Effects of Different Outcome Prompts on Learners' Text Marking

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Abstract

Studies examining learners' text marking displayed some limitations. First, for the most part these studies measured recall as a learning outcome. Very few studies measured inference and none measured transfer. Second, when describing marked text, these studies mainly used two categories: high and low level sentences, and main and subordinate ideas. This classification is insufficient to explore the relationship between learners' text marking and expected learning outcomes. Third, studies providing instructions for learners on what and how much to mark geared learners towards one learning outcome; mostly recall, thus missed on capturing the effects of different prompts that direct learners' expectations to more than one outcome.

This research used nStudy, an online learning tool that allows learners to mark text and logs detailed traces of marking, and provided a detailed description of what and how much learners' marked, using a set of sentence identifiers, such as terms, explanations, main ideas, consequences…etc., when learners are requested to study for recall and transfer tasks. The study also tested the effect of learners' marking on learners' performance on recall and transfer tasks. Moreover, it examined the effect of showing learners examples of kinds of information relevant to answering recall or transfer test questions on learners' performance.

Findings reveal that recall and transfer prompts do have an effect on learners' total marking and some of the categories learners choose to mark. Also, marking text related to recall/ transfer questions enhances learners' performance on these tasks. Moreover, in transfer tasks, marking parts of text unrelated to transfer questions did enhance learners' performance in those tasks. On the other hand, showing learners' examples of kinds of information relevant to answering recall and transfer test questions do not have an effect on learners' marking nor performance on transfer and recall tests. These findings suggest that the goal/reason learners have when they are marking affects their marking as well as their learning.

Keywords: Highlighting, Underlining, Recall, Transfer

To Papa and Mama

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Chapter 1.

Introduction

University students are expected to read an enormous amount of material during their studies (Gier, Herring, Hudnell & Montoya, 2010). Orlando, Caverly, Swetnam and Flippo (1989) claimed an average university student reads up to 2,400 pages per semester. Nist and Hogrebe (1987) opine it is impossible for learners to retain everything they read. Therefore, it is sensible that learners use typographical cues, such as highlighting and underlining, to identify and isolate key concepts to focus their study (Bell & Limber, 2009). Bell and Limber (2009) observed that highlighting and underlining are text marking techniques assumed to be useful organizational tools. According to Fowler and Barker (1974), underlining and highlighting are conceptually the same and they work in the same way. Thus, for brevity I use text marking to refer to both strategies.

Text marking is the most popular and preferred study technique among college students (Gier, Kriener & Natz-Gonzalez, 2009). Entering "highlighting strategy in reading" into the Google search engine yields 28,200,000 results, including websites which promote text marking and provide steps on how and what to mark when studying (slideshare.net; Rogers, K.D., n.d.). Many college students reported that marking textbooks increased concentration, improved comprehension, and helped them review (Nist & Kirby, 1986). Text marking is easy to perform, requires no training, and reduces the amount to study and review (Blanchard & Mikkleson, 1987). Beyond its popularity, most study skills courses in secondary schools and colleges promote text marking as an effective study strategy (Wade & Trathen, 1989) as a means of identifying main ideas and attending to meaning (Kagan, 1982).

However, despite the popularity of text marking among college students and the recommendations to do it, there are contradictory research findings about the efficacy of the strategy (e.g. Bisra, Marzouk, Guloy & Winne, 2014; Dunlosky, Rawson, Marsh, Nathan & Willingham, 2013; Rickards, 1980). This inconsistency is most probably due to a lack of extensive research into text marking (Amer, 1994).

Lonka, LindBlom-Ylanne and Maury (1994) argued that a study strategy may not be helpful in every context and its effectiveness depends on which learning outcome is measured. An early review of the literature on text marking showed that the majority of studies examined recall as a learning outcome. Although one study (Peterson, 1992) investigated the effects of text marking on learners' performance on inferential questions, as far as I can determine, no research has assessed the effects of a text marking strategy on learners' performance on transfer questions.

A first step towards this would be to analyze learners' marking to understand what they choose to mark when studying in preparation for recall in comparison to transfer tasks. Although some studies have analyzed learners' marking, they have used only two categories in their analysis, main ideas and supporting details (e.g. Rickards & August, 1975). In my opinion, this produces insufficient data to fully understand the effects of text marking on different learning outcomes such as recall and transfer. This lack of data heightens the uncertainty of whether text marking is universally beneficial. This study aims to fill this gap by providing a detailed description of learners' marking when studying for recall and transfer tasks.

The Present Study

The present study examines learners' text marking when they are instructed to study and prepare for recall tasks or transfer tasks. Participants in this research used nStudy, an online learning tool, to read and mark texts. nStudy allows learners to use a variety of learning strategies, including text marking, and logs detailed traces of their study activities. In this study, sentences in the reading text were segmented into categories invisible to learners: terms, main ideas, descriptions, explanations, facts, consequences, reasons, examples and conclusions. This detailed codification was

intended to more accurately describe what learners mark when they are expecting recall tasks or transfer tasks.

Specifically, this study addressed the following critical questions:

1. How does text marking vary on recall and transfer tasks?
2. Does text marking facilitate information recall and transfer?
3. Do examples of questions and information categories relevant to answer questions have an effect on learners' text marking?
4 Do these examples have an effect on learners' performance on recall and transfer questions?

Thesis Structure

The research questions in this study were formulated on the basis of gaps in the literature on text marking. The literature presented in Chapter 2 examines studies of the efficacy of text marking. Chapter 3 provides a detailed description of the study procedures. The results are presented in Chapter 4 followed by a discussion in Chapter 5.

Findings

The findings showed that providing prompts to study for recall or transfer tests affects learners' total amount of marking and amount of marking of particular categories of information. Also, marking text related to recall/ transfer questions enhances learners' performance on these tasks. Moreover, learners who were prompted for transfer marked more and performed better on transfer questions. One the other hand, findings reveal that showing learners examples of questions and information categories relevant to answer questions had no effect on learners' marking or performance suggesting perhaps more explicit approach to strategy training. Furthermore, the study demonstrates the importance of prior knowledge as it was found to mediate the effect of text marking on achievement where learners with more prior knowledge were able to benefit more from marking text.

The study has the following instructional implications:

1. Instructors should provide specific goals/reasons for learners when they request them to use text marking as a study strategy.
2. Training learners to mark effectively will likely benefit all learners but not mitigate pre-existing differences in levels of prior knowledge.

Chapter 2.

Review of the Literature

In the literature of study techniques, learners' marking of study materials is viewed as both an encoding and a storage mechanism (Divesta & Gray, 1972). As an encoding mechanism, text marking is assumed to facilitate processing information at input. Processing begins with searching for and selecting important information, then, once the selection is completed, that information is transferred to working memory for further processing (Weinstein & Mayer, 1986). The search and selection processes are regarded as the first step in deeply processing information. Deep processing facilitates storage and recall of information (Leutner, Leopold & Elzen-Rump, 2007). The search and selection processes are also considered essential to learning due to the disparity between the limited processing capacity of working memory and the enormous amount of information that could be processed (Blanchard & Mikkleson, 1987). The success of the selection process depends on the amount and depth of cognitive processing during text marking. Therefore the marked text due to deep processing is the ultimate result of the search and selection processes (Divesta & Gray, 1972).

