008). The maintenance function is to retain the limited information currently needed, that is, all the task-related information provided by previous events (i.e., retention of prequestions). The function of attention processes is to direct attention to task-relevant stimuli and responses selectively and inhibit task-irrelevant stimuli and responses automatically (i.e., attention is guided to related information with prequestions). Finally, the integration function is the ability to combine and rearrange all task-relevant responses from various sources (i.e., integration of related information with prequestions). Thus, the functions of working memory may be a factor to affect the learning of prequestions.

5.2.2. Complete Fixation Time and Number of Fixations

5.2.2.1. Complete Fixation Time and Number of Fixations Findings

It was also hypothesized that the complete fixation time and the number of fixations on prequestioned and non-prequestioned items would be higher in the Prequestion Group than in the Control Group. In the current study, to reduce the variance in complete fixation time and fixation numbers due to individual differences, the percentage of complete fixation time and the percentage of fixation numbers were evaluated. This study reported that for prequestioned items, the percentage of complete

fixation time and the number of fixations was higher in the Prequestion Group than in the Control Group.

These results revealed that participants spent more time on information related to prequestions than information unrelated to prequestions. A possible interpretation of these results might be that the prequestion effect was due to the attentional processes (i.e., top-down attention activated by using prequestions as a cue to guide attention). Participants who answered prequestions would guide more attention to prequestioned items, so they would spend more time on the prequestioned items for integrating them into the instructional material than the Control Group (as in the selective attention process, it was discussed above).

5.2.2.2. Compatibilities of the Complete Fixation Time and Number of Fixations Findings with Literature

Our findings showing longer complete fixation time and higher fixation numbers on prequestioned items are consistent with previous eye-tracking studies, which reported that participants guided more attention to relevant information than irrelevant information than a Control Group. For example, the multimedia research using eye movement measurements (Ozcelik et al. 2010) compared a signaling format in which participants directed their attention to particular multimedia material, such as a label or image, by activating bottom-up processes marked by external cues and a non-signaling format in which participants did not guide their attention to any part of the material. They found that participants had longer total fixation duration and higher fixations on relevant information in the signaled format than in the non signaled format.

Similarly, consistent with our findings, previous eye-tracker studies (de Koning et al. 2010; Grant and Spivey 2003) have shown that the number of fixations and fixation duration on related information increases by attention is directed to related information. In this study, prequestions may have played a role in directing attention as a cue. For this reason, participants in the Prequestion Groups may have exhibited longer complete fixation time and higher fixation number on prequestioned items.

Likewise, consistent with our findings, a recent study on the prequestions by Yang et al. (2021) demonstrated that participants who viewed video material with interpolated prequestions had a longer fixation time on prequestioned information for the high achievement motivation group due to allocating more of their attention.

Additionally, they performed higher post-test scores than the participants who viewed video material with no prequestions. Answering integrative-type questions might require more cognitive effort on the prequestioned information due to selective attention. This effort could lead to longer fixation time and higher fixation numbers on the integrative prequestioned information (Inamdar and Pomplun 2003; Peterson et al. 2008).

This finding may be congruent with the *elaborative retrieval theory*, which included two distinctive processes, spreading activation and degree of semantic elaboration (Carpenter 2009). Searching related information to integrative prequestions— while learning material — can lead to a higher cognitive effort and then a deeper understanding of all material. Therefore, answering integrative prequestions could enhance the general benefit of learning —not only prequestioned information but also non-prequestioned information from reading text— due to the spreading activation effect (Carpenter 2009; Chan et al. 2006). For example, Endres and Renkl (2015) reported that the participants in the short-answer condition performed highly on the non-tested items compared with the restudy condition due to spreading activation, suggesting more effortful retrieval. Similar to the spreading activation effect, the compare-and-contrast nature of integrative questions was suggested to lead to more effortful and active processing due to increasing participants' processing of the material (e.g., St. Hilaire et al. 2019).

However, participants in the Prequestion Group outperformed on the post-test than the Control Group despite less percentage of complete fixation time and fixation number on the prequestioned items; this is an interesting finding. Furthermore, consistent with our findings, a study by Little and Bjork (2016) showed that prequestions facilitated the learning of irrelevant information from prequestions, although participants did not spend more time on that information. Therefore, these finding suggests that attentional processes (i.e., top-down) alone might be insufficient to explain the general benefit of the prequestions. The possible interpretation of these outcomes might be that participants who answered integrative prequestions could exhibit deeper cognitive processing than the Control Group when studying the reading material. Searching answers to integrative questions— which required organizing and integrating information— would promote generative processes while reading material is studied due to the compare-and-contrast nature of integrative prequestions (e.g., "What is the primary difference between mechanical brakes and hydraulic brakes?",

and “There are two key types of mounts in hydraulic brakes. What are the two types? Next, name two ways in which they differ from one another.”; St. Hilaire et al. 2019).

The integrative testing—deep level learning strategy —would enhance generative processes as summarizing (Bonwell and Eison 1991; Chi and Wylie 2014; Doctorow et al. 1978). This interpretation suggested that the compare-contrast structure of integrative prequestions required might improve learning due to a deeper understanding of the reading material (e.g., Ponce and Mayer 2014; St. Hilaire et al. 2019). Searching related information to integrative prequestions—while learning material— may lead to a higher cognitive effort and then a deeper understanding of all material. Like the spreading activation effect, the compare-and-contrast nature of integrative questions might be suggested that they lead to more effortful and active processing due to increasing participants’ processing of the material.

“Select-organize-integrate (SOI) model of generative learning”—which was suggested as awareness and control of learners’ own cognitive processes for generative learning due to active cognitive processing (Mayer 2014)— may be a possible explanation that despite shorter complete fixation times and the lower number of fixations, the Prequestion Group outperformed on the non-prequestioned items in the post-test compared to the Control Group. Therefore, integrative questions could be encouraged generative learning.

According to the SOI model, in this study, participants in the Prequestion Group were expected first to *select* the related information to prequestions, then *organize* the relevant information into a mental representation, and finally, *integrate* them for answering prequestioned items in the post-test. This generative learning process might suggest a deeper understanding due to more significant comprehension of reading passages (e.g., Chi and Wylie 2014), therefore greater comprehension can lead to active processing or more effective learning of all material (e.g., Doctorow et al. 1978).

Therefore, under certain conditions, integrative questions can be accepted as an active learning strategy (Bonwell and Eison 1991), and integrated information can lead to deeper processes (Hannus and Hyönä 1999; Ponce and Mayer 2014).