Text marking is not viewed as just an encoding mechanism. It is also a storage mechanism when learners mark text with the intention of reviewing it at a later time (Divesta & Gray, 1972). Some studies have investigated the efficiency of text marking as a review strategy. Blanchard & Mikkleson (1987) stated that learners who reviewed marked text, performed better on comprehension and recall questions.

But is this reduction useful? Idestein and Jenkins' (1972) study revealed no significant effect of reviewing marked text on learners' performance. Peterson (1992) even argued that over-reliance on reviewing only marked text may impede deep processing of the whole text and prevent the construction of internal connections among ideas.

Since text marking is the most popular and preferred study technique among university students (Gier et al, 2009), researchers have often investigated its efficacy as a study strategy. The efficacy of text marking can be explained through two opposing theoretical perspectives: the Processing Theory (Graik & Tulving, 1978) and the Von Restorff Effect or Isolation Theory (Nist & Hogrebe, 1987)

2.1. Processing Theory

According to the Processing Theory, when learners actively mark information in a text, they process this information at a deeper level, which improves recall of the marked material (Nist & Hogrebe, 1987). This perspective focuses on what takes place during encoding. Anderson and Pearson (1984) explain how this happens. According to their interpretation, when learners actively mark text, they actively engage with it, which leads to greater understanding and easier retrieval. The Processing Theory maintains that text marking is effective as long as it is used as an encoding device, where learners actively search, select and engage with the reading material, and not as a concentration technique, in which case, it would appear to be of little value (Nist & Hogrebe, 1987).

This theory is supported by the work of Silvers and Kreiner (1997). Their findings suggested that when learners actively take part in marking text they process the information at a deeper level. Additionally, Bell and Limber (2009) reported that marking text forces learners to actively engage with the material resulting in better recall of marked information. In fact, the findings of Blanchard and Mikkleson (1987) indicated that when a text was marked there was a 50 percent chance it would be recalled by learners, irrespective of their reading ability or study time.

Anderson (1982) proposed a model that explains the relationship between text marking and the processing of information. According to this model, when sentences are being processed, they are graded for importance. Important sentences are then noted (marked) which increases attention to these parts of the text. Marked text is therefore learnt better because of this extra processing.

Ausubel (1968) theorized that the way knowledge is presented influences learning. He also argued that learners form and organize knowledge by themselves. In light of this view, text marking improves retention when it focuses learners' attention on identifying ideas of high structural importance. High structural importance sentences have an assimilative role that incorporate lower level sentences. This is consistent with Amer's (1994) study in which text marking helped learners identify important ideas rather than assume that each sentence or idea held equal importance.

Some studies found a relationship between marking high structural sentences and better comprehension and recall. According to these studies, the key factor in the efficacy of text marking is which text is marked. Rickards and August (1975) and Johnson (1988) found that, when learners mark high structural ideas, they better recall both high and low structural sentences. Moreover, Cashen and Leicht (1970) reported that marking main ideas resulted in greater retention of both intentional (marked) and incidental (non-marked) information. These findings support Ausubel's theory (1968) that high level information has an assimilative function that integrates lower level information.

While these studies suggest the importance of marking main ideas, other studies claim that important information is learnt whether marked or not. Lonka, Lindblom-Ylanne and Maury (1994) stated that central ideas are learnt regardless of whether they are marked. This finding is consistent with Wade and Trathan's (1989) results that high-level information is remembered whether marked or not. However, the findings of Peterson (1992) challenge the claim that important information is recalled regardless of whether it has been marked. Peterson reported learners were unable to select important information, which explained why their text marking was inefficient (Peterson, 1992). This finding also opposes the interpretation of Anderson's (1982) assumption that learners can grade information in a text for importance, and then mark important sections. Apparently, learners' ability to select important information is essential for learning. This is evident in Bell and Limber's (2009) findings of a positive relationship between ability to identify important information and performance on exams.

To summarize, the Processing Theory maintains that learning depends on learners' active involvement in searching the reading material and selecting and marking high level information.

2.2. Von Restorff Effect

The Processing Theory focuses on what takes place at input, while the Von Restorff Effect focuses on what happens at output. The Von Restorff Effect is increased recall of an item when it is isolated against a homogeneous background (as cited in Nist & Hogrebe, 1987). In educational research, studies by Cashen and Leicht (1972) and Leicht and Cashen (1970) support this theory. In both studies, learners' performance on specific material depended on whether it was marked. Probably the strongest support for the Von Restorff Theory is presented by Nist and Hogrebe (1987). According to their results, studying marked information (output) is more important to learning than the actual act of the marking of information (input). This finding is challenged by the work of Fowler and Barker (1975). Their findings revealed improved retention, after one week, for marked information when compared to non-marked, and better performance for active text markers than readers who simply read marked material (Fowler and Barker, 1975).

To summarize, the efficacy of text marking is explained through two theoretical perspectives; the Processing Theory, which focuses on what takes place during input, and the Von Restorff Effect, which focuses on what happens at output. The next section reviews research examining the efficacy of text marking.

2.3. Efficacy of Text Marking

Investigations of the efficacy of text marking usually fall into one or more of the following categories: examining differences in performance between text marking and non-marking groups (e.g. Johnson, 1988; Fass & Schumacher, 1978); comparing learner-generated with researcher-generated text marking (e.g. Fowler & Barker, 1974; Rickards & Denner, 1979; Rickards & August, 1975); comparing text marking to other

study techniques, such as knowledge maps (e.g. Amer, 1994), note-taking (e.g. Kulhavy, Dyer & Silver, 1975), or repetitive reading (e.g. Idestien & Jenkins, 1972); investigating the effects of text marking on learners' immediate and delayed performance (Hartley, Bartlett & Branthwaite, 1980); and, finally, examining the effect of training a text marking strategy (e.g. Reutzel & Hollingsworth, 1988). There are also studies that investigated the effects of inappropriate text marking on comprehension (e.g. Silvers & Kriener, 1997) and on judgment of learning (e.g. Gier et al, 2009; 2010), as well as studies examining relationships between individual differences among learners and text marking behavior (e.g. Wade & Trathen, 1989). Findings of studies reviewed here are circumscribed by the purpose of this research.

Firstly, studies examining differences in performance between text marking and non-marking groups revealed contradictory results. Johnson (1988) reported more retention of superordinate and subordinate sentences for the text marking group. Findings by Kulhavy et al. (1975), Fass and Schumacher (1978), and Leicht and Cashen (1972) are consistent with Johnson's results. These studies reported that text marking improves recall more than reading only. These findings are not supported by results reported in Fowler and Barker (1974), who found no statistically detectable difference between text marking the read-only groups. The findings of Peterson (1992), on the other hand, suggest that text marking might impede comprehension and learning, as text marking groups performed worse that non-marking group on inferential recall.

2.4. Individual Differences and Text Marking

Individual differences were also investigated in the literature on text marking. In a study by Bell and Limber (2009), learners were categorized according to their reading ability and their marked textbooks were surveyed. Findings were that low-skilled readers marked more text than high-skilled ones (Bell & Limber, 2009). Also, low-skilled readers could not identify important parts as high-skilled ones did, a finding that supports those of Peterson (1992). Moreover, the findings of Crouse and Idestein (1972) revealed that the strategy of text marking is more effective with fast readers than slow ones. This is consistent with Klare, Mabry and Gustafson (1955) who found that text marking was more effective for more able learners than less able ones.

Learners' reading ability was not the only individual difference under examination. In a study by Annis and Davis (1978), prior knowledge and topic familiarity were also examined in regard to text marking. They reported text marking is more effective when the topic is familiar. The relationship between text marking and learners' motivation also has been examined. In a study by Fass and Schumacher (1978), motivated learners marked more effectively that unmotivated ones.

2.5. Types of Outcome

According to results of studies reviewed so far, text marking is sometimes helpful, may make no difference, or it may impede learning. This variance in research findings could be attributed to methodological differences among studies, such as the length and nature of the material to be learnt, instructions given to learners, number of learners tested (Marken & Maland, 1979) and the nature of the criterion task (Hartley et al, 1980).

In spite of these differences between studies, the majority has one thing in common: They measured recall as a learning outcome (Ayer & Milson, 1993; Blanchard & Mikkelson, 2001; Hartley et al, 1980; Idestein & Jenkins, 1972; Leutner et al, 2007; Marken & Maland, 1979; Peterson, 1992; Rickards & Dinner, 1979; Rickards & August, 1975; Wade & Trathen, 1989). Only one study (Peterson, 1992) examined the effect of text marking on learners' performance on inferential questions. In this case, learners studied texts and marked it as they chose, then answered questions. Answers to these questions required synthesizing over different parts of the text by making connections between ideas (Peterson, 1992). The findings revealed that participants that marked and reviewed marked parts did far worse on inferential questions than participants who reviewed clean chapters (Peterson, 1992).

There is a possibility that other studies tested learners' performance on inferential questions but they did not state this. For instance, Gier et al. (2009, 2010) mentioned that GRE passage and multiple-choice questions were used to assess learning but there was no mention of the type of outcome assessed. To my knowledge, transfer questions have not been used to measure the efficacy of text marking. Although

one could argue that Amer (1994) assessed transfer by asking learners to write summaries, no study was conducted to explore the effects of text marking on learners' performance on transfer questions where learners had to use the knowledge they learnt in the text and apply it to a different situation.

Lonka et al (1994) argued that a study strategy may not be helpful in every context and its effectiveness depends on the learning outcome being measured. Since transfer questions were not used to assess the efficacy of text marking and since transfer is an integral part of learning and an important learning outcome, the current study reasonably investigates learners' text marking in regard to their performance on transfer questions.

As I have shown, there have been several attempts to analyze learners' marking of texts. However, only two main categories were used to describe information that was marked: high- and low-level sentences or main and subordinate ideas. Using only these categories to describe learners' text marking may be insufficient to explore relationships between learners' text marking and various learning outcomes. Hence, this study provides a detailed description of what learners mark by cataloguing types of information in the text studied and examining how learners marked these different types of information.

Text marking is a complex, convoluted process (Nist & Hogrebe, 1987), which has not been researched very extensively (Amer, 1994), and its efficacy is still unclear due to the contradictions in research findings (Bisra et al, 2014). This controversy indicates that there remains exploration to be done. Since transfer was not measured as a learning outcome and findings of studies that measured recall were inconsistent, there is a need to examine the effects of learners' text marking on recall and transfer tasks. Therefore answers to research questions, "How does text marking vary on recall and transfer tasks?" and "Does text marking facilitate information recall and transfer?" are needed to resolve the dispute about the benefits of text marking.

2.6. Training in Text marking

Based on the literature reviewed, training learners how and what to mark, irrespective of how brief this training was, led to better performance on comprehension questions (Hayati & Shariatifar, 2009) and essay questions (Amer, 1994). Hayati and Shariatifar (2009) provided 60 minutes training session to participants before they studied and marked text. The training included suggestions on when to mark, how and what. Text marking group outperformed non-marking groups in comprehension questions. Results of Amer (1994) are also in favor of training. In this study participants were trained for ninety minutes session once a week for five weeks. Participants were given four steps adapted from Smith (1985) to follow when attempting to mark text. The findings revealed superior performance for text marking group, in open-ended comprehension questions, than reading only group. The two studies mentioned above examined the effect of training in the learning strategy on learners' performance in comprehension questions. Leutner et al (2007) took training a step further when they included self-regulation as another dimension in the training process. In their research, they examined the effects of two training treatments; text marking learning strategy and text marking learning strategy and self-regulation. According to their findings, learners trained in the learning strategy outperformed those with no training. They also reported that participants in the learning strategy and self-regulation group performed far better than those trained in the learning strategy only. In the current study the principle investigator is not providing extensive and explicit training for participants as studies previously cited, instead is simply showing participants examples of recall and application (transfer) questions along with kinds of information relevant to answering these questions. This would allow for examining the research questions; "Do examples of questions and information categories relevant to answer questions have an effect on learners' text marking?" and "Do these examples have an effect on learners' performance on recall and transfer questions

Chapter 3.

Method

3.1. Participants

The participants in this study were 140 undergraduate students at Simon Fraser University with various majors. Table 3.1 displays the participants' majors and the frequency in each group.

Table 3.1. Participants' Majors and Frequencies in Each Group

Major	Frequency			
	Group A	Group B	Group C	Group D
Archeology	1	0	0	0
Arts	3	2	2	0
Biology	0	2	1	1
Bio-Science	0	1	2	0
Business	5	6	6	5
Chemistry	2	1	2	1
Biomed. Physiology & Kinesiology	1	0	1	0
Behavioral Neuropsychology	0	0	0	1
Computer Science	1	1	0	2
Cognitive science	0	0	0	1
Criminology	3	3	2	2
Communications	0	0	1	0
Earth science	1	0	0	0
Education	0	1	4	1
Economics	0	2	1	3
English	0	2	0	1
Engineering	1	1	0	1
General science	1	1	1	0

Major	Frequency			
	Group A	Group B	Group C	Group D
Health Sciences	1	4	2	3
History	0	1	2	1
Kinesiology	0	0	0	1
Non degree	0	0	0	1
Philosophy	2	0	0	0
Political Science	0	0	0	1
Sociology	0	0	1	1
World Literature	0	1	0	0
Psychology	10	5	7	8
General	1	0	0	0
Liberal Arts	0	0	0	1
International studies	0	1	0	0
Unspecified	0	0	1	0
Total	33	35	36	36

3.2. Materials

A 1005 word text was created based on *Fundamentals of Space Medicine* (Clement, 2005) and other resources from the Internet. It described gravity, weightlessness and their effects on the human cardiovascular system. A PhD Physics student at Simon Fraser University reviewed the content of the reading text for correctness.

Each short sentence in the text was coded as presenting mainly one of nine categories of information: term, main idea, description, explanation, fact, consequence, reason, example or conclusion (See Appendix B). This coding was just exploratory. After the principle investigator coded the text, blank copies were given to two graduate students. Each student was instructed to read the text individually and code each sentence as representing one of the nine categories. The principal investigator and the coders then discussed results and reached consensus on the coding of the text's sentences into categories. Each sentence was registered in nStudy according to its

category using nStudy's target feature. This allowed investigating the kinds of information participants marked.

3.3. Measures

Prior to studying materials in the experiment, participants completed a questionnaire asking for demographic information e.g. major, year and how many years if ESL. Participants completed other questionnaires with nine items for each "Need for cognition" and "Metacognitive awareness". Participants also responded to a task measuring prior knowledge. They were requested to write in bullet form what they know about: (a) gravity, (b) weightlessness and (c) effects of gravity and weightlessness on human cardiovascular system (See Appendix A). An open-ended question was used to measure prior knowledge to avoid priming participants about what to mark.