5.2.3. Fixation Duration Mean

5.2.3.1. Fixation Duration Mean Findings

The eye movement analysis showed that although prequestions had a significant effect on the percentage of complete fixation time and the number of fixations for the prequestioned items, prequestions did not significantly affect the fixation duration mean for the prequestioned items (e.g., Ozcelik et al. 2010).

5.2.3.2. Compatibility of the Fixation Duration Mean Findings with Literature

However, previous studies have shown that if the processing demand of the task increases, fixation duration means on relevant information increases (e.g., Loftus and Mackworth 1978; Underwood et al. 2004). Therefore, the lack of a statistically significant effect on mean fixation duration may be due to the high variance in the eye movement data.

To sum up, results suggest that an eye tracker is a beneficial tool for assessing the role of attention on the prequestion effect. Furthermore, results on learning outcomes and eye measurements complement each other. Also, to our best knowledge, this is the first study to evaluate whether the effects of integrative type prequestions on learning was due to the attentional processes using an eye-tracking method. Finally, the results provide that prequestions can facilitate general learning on the instructional material. The results supported that answering prequestions leads to more fixation time, more fixation number, and more gaze transition on prequestioned items but not non-prequestioned items due to attentional processes compared to the Control Group.

Moreover, answering the prequestions increased learning on the non-prequestioned items, but less fixation time and less fixation number were recorded in these non-prequestioned items. It can be suggested that integrations could increase attention, increased attention can increase mental effort, and increased mental effort can lead to deeper understanding (Cerdán et al. 2009; Cerdán and Vidal-Abarca 2008). The mental effort may be a mediator between attention and deeper understanding (active processing). Therefore, future research should aim to examine this relationship in the prequestion effect.

5.3. LIMITATIONS AND RECOMMENDATIONS

There are several limitations of this study. The first limitation is the small sample size in the study. Finding participants for the study was difficult due to

pandemic conditions. Another limitation was that the Prequestion Group and Control Group also were not homogeneous. This experiment could be applied to a more homogeneous group in future studies. Previous studies with reading material (Richland et al. 2009) had shown that each group should include thirty participants to obtain a reliable prequestion effect. However, the target sample size in the current study consisted of twelve participants for each group. Moreover, the small sample size may cause a high variance in the variables of the study. The sample size should be increased in future studies.

Furthermore, in the current study, two specific questions (one 2-point question, other 3-point question) were determined as prequestioned items, and the other two specific questions were determined as non-prequestioned items for the Prequestion Group. In the previous study (St. Hilaire et al. 2019) , two of the four questions were given as prequestions with counterbalancing. Therefore, each question appears as prequestioned and non-prequestioned items with equal frequency.

The difficulty level of the questions given as the prequestion might affect the results. Whether the difficulty level of these integrative questions affected the retention on learning could be evaluated when non-prequestioned items were given as prequestioned items to another Prequestion Group. Unfortunately, this could not be done in this study due to the pandemic conditions. However, in future studies, non-prequestions can be given as a prequestion to evaluate whether the difficulty level of integrative type questions affects learning.

The reliability analysis but not validity analysis of the Multi-Media Comprehension Battery was performed. Unfortunately, to our knowledge, there is no scale in our country to evaluate adult reading comprehension skills. Therefore, the validity analysis of the Multi-Media Comprehension Battery was not performed, which could be another limitation of this study.

CHAPTER VI

CONCLUSION

Although the pretesting practice is one of the most effective learning strategies, there is not enough evidence demonstrating why prequestions lead to a general benefit of prequestions on learning. Attention and integrative processes have been suggested as the underlying reasons for these benefits. The current study showed that answering prequestions benefited learning of both prequestioned and non-prequestioned items. The participants in the Prequestion Group performed better on both prequestioned and non-prequestioned items. In addition, the participants who answered prequestions had higher gaze transitions between prequestioned items. They also had higher complete fixation time and numbers of fixations for prequestioned items. However, although participants who answered prequestions performed better on the non-prequestioned material, they had lower complete fixation times and numbers of fixation for the non-prequestioned items than the Control group.

These results suggest that integrative prequestions act as an initial cue to guide attention to related information by activating top-down attentional processes, thus increasing attention to relevant information enhances learning. Therefore, while attention can explain the effect of prequestions for prequestioned items, attention alone was not sufficient to explain the impact of questions for non-prequestioned items. Here, integrative processes can explain this effect for non-prequestioned items. In addition, the nature of integrative questions requiring participants to integrate information from different parts of a reading passage may lead to deeper processing or induce greater mental effort in learning non-prequestioned items. These results also suggest that both attention and integrative processes simultaneously play a role in the general benefit of prequestions.

To sum up, if students are encouraged to find their answers, integrative prequestions can be an effective general learning method for guiding attention to the whole material by integrating information and activating top-down processes as an

internal cue. In addition, the eye tracker can be an effective measurement method for assessing learning effectiveness. Therefore, it would be suggested that the eye tracker can help examine the effectiveness of this method on learning in educational settings.

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APPENDIX

LIST OF APPENDIX

APPENDIX 1: Instructional Material / Car Break Passage

Araba Frenleri Metni

Fren, hareketli bir nesneyi yavaşlatan veya durduran bir aygıttır. Çoğu frende sürtünme üretmek için dönen bir tekerleğe -veya bağlı bir üniteye- baskı yapan, fren balatası veya fren pabucu adı verilen bir parça bulunur. Bu sürtünme tekerleğin enerjisini ısıya dönüştürerek, tekerleği yavaşlatır veya durdurur. Araçlar ve endüstriyel makineler geniş bir fren çeşitliliğine sahiptir. Bu metin araçlarda kullanılan belli başlı frenleri anlatır.

Araçlar üç temel fren türü ile donatılmıştır: (1) Mekanik frenler, (2) Hidrolik frenler ve (3) Hava frenleri.

Mekanik frenler, bir veya iki balatası tekerleğe doğru baskı yapan fren kollarına veya kablolara sahiptir. Çoğu bisiklette her tekerlek için bir tane olmak üzere, fren kaliperi adı verilen iki mekanik fren bulunur. Her frende, tekerlek jantının her iki tarafında birer tane olmak üzere iki küçük lastik balata bulunur. Balatalar uzun bir kablonun ucuna bağlanan mekanik bir cihaza monte edilmiştir. Kablonun diğer ucu gidondaki bir kola bağlanmıştır. Mekanik frenlerde, sürücü bu kolu sıktığında kablo üzerindeki kuvvet tekerleğin dışına doğru balataları baskılar.