A posttest of achievement was developed from the text participants studied. It had two parts: 8 recall questions and 8 transfer questions (See Appendix C). Recall questions required the participant to remember the gist of declarative information presented in the text. Transfer questions required participants to use information they learnt from the text to solve a problem or make a prediction.

A scoring rubric for responses of achievement questions (recall & transfer) was developed. Creating this rubric helped identify coded sentences in the reading text that are needed to answer each question (See Appendix D). Changes were made to the grading rubric for transfer question "8" after learners took the test because the selected question type on fluid survey did not allow learners to choose more than one option. The question requested learners to check all symptoms they could observe in a microgravity chamber.

3.4. Independent Variables

Four bookmarks were created to manage the treatment conditions. Bookmarks A & C (the recall groups) had the recall prompt: "Study the following text and highlight

parts that would help you answer recall questions about gravity and weightlessness and their effects on human cardiovascular system". Bookmarks B & D on the other hand had the application prompt (transfer): "Study the following text and highlight parts that would help you answer application questions about gravity and weightlessness and their effects on human cardiovascular system".

Groups A & B were provided with examples of recall and application (transfer) questions along with kinds of information relevant to answering these questions, while groups C & D were not provided with any examples.

3.5. Design

This study used a 2 x 2 factorial design study with two independent variables, each at two levels: (a) examples vs. no examples of kinds of information relevant to answering recall and transfer test questions, and (b) prompting to prepare for a recall test vs. a transfer test of achievement.

3.6. Procedures

Part 1: Arrival

Four paper cards, one for each group, were placed face down on the table before a participant entered the room. Each participant was welcomed upon arrival at the lab and given the letter of consent to read and sign. Then the participant was asked to draw a paper card. In doing so, they randomly assigned themselves to one of four groups. As succeeding participants selected a card, it was not replaced. Thus, the next participant could not select the same group as a preceding one. Once all four cards had been removed, they were replaced for the next quartet of participants.

A PowerPoint presentation was used for training. All participants were trained to use nStudy. The principle investigator used a bookmark in nStudy to show learners how to use the quote.

Participants in the groups exposed to examples of information in a text that corresponded to posttest tasks received additional instruction. A 172-word text about "Food Deserts" was displayed along with three questions. Two questions targeted recall, one about the main idea of the text and another about a term. A third question that required application and transfer of information in the text based on two segments in the sample text, an explanation and a consequence (See Appendix A). Participants read the text and then read the first recall question. After reading the question, they were shown the segment in the text with the answer to that question in red. The same procedure followed for the second recall question and the transfer question. Participants were told that recall questions entail remembering information in the text and that application (transfer) questions require them to use information they studied to solve a problem or make a prediction.

Participants in the groups not exposed to examples were told they might be expected to answer recall and application (transfer) questions. They were also told (without seeing any examples) that recall questions entail remembering information in the text and that application (transfer) questions require them to use information they studied to solve a problem or make a prediction.

Part 2: Reading and Marking

Four "surveys," one for each group, were created using the online service FluidSurvey. Each survey had the same text and achievement questions. The surveys differed according to prompts presented. Surveys "A" and "C" presented the recall prompt while surveys "B" and "D" presented the application (transfer) prompt.

Each survey was bookmarked on every computer in the lab. Each survey consisted of a separate page: (a) the demographic survey, (b) prior knowledge questions, (c) the need for cognition (NFC) questionnaire, (d) the metacognitive awareness inventory (MAI), (e) – (g) sections 1 – 3 of the text 1, (h) the global JOL rating, (i) posttest application questions and (j) posttest recall questions. A "Next" button at the bottom of each page allowed participants to progress to the following page. Once "Next" was selected, a participant could not return to any previous page. This controlled for possible effects of review.

After the training session, participants were instructed to sit at any computer. Participants accessed the bookmark matching the card chosen previously. Participants studied as long as they desired. A sentence was considered marked, when learners mark all of it or any part of it.

When learners finished reading and marking, they moved to the achievement test. The first part included eight application (transfer) questions and the second part was made up of eight recall questions. At the end of part two, learners pressed the “Submit” button and they logged out of nStudy.

Chapter 4.

Results

This research examined learners' text marking when prompted to study for recall or for transfer tasks. The main questions investigated are: Does text marking vary on recall and transfer tasks? Does text marking facilitate information recall and transfer?

Do examples of questions and information categories relevant to answer questions affect learner's text marking? Do these examples affect learners' performance on recall and transfer questions?

4.1. Categories marked by learners

Data were examined for normality of distributions and outliers. None of the variables was non-normally distributed (all skewness and kurtosis values ≤ 1.5), however, four outliers were identified in "Total Marking" but a decision was made to keep them in the data to maximize sample size and because other data for these cases was not atypical. Means and standard deviations of the frequency of learners' marking were calculated for each category of information in the text (marked terms, marked examples, marked main ideas, marked explanations, marked facts, marked reasons, marked consequences and marked descriptions) as well as total marks (Table 4.1).

Table 4.1. Mean and Standard Deviation of Categories Marked by All Groups (N=140)

Marked Categories	Group A Recall-Examples n=33		Group B Transfer-Examples n=35		Group C Recall-no examples n=36		Group D Transfer-no examples n=36	
	M	SD	M	SD	M	SD	M	SD
Terms	5.87	2.64	6.65	2.71	5.47	2.50	6.25	2.80
Examples	1.60	1.19	2.11	1.60	1.25	1.15	1.63	1.37
Main ideas	3.54	1.85	4.28	2.25	3.00	2.01	4.30	2.68
Explanations	1.06	0.96	1.42	0.94	1.22	1.01	1.08	0.90
Descriptions	0.90	0.97	1.14	1.14	1.00	1.01	0.97	1.15
Facts	2.42	2.35	3.17	2.59	2.47	2.24	3.41	2.98
Reasons	2.30	1.46	2.80	1.47	1.86	1.24	2.52	1.68
Consequences	1.54	1.14	1.20	1.25	1.13	1.04	1.30	1.23
Total Marks	19.27	9.13	22.80	9.94	17.41	9.33	21.50	10.91

4.2. Examples/No-examples, Recall/Transfer and Learners' Marking

A MANOVA was computed with examples/no examples and transfer/recall as independent variables and the frequency of marking each of the eight categories of information as dependent variables. There were no statistically detectable differences between examples and no examples groups, F=0.846, p=0.564. However, the interaction between transfer and recall groups was significant where F= 2.076, p= 0.043. Tables 4.2 to 4.9 show the interaction effect on marking of each category of information for the examples/no examples and transfer/ recall factors. Learners prompted to study for transfer tasks marked more examples, main ideas and reasons ($p \leq .051$).