Otomobiller acil durum freni ya da el freni adi verilen başka bir tür mekanik fren ile donatılmıştır. Ayrıca bu fren park freni olarak da bilinir, çünkü park edilmiş bir arabanın kaymasını önlemeye yardımcı olur. Sürücü bir kol sistemi olan acil durum frenini kullandığında, rotlar ve kablolar arka tekerleklerin pabuçlarına veya balatalarına baskı uygular.

Hidrolik frenler, balatalara veya pabuçlara fren basıncı uygulamak için fren hidroliği sıvısı adı verilen özel bir sıvı kullanır. Çoğu otomobil hidrolik frenleme sistemine sahiptir. Bu sistemin temel parçaları, fren pedalının yanında bulunan merkez silindir adı verilen bir bölme; her tekerlekte en az bir tekerlek silindiri; bu merkez silindiri tekerlek silindirine bağlayan fren hatları adı verilen borulardan oluşur. Silindirler ve fren hatları fren sıvısı ile doludur.

Hidrolik frenlerde, merkez silindirin içinde ileri geri kayabilen bir piston bulunur. Basit bir hidrolik sistemde, fren pedalı, bir rot veya başka bir mekanik bağlantı aracılığıyla bu pistonu kontrol eder. Sürücü pedala bastığında, merkez silindirin içindeki piston sıvıya basınç uygular ve kısa bir mesafe ileri doğru kayar. Fren sıvısı bu basıncı fren hatlarından geçirerek tekerlek silindirlerindeki pistonları ileri doğru itmeye zorlar. Tekerlek silindirleri ileri doğru hareket ettikçe, balatalara veya pabuçlara fren basıncı uygular.

Hidrolik sistemlerde, tekerlek silindirleri ya disk frenlerin ya da kampanalı frenlerin içine monte edilmiştir. Çoğu arabanın ön tekerleklerinde disk freni ve arka tekerleklerinde kampanalı fren bulunur.

Disk frenler, aracın aksına tutturulmuştur ve genellikle dökme demirden yapılmış bir diske sahiptir. Tekerlek diske bağlanmıştır. U şeklindeki bir kaliper düzeneği diskin bir parçasını kaplar fakat diskle beraber dönmez. Bu düzenek, her biri bir piston ve diskin her iki tarafında birer tane olmak üzere iki fren balatası içeren bir veya iki tekerlek silindiri içerir. Fren balataları ısıya dayanıklı bir malzeme ile kaplı yassı metal parçalardır. Disk frenler, fren uygulandığında balatalar diskin içine doğru bir basınç uygular.

Kampanalı frenler aksa sabitlenmiş genellikle demir döküm kampanaya sahiptir. Tekerlek kampanaya bağlanmıştır. Kampananın içinde ısıya dayanıklı malzeme ile kaplanmış iki yarı dairesel fren pabucu bulunur. Fren pabuçları kampanayla beraber dönmez. Pabuçlar arasında tekerlek silindiri bulunur. Silindir her biri bir pabuca dayanan, zıt yönlerde itme hareketi gerçekleştiren iki pistona sahiptir. Kampanalı frenler, fren uygulandığında, pabuçlar diskin dışına doğru basınç uygular.

Hava frenleri**,** kompresör adı verilen bir makine tarafından sağlanan basınçlı havayı kullanır. Çoğu otobüs, ağır kamyon ve trende hava frenleri vardır. Sürücü ya da makinist fren uyguladığında, bir depolama ünitesi, basınçlı hava salar. Bu hava balatalara veya pabuçlara fren basıncı uygulayan bir pistonu veya diyagramı iter. Otobüslerde ve kamyonlarda otomobillerdeki gibi disk freni ve kampanalı fren bulunur. Ancak trenlerde pabuçlar tekerleğin dışına doğru baskı uygular.

APPENDIX 2: Pre-test Questionnaire

Aşağıdaki soruları dikkatlice okuyup, bir tahminde bulunun. Tahminde bulunmanız için size 2 dakika süre verilecektir.

1. Mekanik frenler ile hidrolik frenler arasındaki temel fark nedir?

2. Hidrolik frenlerde iki temel monte etme tipi vardır. Bunlar nelerdir? Ardından farklarını yazınız.

APPENDIX 3: Post-test Questionnaire

Aşağıdaki soruları okuduğunuz metne göre cevaplandırınız.

1. Mekanik frenler ile hidrolik frenler arasındaki temel fark nedir?

2. Hidrolik frenlerde iki temel monte etme tipi vardır. Bunlar nelerdir? Ardından farklarını yazınız.

3. Hava frenleri mekanik frenlere mi yoksa hidrolik frenlere mi daha çok benzer? Neden?

4. Tren frenleri ve bisiklet frenleri çalışmak için farklı sistemlere dayanır. İki sistemin temel olarak farklılıkları ve benzerlikleri nelerdir?

APPENDIX 4: Multi-Media Comprehension Battery/ Çoklu-Ortam Kavrama Bataryası

HİKAYE1*: *MİKE HOOTER VE MİSSİSİPİ'DE BULUNAN AKILLI AYILAR

Akıllı ayılar ve aptal ayılar olmak üzere iki tür ayı vardır. Missisipi halkı, Missisipi ayılarının tüm ABD'deki en akıllı ayılar olduklarını söylerdi.

Büyük ayı avcısı ve Manolya eyaleti vaizi Mike Hooter'ın, hayattayken ve bütün herkesin ayılar hakkında bildiği her şeyi bildiğine eminken söylediği de budur. Gerçek şu ki, o Missisippi'deki gelmiş geçmiş en büyük ayı avcısıydı.

Halkın bir kısmı, Mike vaaz verirken ya da Missisipi ayılarının akıllılığı hakkında tartışırken daima on şelaleden daha yüksek sesle gürlediği için ona Mike Gümbürtü adını taktı. Ne zaman birisi ayılar hakkında tartışmaya çalışırsa, Mike onlara Ike Hamberlin'i ve akıllı ayılar ile geçirdiği zamanı anlatırdı.

Bir keresinde Mike Hooter ve Ike Hamberlin ayılar hakkında konuşuyorlardı ve beraber ava gitmeye karar verdiler. Fakat Ike korkunç bir şekilde Mike'ı kıskanıyordu, bu yüzden Mike'ın bir adım önde olacağını ve ondan önce tek başına gideceğini düşündü. Sabah erkenden köpekleriyle beraber yola koyuldu.