Table 4.2. Univariate F-tests for Frequency of Marking Terms

Source	Type III Sum of Squares	df	MS	F	p
Examples	5.786	1	5.786	0.814	0.369
Transfer	21.162	1	21.162	2.976	0.087
Examples ×Transfer	2.91E-06	1	2.91E-06	0.000	0.999
Error	967.123	136	7.111		

Table 4.3. Univariate F-tests for Frequency of Marking Examples

Source	Type III Sum of Squares	df	MS	F	p
Examples	6.041	1	6.041	3.334	0.07
Transfer	7.033	1	7.033	3.881	0.051
Examples × Transfer	0.124	1	0.124	0.069	0.794
Error	246.477	136	1.812		

Table 4.4. Univariate F-tests for Frequency of Marking Main Ideas

Source	Type III Sum of Squares	df	MS	F	p
Examples	2.414	1	2.414	0.485	0.487
Transfer	36.576	1	36.576	7.348	0.008
Examples × Transfer	2.793	1	2.793	0.561	0.455
Error	676.964	136	4.978		

Table 4.5. Univariate F-tests for Frequency of Marking Explanations

Source	Type III Sum of Squares	df	MS	F	p
Examples	0.295	1	0.295	0.320	0.573
Transfer	0.459	1	0.459	0.497	0.482
Examples × Transfer	2.245	1	2.245	2.434	0.121
Error	125.422	136	0.922		

Table 4.6. Univariate F-tests for Frequency of Marking Descriptions

Source	Type III Sum of Squares	df	MS	F	p
Examples	0.056	1	0.056	0.485	0.827
Transfer	0.371	1	0.371	0.319	0.573
Examples × Transfer	0.598	1	0.598	0.515	0.474
Error	157.985	136	1.162		

Table 4.7. Univariate F-tests for Frequency of Marking Facts

Source	Type III Sum of Squares	df	MS	F	p
Examples	0.751	1	0.751	0.114	0.736
Transfer	25.008	1	25.008	3.793	0.540
Examples × Transfer	0.340	1	0.340	0.052	0.821
Error	896.754	136	6.594		

Table 4.8. Univariate F-tests for Frequency of Marking Reasons

Source	Type III Sum of Squares	df	MS	F	p
Examples	4.457	1	4.457	2.049	0.155
Transfer	11.833	1	11.833	5.440	0.021
Examples × Transfer	0.252	1	0.252	0.116	0.734
Error	295.847	136	2.175		

Table 4.9. Univariate F-tests for Frequency of Marking Consequences

Source	Type III Sum of Squares	df	MS	F	p
Examples	0.792	1	0.792	0.574	0.450
Transfer	0.279	1	0.279	0.202	0.654
Examples × Transfer	2.292	1	2.292	1.660	0.200
Error	187.726	136	1.380		

A between subjects ANOVA was computed to compare total marking in the recall and transfer groups. There was a statistically detectable difference: recall groups (*M*=18.30, *SD*= 9.21), transfer groups (M= 22.14, SD= 10.39), F= 5.194, p=0.024. Taken together, these results suggest that showing learners examples of kinds of information relevant to answering recall or transfer test questions does not affect learners' marking. Prompts to study for recall or transfer tests do affect learners' total marking and some categories of information learners choose to mark.

4.3. Examples/No examples and Learners' Performance on Recall and Transfer Questions

Recall was correlated with transfer performance, r= 0.477; $p \leq .001$, two tailed). Therefore, a MANOVA was calculated with examples/no examples and recall/ transfer as independent variables, and recall and transfer performance as dependent variables. No statistically detectable ($p > .10$) results were observed (Table 4.11)

Table 4.10. Mean and Standard deviation for all groups on total recall and transfer items

	Group A Recall-Examples n=33		Group B Transfer-Examples n=35		Group C Recall-no examples n=36		Group D Transfer-no examples n=36	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Total recall	5.42	1.78	5.48	1.78	5.11	2.21	4.55	2.07
Total transfer	10.48	3.77	10.57	3.76	9.94	3.77	9.56	3.19

Table 4.11. Result Summary of MANOVA for the Interaction of Examples/no Examples and Recall/ Transfer and Total recall and Total Transfer

Source	Dependent variable	Type III Sum of Squares	df	MS	F	p	Partial Eta Squared	Observed Power
Transfer	Total recall	2.130	1	2.133	0.544	0.462	0.004	0.113
	Total transfer	0.799	1	0.799	0.061	0.806	0.000	0.057
Examples	Total recall	13.508	1	13.508	3.445	0.066	0.025	0.454
	Total transfer	21.166	1	21.166	1.605	0.207	0.012	0.242
Transfer × Examples	Total recall	3.327	1	3.327	0.849	0.359	0.006	0.150
	Total transfer	1.976	1	1.976	0.15	0.699	0.001	0.067
Error	Total recall	533.248	136	3.921				
	Total transfer	1793.592	136	13.188				

Providing learners with examples of questions and information categories relevant to answer questions had no statistically detectable effect on learners' performance on recall and transfer questions.

4.4. Text marking, recall and transfer tasks

A MANCOVA was conducted with examples/no examples and recall/transfer as independent variables, total recall and total transfer as dependent variables and total marking as a covariate. A statistically detectable difference between groups was observed in multivariate tests $F = 3.09$, $p = 0.048$.

As shown in Table 4.12, there is a statistically detectable relationship between total marking and transfer ($F = 5.885$, $p = 0.017$). Learners who marked more performed better on transfer.

Table 4.12. Result Summary of MANCOVA for the Interaction of Examples/no Examples and Recall/ Transfer and Total recall and Total Transfer and the Covariate Total Marking

Source	Dependent variable	Type III Sum of Squares	df	MS	F	p	Partial Eta Squared	Observed Power
Total marking	Total recall	10.324	1	10.324	2.665	0.105	0.019	0.367
	Total transfer	74.981	1	74.981	5.885	0.017	0.042	0.673
Transfer	Total recall	4.201	1	4.201	1.085	0.300	0.008	1.085
	Total transfer	6.437	1	6.437	0.506	0.478	0.004	0.506
Examples	Total recall	11.586	1	11.586	2.991	0.086	0.022	0.404
	Total transfer	15.104	1	15.104	1.186	0.278	0.009	0.191
Transfer × Examples	Total recall	3.496	1	3.496	0.903	0.344	0.007	0.156
	Total transfer	2.338	1	2.338	0.184	0.669	0.001	0.071
Error	Total recall	522.924	135	3.874				

Separate regression analyses predicting each of recall and transfer performance were computed using total incidental marks (marked parts of the text that are incidental to any of the recall and transfer questions), recall central (parts in the text needed to answer recall questions) and transfer central (parts in the text needed to answer transfer questions) as predictors. Results in Table 4.13 reveal that marking incidental parts predicts learners' performance in transfer tasks, F= 4.571; p= 0.034, but not recall tasks where F=0.998, p= 0.320. Marking parts central to recall and transfer tasks predicts learners' performance in recall (F= 7.389; p=0.007) and transfer tasks (F=6.658; p=0.011). As Table 4.13 shows, marking parts central to recall also predicts learners' performance in transfer tasks, F= 5.536, p=0.020.

Table 4.13. Regression Analysis Summary for learners' marking predicting performance on recall and transfer questions.

Achievement Measure	Predictor	β	F	p
Recall	Incidental Marks	0.085	0.998	0.320
	Recall central	0.225*	7.389	0.007
	Transfer central	0.166*	3.933	0.049
Transfer	Incidental Marks	0.179*	4.571	0.034
	Transfer central	0.215*	6.658	0.011
	Recall central	0.196*	5.536	0.020

Note. *p<0.05.

4.5. Prior Knowledge, Text Marking and Achievement

A MANCOVA was conducted with examples/no examples and recall/transfer as independent variables, and total recall and total transfer as dependent variables and related prior knowledge (prior knowledge related to ideas in the reading text) and general prior knowledge (general knowledge about the theme of the reading text) as covariates. There is a proportional relation between related prior knowledge and learners' performance on recall tasks, F= 4.634, p= 0.033 (Table 4.14)

Table 4.14. MANCOVA for the Interaction of Examples/no Examples and Recall/ Transfer and Total recall and Total Transfer and the Covariates Related Prior Knowledge and General Prior Knowledge

Source	Dependent variable	Type III Sum of Squares	df	MS	F	p	Observed power	Partial Eta Squared
Prior related	Total recall	17.082	1	17.082	4.634	0.033	0.570	0.033
	Total transfer	23.257	1	23.257	2.105	0.149	0.302	0.015
Prior general	Total recall	1.835	1	1.835	0.498	0.482	0.108	0.004
	Total transfer	15.759	1	15.759	1.427	0.234	0.220	0.011
Examples	Total recall	3.642	1	3.642	0.988	0.322	0.167	0.007
	Total transfer	0.592	1	0.592	0.054	0.817	0.560	0.000
Transfer	Total recall	3.116	1	3.116	0.845	0.360	0.150	0.006
	Total transfer	4.606	1	4.606	0.417	0.520	0.098	0.003
Examples × Transfer	Total recall	0.289	1	0.289	0.079	0.780	0.059	0.001
	Total transfer	0.695	1	0.695	0.063	0.802	0.057	0.000
Error	Total recall	493.941	134	3.686				
	Total transfer	1480.162	134	11.046				

Table 4.15 shows correlations calculated for related prior knowledge (prior knowledge related to ideas in the reading text) and general prior knowledge (general knowledge about the theme of the reading text), total marking, recall central (marked parts in the text needed to answer recall questions) and transfer central (marked parts in the text needed to answer transfer questions).

Table 4.15. Correlations Matrix of Prior Knowledge and Text Marking

	Prior related	Prior General	Total Marking	Recall Central	Transfer Central
Prior related	1.000	0.884**	0.263**	0.201*	0.310 **
Prior General		1.000	0.263**	0.204*	0.284**
Total Marking			1.000	0.848**	0.921**
Recall Central				1.000	0.853**
Transfer Central					1.000

Note. ** p<0.01; *p<0.05; Prior related is a composite of Prior General; Recall central and Transfer Central are both composites of Total Marking.

Three regression analyses were computed to investigate: (1) the direct effect of total marking on achievement (performance on both recall and transfer questions) (total

marking➔ achievement); (2) the mediated effect of total marking on achievement through related prior knowledge (total marking ➔ related prior knowledge ➔ achievement). According to Table 4.16, the *b* and beta coefficients for total marking controlling for prior knowledge are 0.048 (*SE*=0.039) and 0.098, down from the values of 0.100 and 0.041, respectively, when analyzing its direct effect. Prior knowledge was associated with a *b* coefficient of 0.910 (*SE*=0.179) and a *beta* coefficient of 0.404 when controlling for total marking.

Table 4.16. Regression Analysis

Model	R^2	Variables	b	SE-b	Beta	Pearson r
1	0.035	Constant	13.239	0.921		
		Total Marking	0.100	0.041	0.204	0.204
2	0.062	Constant	2.098	0.403		
		Total Marking	0.057	0.018	0.263	0.263
3	0.182	Constant	11.330	0.927		
		Total Marking	0.048	0.039	0.098	0.204
		Prior knowledge	0.910	0.179	0.404	0.263

Note. Model1: Total Marking predicting achievement; Model 2: Total Marking predicting prior knowledge; Model3: Total Marking and prior knowledge predicting achievement.

The results of both the Aroian test indicated that the mediation effect was statistically detectable, z=4.617, p<0.05, and the Freedman- Schatzkin test, t= 4.816, p<0.05, indicated that the effect of total marking on achievement was statistically reduced when prior knowledge was included as a mediator.

The ratio of the indirect to the total direct effect was used as an index of relative strength of the mediated effect. The indirect effect, computed as the product of the mediated path coefficients of 0.263 and 0.404, was 0.106, the total direct effect was 0.204, and the ratio of the two is approximately 0.52. It thus appears that approximately 52% of the effect of total marking is mediated through prior knowledge. This means that the amount of marking is proportional to the level of a participant's prior knowledge – as prior knowledge increases, so does the amount of marking.

4.6. Need for Cognition, Transfer tasks and Achievement

The nine "Need for Cognition" items yielded a Cronbach alpha reliability coefficient of 0.711. Statistically detectable correlations were observed between Need for Cognition scores and total transfer and achievement. Therefore, a MANCOVA was conducted with examples/ no examples and recall/ transfer as independent variables, and achievement and total transfer as dependent variables and need for cognition as a covariate. There is a proportional relation between learners' need for cognition and achievement, F= 12.131, p= 0.001, and transfer tasks, F= 11.958, p=0.001 (Table 4.17). No other effects were statistically detectable.

Table 4.17. MANCOVA for the Interaction of Examples/no Examples and Recall/ Transfer and Total Transfer and Achievement and the Covariate Need for Cognition

Source	Dependent Variable	Type III Sum of Squares	df	MS	F	p	Partial Eta Squared
Total_ NFC	Achievement	270.656	1	270.656	12.131	0.001	0.084
	Total transfer	147.566	1	147.566	11.958	0.001	0.082
Examples	Achievement	40.936	1	40.936	1.835	0.178	0.014
	Total transfer	10.542	1	10.542	0.854	0.357	0.006
Transfer	Achievement	19.433	1	19.433	0.871	0.352	0.007
	Total transfer	5.936	1	5.936	0.481	0.481	0.004
Examples × Transfer	Achievement	11.31	1	11.31	0.507	0.478	0.001
	Total transfer	1.892	1	1.892	0.153	0.696	0.004
Error	Achievement	2967.279	133				
	Total transfer	1641.263	133				

4.7. Metacognitive Awareness Items:

Metacognitive awareness items on the other hand were not used in the analysis because they generated a very low Cronbach alpha of 0.312.

Chapter 5.

Conclusions

This study was designed to answer the following questions: How does text marking vary on recall and transfer tasks? Do examples of kinds of information that are candidates for marking have an effect on learners' text marking? Do these examples have an effect on learners' recall or transfer performance? Does text marking facilitate information recall and transfer? In this chapter, I review results of each question and implications, as well as limitations of the study.

5.1. How does text marking vary on recall and transfer tasks?

In this study, recall and transfer prompts had an effect on learners' total marking and some of the categories of information learners chose to mark. Learners prompted to study for recall tasks marked less text in general. They also marked fewer examples, main ideas and reasons than learners prompted to study for transfer tasks. When learners are studying and marking text they make decisions about what and how much to mark. What standards learners use when prompted for recall and transfer is worthy of further investigation. Future research is needed to validate these findings and to examine the effects of other specific prompts on learners' text marking and performance.

The question now is: Is this text marking effective? Does it enhance learners' performance on recall and transfer tasks? The following part reviews analysis of results of this question.

5.2. Does text marking facilitate information recall and transfer?

In this study, marking text central to recall and transfer questions was observed to enhance learners' performance on these tasks. Regarding information recall, these findings corroborate Kulhavy et al.'s (1975) and Fowler and Barker's (1974) results. Recall improves as a function of marking. However, these studies and mine challenge findings of Johnson (1988) and Peterson (1992) who reported no effect of text marking on learners' recall.