Mike bunu anladı, bu yüzden o sabah erken kalktı, çift kırmasını aldı ve Ike'ı aramaya gitti. Fakat Mike köpeklerini almadı.

Bir süre sonra Ike'ı gördü ve onu bir süre takip etti. Köpekleri hırlamaya ve havlamaya başladığında, Ike ormanın epeyce derinlerine gitmişti. Köpekler derinlerden gelen başka bir tür ses duydular ve tüyleri kavgadaki erkek kediler gibi sırtlarında dikeldi.

Ike köpeklere "Koş git, yakala onları" diye bağırdı. Fakat köpekler yapmayacaktı. Sadece Ike'ın etrafında havlayarak ve ağlayarak koştular, ölümüne korkmuşlar gibi.

Ike köpeklere "Tut! Tut!" diye bağırmaya devam etti, ama onun söylediklerini umursamadılar.

Mike bir sonraki adımda ne olacağını merak ederek sürekli izliyordu.

Ike bir eşek arısı kadar çılgındı, ama sakin kalmaya çalışıyordu, sadece oralarda bir yerlerde olduğunu bildiği ayıyı kışkırtmak için köpekleri ikna etmeye devam etti.

Bu köpekler doğal davranmıyordu. Mike izliyordu ve hatta Ike için biraz üzgün hissetti.

Ne de olsa, dışarıda ayı avlayan bir adam vardı ve yakalanmayı bekleyen bir ayı vardı ve ayıyı kışkırtacakları farz edilen ayı avlayan köpekler vardı. Ama köpekler iyi avcı

köpeklerinin yapması gerektiği gibi görevlerini yapmak yerine, sadece inlemeye ve orada bacaklarının arasındaki kuyruklarıyla dikilmeye devam ettiler. Kesinlikle doğru değildi. Siz onların lanetlendiğini düşünürdünüz. Ike küplere binmişti. "İşe yaramaz yaratıklar, size yapmanız gerektiği gibi işinizi yapmayı öğreteceğim" diye bağırdı. Daha sonra tek kırma tüfeğini aldı, onu ağaca dayadı ve dereye koştu. Oradan taş toplamaya ve taşları köpeklerine fırlatmaya başladı. Köpekler gökyüzüne doğru havlamaya başladı.

Tam o sırada Ike'ın taşları bitti, biraz daha toplamak için etrafında döndü. Arkasını döndüğünde ve köpekleri hala bir fırtına gibi havlarken, ormandan gelen ani bir çıtırdama ve kırılma sesi vardı. Mike izliyordu ve gördüğü en büyük ve en güçlü ayı dışarı çıktı. Ike da bu sesi duydu ve büyülenmiş köpeklerinin işlerine devam etmeleri için yeterince taş atmış olması gerektiğini düşündü.

Böylece Ike ihtiyaç duymayacağı taşları yere bırakmaya başladı. Ama o esnada bu büyük vahşi ayı Ike'ın tüfeğini koyduğu ağaca doğru yürüyordu. Ayı ön pençeleriyle onu yerden kaldırdı ve ona baktı. Daha sonra güçlü bir nefesle içine üfledi.

Ike pençeleri tüfeğin üzerinde olan ayıyı görmek için tam zamanında arkasını döndü. Ike ayakları üzerinde dona kaldı. Saçları başının üzerinde dikildi, ağzı kocaman açıktı ve gözleri yuvasından fırlamaya hazırdı. Ve izleyen Mike donakalmış gibiydi.

Ayı, sırıtarak Ike'a baktı, sonra tüfeği tekrar ağaca dayadı, arkasını döndü ve uzaklaştı. Ike tüfeğine koştu, onu kaptı, doğruca ayıya nişan aldı ve kilidini kaldırdı!... Ama güvenilir eski parçadan bir ses gelmedi. Ancak uzaklarda bir gülme sesi vardı. Tam o sırada Ike ayaklarının dibine baktı ve bir barut yığının üzerinde durduğundan emin oldu.

Katıla katıla gülen Mike artık açığa çıkmasının vakti geldiğine karar verdi. Böylece saklandığı yerden dışarı çıktı ve arkadaşına akıllı Missisipi ayısının onun tüfeğine ne yaptığını anlattı. Yaşlı Ike bunun bu kadar eğlenceli olduğunu düşünmemişti. Ancak Mike'ın anlattığını yıllarca dinledikten sonra, Ike da artık diğer dinleyiciler kadar gülecekti. Ve Ike özellikle, Mike hikâyenin, ayının uzaklaşmaya başladığı zaman, ve işe yaramaz tüfeği ve işe yaramaz köpekleri ile orada dikilen Ike'ın arkasından bakmak için nasıl durduğu ve daha sonra ayının nasıl ön pençelerinden birini Ike'ın yüzüne koyduğu ve zavallı yaşlı Ike'ın burnunu kıvırdığı ile ilgili kısmını anlattığı zaman çok fazla gülecekti.

Hikaye 1: Mike Hooter ve Missisipi'de Bulunan Akıllı Ayılar' ın Soru ve Cevapları

1. Hikâyeye göre orada hangi iki tür ayı vardı?

a. akıllı ve akılsız
b. iyi ve kötü
c. zeki ve işe yaramaz
d. zeki ve akılsız
e. akıllı ve aptal

2. Ike'ın soyadı neydi?

a. Halberdin
b. Hamberlin
c. Hambelton
d. Harrigan
e. Handlin

3. Ayı Ike'ın tüfeğine ne yaptı?

a. barutu boşalttı
b. pençesini tüfeğin üzerine koydu
c. tüfeği aldı
d. barutu üfledi
e. kurşunları döktü

4. Ike köpeklerinin itaat etmesi için ne yapmayı denedi?

a. kızdı
b. kaya parçası fırlattı
c. "Yakala onları" diye bağırdı
d. onlara vurdu
e. bağırdı ve taş attı

5. Mike ayı avcısı olmasının dışında, başka neydi?

a. çiftçi
b. vaiz
c. bağıran biri
d. hikâye anlatıcısı
e. bakan

6. Bir gözlemci köpeklerin bu kadar garip davranmasıyla ilgili ne düşünebilirdi?

a. onların lanetlendiğini
b. onların itaatsiz olduklarını
c. bir hayalet olduğunu
d. onların çıldırdığını
e. onların büyü altında olduklarını

7. “Mike Gümbürtü” olarak bilinen Mike Hooter ne kadar yüksek sesle gürledi?