An interesting finding of this study is that marking parts of text incidental to transfer questions was observed to enhance learners' performance on transfer tasks. For instance transfer question 3: "Two asteroids travelling in space, where there is no air resistance, from the same starting point at a speed of 18.6 km/s. One is 10,000 k. the other is 15,000 k. which one would reach the Earth's atmosphere first and why?" To answer this question, learners needed to know the underlined parts in the following extract:

> At standard gravity, ignoring air resistance and any other friction, an object falling freely increases its velocity by 9.81 meters/second (or 32.17 feet/second or 22 miles/hour) for each second that passes. Starting from rest, an object reaches a velocity of 9.81 meters/second (32.17 feet/second) after one second. Two seconds after it started falling, its velocity is 19.62 meters/second (64.38 feet/second), and so on. If air resistance could be ignored, like in a vacuum, every object dropped from the same height would hit the ground at the same time.

Although the two unmarked sentences are not directly related to answering this transfer question, they help the learners elaborate this concept.

Transfer tasks, by definition, require learners to apply knowledge to new situations. It may be that material incidental to the basis for transfer could help learners extend conceptual understanding of the topic which may better prepare learners for transfer tasks. Further research is recommended to investigate learners' text marking of both central and incidental parts to transfer questions and learners' performance on these questions.

Findings so far indicate that giving learners specific goals for study affects the quantity of text marking as well as performance on recall and transfer tasks. Considering these effects, instructors and researchers need to provide clear goals for learners when they request them to use text marking as a study strategy. Similar effects were not detected for showing learners examples of kinds of information needed to answer recall and transfer questions.

5.3. Do examples have an effect on learners' text marking?

Briefly showing learners examples of kinds of information to mark was not enough to influence what learners choose to mark. This is a new finding in the literature on text marking. Since the amount of text marking and what is marked affects performance, future research should investigate how training affects learners' text marking and how to optimize such training.

5.4. Do examples have an effect on learners' performance on recall and transfer questions?

In this study, briefly showing learners examples of kinds of information relevant to answering recall and transfer test questions did not affect learners' performance on recall and transfer tasks. Other studies examining effects of training on learners' performance on comprehension and essay questions showed benefits for training. Several factors have been identified: (1) duration of the training, which ranged between 60 minutes for one session (Hayati & Shariatifar, 2009) to 90 minutes per session for five weeks (Amer, 1992); (2) clear steps and explicit suggestions on when to mark and when not to, how and what to mark (Hayati & Shariatifar, 2009; Amer, 1994; Leutner et al, 2007); and, (3) training in the strategy of text marking, especially if coupled with self regulation (Leutner et al., 2007). None of these characteristics were present in my study, which may explain the lack of effects for briefly showing examples.

This finding and the previous one imply that to help learners' mark text efficiently, one needs to resort to explicit training.

5.5. Text Marking, Prior Knowledge and Achievement

Learners with more prior knowledge of the topic performed better on recall questions than learners with low prior knowledge. This finding is in accordance with results of prior knowledge studies which reported that more background knowledge about a topic improves learners' recall (e.g. Bransford & Johnson, 1972).

In the current study, prior knowledge was also found to mediate the effect of text marking on achievement (performance on both recall and transfer tasks). Learners with more prior knowledge were able to benefit more from marking text. This finding parallels results of Annis and Davis (1978) where text marking was found more effective when the topic is familiar. It also represents the "Matthew Effect" where individuals with initial advantages tend to gain further advantages and vice versa. Beyond recommending explicit training for text marking, it would be predicted that training learners to mark will benefit but not erase pre-existing differences due prior knowledge. More research is needed to verify this finding.

5.6. Need for Cognition and Achievement

Results revealed a proportional relation between learners' need for cognition and: (1) achievement; (2) transfer tasks. The need for cognition questionnaire assesses an individual's inclination to be involved in effortful cognitive activities. Since transfer questions required learners to relate and apply what they learnt from the text in new situations, one infers that learners high in need for cognition tended to be more involved in deeply processing information in the text. This supports other findings in the literature of need for cognition where learners high in need for cognition recalled more arguments in text (Cacioppo, Petty and Morris, 1983) and worked harder to think about and expand on information (Craik & Lockhart, 1972).

5.7. Study Limitations

There are two issues with tasks used in this study. Recall question 4 was: “ In your house, why does a sock fall more slowly than a shoe?” This question can be considered to assess more than recall. The other issue has to do with transfer question 3: “Two asteroids are travelling in space, where there is no air resistance, from the same starting point at a speed of 18.6 km/s. One is 10,000 k. the other is 15,000 k. which one would reach the Earth's atmosphere first and why?” Two participants mentioned they could not tell whether the “k” is for kilometers or kilograms. There is a possibility that other participants misunderstood what the “k” referred to as well. Other research with different recall and transfer tasks is needed to examine these findings.

An important note to make, using multiple statistical analysis on the same sample raises caution about probability of type I error.

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Appendix A.

Questionnaires

Demographics:

Please complete the following with information about yourself:

1. Program of study (e.g. Psychology, Engineering...etc.)
2. Year (e.g. second year, fourth year...etc.)
3. If ESL, how many years of studying English:_____
4. Please rate how important highlighting is as a method you use to learn.

0 10

Assessing Metacognitive awareness:

1. I think about what I really need to learn before I begin a task
2. I am a good judge of how well I understand something
3. I ask myself how well I accomplished my goals once I'm finished
4. I ask myself if what I 'm reading related to what I already know
5. I know what kind of information is most important to learn
6. I am good at organizing information
7. I am good at remembering information
8. I ask myself questions about the material before I begin
9. I focus on the overall meaning rather than specifics

Source: Schraw, G. & Dennison, R. S (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology*, 19, 460-475

Need for Cognition:

1. I would prefer complex to simple problems.
2. I like to have the responsibility of handling a situation that requires a lot of thinking.
3. Thinking is not my idea of fun.
4. I would rather do something that requires little thought than something that is sure to challenge my thinking abilities.

5. I try to anticipate and avoid situations where there is likely a chance I will have to think in depth about something
6. I only think as hard as I have to.
7. I really enjoy a task that involves coming up with new solutions to problems.
8. I feel relief rather than satisfaction after completing a task that required a lot of mental effort.
9. It's enough for me that something gets the job done; I don't care how or why it works.

Prior Knowledge:

List information you know about the following concepts in bullet form:

1. Gravity:
2. Weightlessness:
3. Effects of weightlessness on the cardiovascular system:

Practice:

Reading text:

Many serious health concerns in North America can be linked to poor diet. Poor diets high in sodium, sugar and saturated fats increase risks of developing heart disease, hypertension, diabetes and several types of cancer. People with poor diets are not necessarily undereducated about proper nutrition. For instance, individuals who live in a food desert – areas in low-income neighborhoods that lack easy access to healthy, affordable food– may not be able to buy nutritious food.

Food deserts are created when major supermarket chains move out of areas of poverty or simply don't build stores there. Big retail chains prefer to locate stores in wealthier urban or suburban neighborhoods. This means that people living in high-poverty areas often live far from fresh meats, dairy products and other nutritious foods these supermarkets sell. Moreover, fast food restaurants often concentrate in low-income areas. Recent estimates suggest that people living in the poorest areas of a city experience 2.5 times more exposure to fast food restaurants than people living in the wealthiest areas of that city.