a. şelale kadar
b. on şelale kadar
c. on şelaleden daha yüksek
d. bir şelaleden daha yüksek
e. çok yüksek sesli

8. Bu hikâye Ike’ın ney kadar çılgın olduğunu söyledi?

a. kavga eden iki erkek kedi
b. ayı
c. eşek arısı
d. eşek arısı tarafından sokulmuş biri
e. yaban arısı

9. Ike’ın köpekleri düzgün davranmadığında, Mike nasıl hissetti?

a. gülünç
b. Ike için korkmuş
c. hissiz
d. Ike için mutsuz
e. Ike için üzgün

10. Kimin silahı daha iyiydi? Mike veya Ike?

a. Mike’ın ve Ike’ın aynı tip silahı vardı
b. Ike çünkü çift kırması vardı
c. Ike çünkü Ike’ın otomatik tüfeği vardı
d. Mike çünkü çift kırması vardı
e. Mike çünkü Ike’nin otomatik tüfeği vardı

11. Hikâye anlatıcısı Missisipi için hangi eyalet takma adı kullanıyordu?

a. Marigold Eyaleti
b. Lily Eyaleti
c. Mississippi
d. Yaşlı Miss
e. Manolya Eyaleti

12. Hikâyeye göre ayı Ike ile nasıl dalga geçti?

a. Ike'ın burnunu kaldırdı
b. Ike'ın burnunu kıvırdı
c. burnu ile Ike'ı dürttü
d. burnunu Ike'ın yüzüne koydu
e. Ike'ın burnuna pençesini koydu

HİKAYE2: *EV İŞLERİ İLE İLGİLENEN KOCA*

Bir zamanlar memnun etmesi çok zor ve karısının evde hiçbir şeyi doğru yapmadığını düşünen bir adam vardı. Hasat zamanında bir akşam, adam her zamanki gibi karısını azarlayarak, küfrederek ve bir yaygara koparak eve geldi.

Karısı "Sevgili aşkım, keşke ev işlerini yapış şeklime her zaman bu kadar kızgın olmasaydın. Bu işte elimden gelenin en iyisini yapmaya çalışıyorum ama seni hiçbir zaman memnun edemem" dedi. "Yarın görevleri değiştirelim. Ben çiftçiler ile işe gideceğim ve samanı hasat edeceğim, sen evde kalacaksın ve ev ile ilgileneceksin."

Kocası bunun çok iyi bir fikir olabileceğini düşündü ve bunu denemeye istekli olduğunu söyledi.

Böylece ertesi gün sabah erkenden karısı kocasının tırpanını aldı, onu boynuna yerleştirdi ve çiftçilerin kalanıyla birlikte saman tarlasına gitti. Bu arada kocası ev ile ilgilenecekti ve karısının her zaman yaptığı işleri yapacaktı, elbette sadece kendi isteğine göre çok daha iyi ve daha fazlasını yapacaktı.

Yapmaya ihtiyaç duyduğu ilk şey biraz tereyağı yapmaktı ama bir süre çalkaladıktan sonra susadı. Bu yüzden bir ale birası fıçısının musluğunu açmak için kilere indi. Bardağını musluğunun altına koyduğu ve musluğu açtığı anda, domuzlarının mutfakta dolaştığını duydu. Daha sonra domuzun yayığı devirmeyeceğinden emin olmak için olabildiğince hızlı kiler merdivenlerinden yukarı koştu. Üst kata çıktığında, domuzun yayığı çoktan devirdiğini ve kaymağın içinde yuvarlandığını ve homurdandığını gördü. Adam öyle vahşice bir öfkeye kapıldı ki alt katta başladığı bütün şeyleri unuttu

ve domuza doğru olabildiğince hızlı koşmaya başladı. Dışarda onu yakaladı ve öyle bir tekme attı ki zavallı domuzcuk hemen oracıkta öldü. Tüm bunlardan sonra bir anda, alt kattaki fıçıyı hatırladı. Ancak kilere geri döndüğünde fıçı boştu ama kilerin zemini doluydu.

Bu dağınıklığı temizlemeyi denedi ama hayal kırıklığına uğramıştı ve ayrıca hala biraz tereyağı yapması gerektiğini hatırladı.

Böylece mandıraya gitti ve yayığı dolduracak kadar kaymak buldu. Bir süre çalkaladıktan sonra, süt ineklerinin hala ahırda kapalı olduğunu hatırladı ve yemek için bir lokması ve içmek için bir damlası yoktu ve neredeyse öğlen olmuştu. İnek hakkında düşünürken, çayırlığa inmenin ne kadar uzak bir yolculuk olduğunu da düşündü. Daha sonra aklına bir fikir geldi: Çayıra gitmek yerine onu çatıya çıkarabilirdi. Sonuçta çatılarındaki çatlakların arasındaki otlar büyümeye başlamıştı. Bu, onlardan kurtulmanın bir yolu olabilirdi.

Onların evi çok dik bir tepenin zirvesindeydi, bu yüzden adam zeminden çatıya bir ahşap tahta koyabileceğini ve ineğin oraya doğru yürümesini sağlayabileceğini düşündü. Elbette, bir tahta buldu ve inek yukarı yürüdü.

Evin içine döndüğünde, otlayan ineğin şimdi içmek için muhtemelen bir şeylere ihtiyacı olduğunu düşündü. Biraz su almak için kuyuya inmesi gerekecekti. Ama bunu yapana kadar bebekleri uykusundan uyandı ve o diğer odada oynuyordu. Adam yayığı kesinlikle sahipsiz bir şekilde bırakamayacağını düşündü, bebek mutfağa emekleyebilir ve onu devirebilirdi. Yayığı yanına alması gerektiğine karar verdi. Böylece onu çantasına koydu, bir kova kaptı ve evden ayrıldı.

Kuyuya gittiğinde kovasını doldurmak için durdu ve eğildi. Fakat bunu yaptığında bütün kaymak omuzlarının üstündeki yayıktan süzüldü ve kuyuya döküldü.

Şimdi öğlen vakti yaklaşmıştı ve karısının öğle yemeği için geleceğini biliyordu, ama henüz yapılmış bir tereyağı bile yoktu. Bu yüzden yapılması gereken en iyi şeyin yulaf lapası kaynatmaya başlamak olduğunu düşündü. Bir tencereyi su ile doldurdu ve ateşin üstüne astı. Bunu bitirdiğinde aklından korkunç bir düşünce geçti: Ya inek çatıdan düşerse ve boynunu kırarsa?

Bu yüzden yukarıya gitmesi ve onu bağlaması gerektiğine karar verdi. Halatın bir ucunu ineğin boynuna bağladı ve diğer ucunu bacadan aşağı attı. Mutfağa geri döndüğü zaman, bu ucunu uyluğuna bağladı. O esnada su kaynamaya başladı ve onun hala yulaf ezmesini öğütmesi gerekiyordu.

Böylece yulaf ezmesini öğütmeye başladı, ama bunu yapmakta zorlanırken inek dengesini kaybetti ve çatıdan aşağı düştü ve inek düşerken adamı yukarıya sürükledi. Adam yarı yolda bacaya sıkıştı ve inek yarı yolda asılı kaldı.

Saman tarlasında karısı yaklaşık iki saat kocasının onu öğlen yemeği için çağırmasını beklemişti. Nihayet bir yarım saat daha bekledikten sonra, karısı eve gitti. Oraya vardığında ineğin havada asılı olduğunu gördü. Karısı inek için üzüldü. Böylece tırpanıyla halatı kesti. Karısı bunu yaptığında kocası yere düştü. Bu yüzden, mutfağa giderken, ev işleriyle ilgilenecek olan kocasının kafasını yulaf lapasının içinde gördü.

Hikaye2: Ev İşleri İle İlgilenen Koca Soru ve Cevapları

1. Ev işlerine başlarken, kocanın yapmaya çalıştığı ilk şey neydi?

a. biraz kaymak elde etmek
b. biraz su almak
c. biraz yulaf lapası yapmak
d. ineği beslemek
e. biraz tereyağı yapmak

2. Onların tarlada hasat ettikleri neydi?

a. mısır
b. saman
c. buğday
d. tahıl
e. yonca

3. Kilerdeki fıçının içinde ne vardı?

a. şarap
b. elma şarabı
c. patates
d. ale birası
e. bira

4. Kaymak hangi iki şekilde döküldü?

a. domuz tarafından kuyuya ve adam tarafından kilere
b. inek tarafından mutfağa ve adam tarafından kuyuya
c. inek tarafından kuyuya ve adam tarafından kilere
d. inek ve bebek tarafından
e. domuz tarafından mutfağa ve adam tarafından kuyuya

5. Karı ve kocanın rollerini değiştirmesi kimin fikriydi?

a. karısının annesinin
b. karısının
c. kocanın
d. kocanın patronunun
e. karı ve kocanın

6. Adam kilerin merdivenlerinden yukarı neden koştu?

a. mutfakta bebeği duydu
b. ineği duydu
c. mutfakta domuzu duydu
d. bebeğin yayığı devirdiğini duydu
e. domuzun yayığı devirdiğini duydu

7. Öğlen yemeği için hangi tür lapa düşünüldü?

a. yulaf
b. buğday
c. çavdar
d. arpa
e. çok tahıllı

8. Karısı öğlen yemeğine çağırılmak için toplamda ne kadar bekledi?

a. bir buçuk saat
b. üç saat
c. iki buçuk saat
d. iki saat
e. yarım saat

9. Karısı tırpanı ne şekilde taşıdı?

a. omuzlarında
b. beline yerleştirerek
c. elinde
d. sırtında
e. boynuna yerleştirerek

10. İnek çatının zeminine bağlanırken adam neden acele etmek zorundaydı?

a. domuz, kaymağı yiyebilirdi
b. yulaf lapası yanıyordu
c. bebek kaymağı yiyebilirdi
d. yulaf ezmesini öğütmek zorundaydı
e. karısının öğle yemeğini hazırlamak zorundaydı

11. Adam halatı vücudunun hangi bölümüne bağladı?

a. sol bacağına
b. koluna
c. beline
d.ayak bileğine
e. uyluğuna

12. Ocak evin neresindeydi?

a. kiler
b. mutfak
c. ocak yoktu
d. oturma odası
e. mutfağın yanında

HİKAYE3: *EN DEĞERLİ VARLIK*

İtalyan tüccarların ve kaşiflerin Doğu'ya giden yollarının Türkler tarafından engellendiği bir dönem vardı. Böylece, İtalyanlar, ticaret yapacak yeni toprak arayışında batıya yöneldiler.

O günlerde Floransa'da Ansaldo adında bir tüccar yaşıyordu. Ansaldo sadece serveti ile değil, cesur ve kurnaz genç erkekleriyle de tanınan Ormanini ailesine mensuptu. Ansaldo, macera ve ticaret arayışlarından birinde, Cebelitarık Boğazı'nın ötesine geçmeye cüret etti ve korkunç bir fırtına ile savaştıktan sonra Kanarya Adaları'ndan birinde karaya çıktı.

Adanın kralı, Ansaldo'yu kollarını açarak karşıladı, aynalar ve altınlar ile dekore edilmiş şık bir salonda muhteşem bir ziyafet hazırlanmasını ve servis edilmesini emretti.

Akşam yemeğinde Ansaldo, uzun kalın sopalar taşıyan gençlerden oluşan küçük bir ordunun salona girmesini ve ziyafet salonunun duvarına doğru dizilmesini şaşkınlıkla

fark etti. Oturan her misafire olduğu gibi, gençlerden biri sopası hazır bir şekilde onun doğrudan arkasında yer aldı.

Ansaldo bütün bunların ne anlama geldiğini merak etti. Merakını gidermesi çok uzun sürmedi. Aniden, çok iri vahşi fare sürüsü salona doluştu ve servis edilen yemeğin üzerine kendilerini attılar. Gençler oradan oraya sopalarını sallayarak koşarken, kızılca kıyamet koptu.

Uzun yıllardır Floransalılar dünyadaki en zeki insanlar olmaları ve her durumla başa çıkabilmeleri şöhretinin keyfini sürmüşlerdi. Ansaldo bu geleneği sürdürmek için bir şans gördü. Gemisine geri dönmek için kraldan izin istedi ve kısa süre içinde iki büyük Fars kedisi ile döndü, çünkü gemi uzun bir yolculuğa çıktığında bir veya iki kedi her zaman mürettebata katılırdı.

Ansaldo kedilerin gitmesine izin verdi ve çok geçmeden tüm salon farelerden temizlendi.

Kral bir mucizeye şahit olduğunu düşündü. Ansaldo'ya teşekkür etmek için yeterli kelime bulamadı. Kral, adanın kurtarıcısı Ansaldo'yu selamladı ve Ansaldo kedileri hediye olarak krala verdiğinde, kralın minnettarlığı çok fazlaydı.

Ansaldo çok geçmeden evine yelken açmaya hazırdı. Kral ona gemisine kadar eşlik etti ve onu orada pahalı ve değerli hediyelere boğdu. Ona büyük miktarda altın, gümüş ve her çeşit ve renkte yakut, topaz ve elmastan oluşan birçok değerli taş verdi.

Ansaldo eve döndüğünde yaşadığı garip macerasının hikayesiyle arkadaşlarını heyecanlandırdı. Arkadaşları arasında Georgio Fiffanti adında bir arkadaşı vardı. Georgio, zekada fakir olduğu kadar imrenmede zengindi. Georgio şöyle düşündü: "Eğer kral, Ansaldo'ya bütün bu hediyeleri iki aptal kedi için verdiyse, ben şehrimizin sunmak için sahip olduğu en güzel ve değerli şeyleri ona takdim edersem, bana neler vermez ki?". Der demez, Georgio güzel kemerler, kolyeler, lüks giysiler ve daha birçok pahalı hediye satın almış ve Kanarya Adaları'na giden bir gemi ile yola koyulmuştu.

Georgio limana ulaştı ve aceleyle kraliyet sarayına gitti. Kral bu güzel hediyelerden dolayı çok müteessirdi ve aynı şekilde cömert olmak istedi. Halkıyla uzun bir görüşme yaptı ve ardından halkının sahip olduğu en değerli varlıklarını Georgio ile paylaşmaya izin vermeye karar verdiklerini ona mutlu bir şekilde bildirdi.

Ayrılma tarihi nihayet geldi ve Georgio kralın veda ziyareti için gemisinde sabırsızlıkla bekliyordu. Çok geçmeden, kral tüm kraliyet hanesi ve adalıların yarısı

eşliğinde Georgio'nun gemisine yaklaştı. Kral, değerli hediyeyi ipek bir yastık üzerinde bizzat kendisi taşıdı. Gururla yastığı Georgio'nun açgözlülükle uzanmış ellerine koydu. Georgio'nun dili tutulmuştu. Yastığın üzerinde uykulu şekilde kıvrılmış kürklü toplar, iki yavru kediydi.

Hikaye3: *En Değerli Varlık Soru ve Cevapları*

1. Uzun bir yolculukta, Floransa gemilerinde her zaman ne taşınırdı?

a. bir veya iki kedi
b. değerli taşlar
c. yemek ve su
d. iki yavru kedi
e. altın ve gümüş

2. Gençler neden yemek salonunda sopa tutuyorlardı?

a. fareleri öldürmek için
b. fareleri yemeklerden uzak tutmak için
c. farelere saldırmak için
d. misafirleri korumak için
e. kralı selamlamak için

3. Georgio hangi kişilik özelliğiyle "zengindi"?

a. kıskançlık
b. aptallık
c. bencillik
d. imrenme
e. açgözlülük

4. Kral hangi üç tür değerli taşı Ansaldo'ya verdi?

a. yakut, zümrüt ve elmas
b. safir, topaz ve opal
c. yakut, zümrüt ve opal
d. yakut, topazlar ve opal
e**. yakut, topaz ve elmas**

5. Ansaldo krala hangi cins kedi verdi?

a. Man kedisi
b. Paris kedisi
c. Calico kedisi
d. Siyam kedisi
e. Fars kedisi

6. Kanarya Adaları halkı ne kadar varlıklıydı?

a. idare edecek kadar
b. yoksul
c. çok varlıklı
d. oldukça fakir
e. orta düzeyde varlıklı

7. Ansaldo'ya hediyesini verirken krala kimler eşlik etti?

a. kraliyet ailesi
b. kraliyet ailesi ve adalıların üçte biri
c. kraliyet ailesi ve adalıların yarısı
d. kraliyet ailesi ve tüm adalılar
e. kralın koruyucuları

8. İtalyan tüccarların Doğu'ya giden yolunu engelleyen kimdi?

a. Ruslar
b. Türkler
c. Parisliler
d. Floransalılar
e. Farslar

9. Georgio'nun güzel hediyeleri ile ilgili kral ne hissetti?

a. ihtişamlarından çok etkilendi
b. çok onur duydu
c. derinden etkilendi
d. aşırı minnettardı
e. ihtişamlarından çok müteessirdi

10. Kediler yemek salonunu temizlediğinde kral ne düşündü?

a. hayret etti ve memnun oldu
b. Ansaldo'nun adanın kurtarıcısı olduğunu
c. kedilerin inanılmaz olduğunu
d. bir mucizeye tanık olduğunu
e. gözlerine inanamadığını

11. Kralın Georgia'ya verdiği hediye nasıl hazırlanıp sunuldu?

a. ipek bir yastığın üzerinde
b. kürk yumaklarının içinde
c. paketlenmenden
d. bir battaniye içinde
e. bir yastık kılıfı içinde

12. Floransalıların dünya üzerindeki şöhreti neydi?

a. olağanüstü kâşifler
b. zekilik ve başa çıkma yeteneği
c. cüret ve kurnazlık
d. zeki ve olağanüstü kâşifler
e. herhangi bir olayın üstesinden gelme yeteneği

HİKAYE4: *BAL TOPLAYICISININ ÜÇ OĞLU*

Bir bal toplayıcısının hepsi aynı anda doğmuş üç oğlu vardı. İsimleri, Duy ses kısık olsa dahi, Takip et mesafe büyük olsa dahi ve Birleştir parçalar küçük olsa dahi idi. Bu isimler bu genç adamların özelliklerini göstermek için uygundu ama arkadaşları onları kısaca Duy, Takip ve Birleştir olarak çağırırlardı.

Bir gün bal toplayıcısı ormanın içinde bir tepe kadar yüksek ve içinde ve dışında vızıldayan arıların açıkça gösterdiği kadarıyla içi bal dolu olan bir ağaca denk gelene kadar uzun bir yolculuğa çıktı. Yukarı tırmandı ancak çürük bir dal üzerinde dengede duruyordu, yere düştü ve on parçaya bölündü.

Duy köydeki kulübenin yanında oturuyordu ama "Babam ağaçtan düştü. Gelin! Ona yardıma gidelim." diyerek aniden ayağa fırladı.

Kardeşi Takip yola koyuldu ve on parça halinde yatan bedenin yanına gelene kadar babalarının izlerini sürmekte onlara yol gösterdi. Birleştir daha sonra bütün parçaları

bir araya getirdi ve onları sabitledi. Daha sonra oğulları babalarının balını taşırken, baba eve yürüdü.

Ertesi gün, çocukları evde oturup her biri kendisinin diğerlerinden daha önemli olduğuyla övünürken, bal toplayıcısı yeniden bal aramaya koyuldu.

"Ben olmadan onu duyamazdınız" dedi Duy.

"Sen onu duymana rağmen ben olmadan onu bulamazdın" dedi Takip.

"Sen onu bulmana rağmen ben olmadan onu bir araya getiremezdin" dedi Birleştir.

Bu arada yaşlı bal toplayıcısı bulutlar kadar yüksek ve içindeki ve dışındaki arılardan belli olduğu kadarıyla bal dolu olması gereken bir ağaca denk gelene kadar ormanın içinde uzaklara gitmişti. Yukarı tırmandı ama çürük bir dala adım attı ve dal kırıldı. Bal toplayıcısı yere düştü ve doksan dokuz parçaya bölündü.

Duy "Babamız düştü" diye ayağı fırladığında, çocuklar bireysel becerileri hakkında övünerek evde oturuyorlardı. Takip isteksiz bir şekilde ayak izlerini takip etmek için yola koyuldu ve doksan dokuz parçayı yerde buldu. Onları işaret ederek "Bakın ne kadar vazgeçilmezim. Onu sizin için buldum" dedi.

Daha sonra Birleştir doksan dokuz parçayı istemeyerek bir araya getirdi ve "Ben, yalnızca ben babamı eski haline getirdim." dedi.

Oğulları balı taşırken babaları eve yürüdü.

Ertesi gün yaşlı bal toplayıcısı ormanda her zamankinden daha uzağa yürüdü ve yıldızlara erişen bir ağaç buldu. Ağacın içinde ve dışında vızıldayan arılar bal dolu olması gerektiğini gösterdi. Yukarı tırmandı ama çürük bir dalın üstüne adım attı, yere düştü ve bin bir parçaya bölündü.

Duy bu düşüşü duydu ama kardeşlerine bunu söylemeyecekti. Takip babası geri dönmediği için bir kaza olması gerektiğini biliyordu, Birleştir ise babasının yardımına ihtiyacı olduğunu fark etti ama onu bir araya getirmek için kardeşlerine babalarını bulmayı teklif etmeyecekti.

Böylece yaşlı bal toplayıcısı öldü, çünkü onun bencil çocuklarının her biri babalarınkinden çok kendi itibarlarını düşünüyorlardı. Aslında her birinin diğerine ihtiyacı vardı ve hiçbiri diğerlerinden daha akıllı ya da daha iyi değildi.

HİKAYE4: *BAL TOPLAYICISININ ÜÇ OĞLU Soru ve Cevapları*

1. Bal toplayıcısı üçüncü kez düştüğünde kaç parçaya bölündü?

a. on

b. doksan dokuz

c. bin

d. bin bir

e. yüz

2. Balı her zaman eve kim taşırdı?

a. Duy

b. bal toplayıcısı

c. Birleştir ve Takip

d. Takip

e. üç çocuğun hepsi

3. Takip her defasında babası düştüğünde onu nasıl buldu?

a. babasının ayak izini takip etti

b. balı takip etti

c. sihirli güçler ile

d. içgüdü ile

e. kardeşi Duy'u takip etti

4. Bal toplayıcısı ikinci kez düştüğünde kaç parçaya bölündü?

a. on

b. yüz

c. doksan dokuz

d. bin

e. bin bir

5. Üç oğuldan hangisi en büyüktü?

a. hikâyede geçmedi

b. Duy

c. Takip

d. Birleştir

e. hepsi aynı yaştaydı

6. Bal toplayıcısı ilk kez düştüğünde kaç parçaya bölündü?

a. on

b. yüz

c. doksan dokuz

d. bin

e. bin bir

7. Babaları ikinci kez düştüğünde oğulları ne yapıyordu?

a. birbirleriyle tartışıyorlardı

b. her biri kendisinin daha önemli olduğuyla övünüyordu

c. birbirleriyle zaman geçiriyorlardı

d. birbirleriyle konuşuyorlardı

e. her biri kendisinin daha yetenekli olduğu ile övünüyordu

8. Bal toplayıcısının düştüğü üçüncü ağaç ne kadar uzundu?

a. bir tepe kadar yüksek

b. gökyüzüne erişiyordu

c. bulutlar kadar yüksek

d. yıldızlara erişiyordu

e. aya erişiyordu

9. Bal toplayıcısı ilk ağaçtan neden düştü?

a. daha yükseğe erişti

b. zayıf bir dalı tuttu

c. çürük bir dal üzerinde dengede durmaya çalıştı

d. arı tarafından sokuldu

e. ağacın dalı kaygandı

10. Bal toplayıcısının düştüğü ikinci ağaç ne kadar uzundu?

a. bir tepe kadar yüksek
b. gökyüzüne erişiyordu
c. bulutlar kadar yüksek
d. yıldızlara erişiyordu
e. aya erişiyordu

11. Bal toplayıcısı üçüncü kez düştüğünde Takip bunu nasıl bildi?

a. kardeşi garip davranıyordu
b. babasının düşüşünü duydu
c. bir şeylerin yanlış gittiğini hissetti
d. babası eve gelmedi
e. içgüdü ile

12. Üç çocuğun tam isimleri neydi?

a. Duy ses uzak olsa dahi, Takip et mesafe büyük olsa dahi, Onar parçalar çok olsa da
b. Duy ses uzak olsa dahi, Takip et patika uzak olsa dahi, Onar parçalar çok olsa dahi
c. Duy ses uzak olsa dahi, Takip et mesafe büyük olsa dahi, Birleştir parçalar küçük olsa dahi
d. Duy ses kısık olsa dahi, Takip et mesafe büyük olsa dahi, Birleştir parçalar küçük olsa dahi
e. Duy ses kısık olsa dahi, Takip et patika uzak olsa dahi, Birleştir parçalar küçük olsa dahi

APPENDIX 6: Demographic Information Form

Demografik Bilgi Formu

DEMOGRAFİK BİLGİLER:

Yaş :

Cinsiyet : ☐ Kadın ☐ Erkek

En son mezun olduğunuz öğrenim durumu :

☐ Ortaöğretim (Lise) ☐ Ön-Lisans ☐ Lisans

☐ Yüksek Lisans ☐ Doktora