Recall questions:

a. What is a major cause of serious health concerns in modern America?
b. What is a food desert?

Application question (Transfer):

A recent study investigated people's use of the bus system in a very large city. Interestingly, people who used the bus system most were very healthy and had low incomes. How would you explain this finding?

Appendix B.

Reading Text

Section 1:

Gravity accounts for why objects seem to attract each other with a force that is proportional to their masses (Term 1). Our most common experience with gravity is when we watch objects fall when we drop them (Example1).

An object's weight is not the same as its mass (MI 1). Mass is the quantity of matter an object has (Term 2). Weight is the result of an object's mass and the force of gravity (Term 3). The mass of an object is constant wherever it is (fact 1). But gravity is not a constant value (fact2). Gravity decreases with distance from the center of the Earth (Explanation 1).

Every planetary body, including Earth, is surrounded by its own gravitational field which exerts an attractive force on all objects (MI 2). If planets were exactly spherical, the influence of this field on an object would vary in proportion to the planet's mass and vary in inverse proportion (as one thing increases, the other decreases) to the square of the object's distance from the center of the planet (Explanation 2).

The strength of a gravitational field is described by a number that describes how fast an object accelerates due to gravity (MI 3). At the Earth's surface, this is 9.80665 m/s^2 or 32.1740 $ft/s^{2;}$ that value is called standard gravity, which physicists symbolize by the letter g (Term 4). At standard gravity, ignoring air resistance and any other friction, an object falling freely increases its velocity by 9.81 meters/second (or 32.17 feet/second or 22 miles/hour) for each second that passes (Description 1). Starting from rest, an object reaches a velocity of 9.81 meters/second (32.17 feet/second) after one second (Example 2). Two seconds after it started falling, its velocity is 19.62 meters/second (64.38 feet/second), and so on (Example 3). If air resistance could be ignored, like in a vacuum, every object dropped from the same height would hit the ground at the same time (Fact 3). [293]

Section 2:

Weightlessness isn't actually a condition where an object has no weight, it's a condition when there is no stress or strain on an object due to gravity (Term 5). For example, when you lie on the floor, you "feel" gravity – weight – because the floor reduces your acceleration due to gravity from a standard gravity of 1g to 0g (Example 4). You aren't falling at all (Consequence 1).

An object affected by the force of gravity only is said to be in a state of free fall (Term 6). In free fall, you would feel weightless because you're falling at a rate of 1g, the rate of acceleration due to gravity (Reason 1). Suppose you fall off a diving board (Example 5). You fall at 1g and you'd feel weightless (Consequence 2).

If an astronaut on the International Space Station drops an apple, it falls too (Example 6). But to the astronaut, it just doesn't look like it's falling (Description 2). That's because

the astronaut, the apple and the space station are all falling together at the same rate (Reason 2). Because they all fall at the same rate, objects inside of the station appear to float in a state we call “zero gravity” (0g) (Term 7). Actually, there is microgravity corresponding to a rate of 1x10-6 g but it’s undetectable by the astronaut (Fact 4).

The sensation of weightlessness that astronauts experience is not due to zero gravity – 0g (MI 4). The astronaut feels weightless because there is zero difference between the acceleration of the space station and the acceleration of the astronaut (Reason 3). Spacecraft stay in space because of their tremendous horizontal speed (Reason 4). The curvature of the Earth's surface is the same as difference between the spacecraft's horizontal motion and its fall toward the ground caused by gravity (Explanation 3). Speed, not position or lack of gravity, keeps spacecraft in orbit around the Earth (conclusion). [309]

Section 3:

Humans are well adapted to conditions at the surface of the Earth (Fact 5). But exposure to weightlessness in space raises health concerns (MI 5). One major concern for spaceflight is cardio-vascular deconditioning (Example 7).

The cardio-vascular system consists of a driving pump, the heart, and two key circulatory systems that it feeds (Term 8). One system is the pulmonary system that cycles blood between the heart and the lungs (Term 9). In second system, the systemic, arteries carry blood cells made red with oxygen under relatively high pressures throughout the body and veins return deoxygenated blood to the heart (Term10). Pressure in the systemic system is measured in terms of millimeters of mercury in a vertical tube, symbolized mmHG (Fact 6). Normal pressure in the arterial system is 80 to 90 mmHg (Fact 7). In the venal system, pressure is lower, usually 5 to15 mmHg (Fact 8).

On Earth, there is a large difference in blood pressure from head to foot (MI 6). Average arterial pressure is about 70 mmHg at the head, 100 mmHg at the heart, and 200 mmHg at the feet (Description 3). This is because the vascular system is essentially a set of vertical “columns” of blood (Reason 5). Like in a swimming pool, pressure in these columns increases with depth (Example 8).

The flow of blood in the body is influenced by gravity (MI 7). When a person stands, gravity causes blood to pool in the relatively more flexible leg veins (Example 9). In fact, usually about 70% of a person’s blood is in the veins (Fact 9). In addition to circulating blood throughout the body, the heart also is responsible for managing pressure in blood system to keep it (Fact 10).

Gravity makes it difficult for blood to flow upward toward the heart and to the lungs for more oxygen (MI 8). Rapid changes between standing, sitting, and lying down require quick adjustments by the heart to maintain adequate pressure to move blood in the body (Description 4).

During Spacecraft launch, astronauts lie in a nearly horizontal position (MI 9). If they stood, the force of the accelerating rocket would push blood away from their heads and they would become unconscious (Consequence 3). By lying horizontally, a significant

volume of blood is above the heart, thereby increasing pre-load to the heart (central venous pressure) and improving cardiac output (Reason 6).

In orbit, where there is just microgravity, blood shifts from the lower part of the body towards the chest virtually doubling the volume of blood within the heart (MI 10). The heart's response to extra load caused by this headward shift is to increase the volume of blood it pumps (Consequence 4). This increased work by the heart creates a more balanced distribution blood pressure than is the case when the astronaut is standing on Earth (Consequence 5). [426]

Appendix C.

Achievement Test

Part 1: (Transfer Questions)

1. If gold were always sold by weight, could you make money buying gold at one altitude above the ground and selling at a different altitude? Where would you want to buy - at a high altitude or a low altitude?
2. The **Purple planet:** Volume: 68 (9) km (3), Mass: 86 (21) kg, mean radius : 3.98 Re, while the **Green planet:** Volume: 62 (9) km (3), Mass: 102 (21) kg., radius: 3.86 Re. A human being would weigh more on the Purple or on Green planet. Why?
3. Two asteroids travelling in space, where there is no air resistance, from the same starting point at a speed of 18.6 km/s. One is 10,000 k. the other is 15,000 k. which one would reach the Earth's atmosphere first and why?
4. 1 pound of cotton put in a box of 10 centimeter on each side and 1 kg iron in a box of 10 centimeter are dropped from the 10th floor. Which one will reach the ground first and why?
5. A man is in a lift holding a ball. The lift suddenly breaks free, falls from the 30^{th} floor and the man LETS GO OF the ball. Choose the option that best describes what happens after the man LETS GO OF the ball, then justify your choice.
   a. The ball will float in the lift
   b The ball will fall on the floor
   c. The ball will continue to fall and will never reach the floor of the lift
   d. The man and the ball will be floating inside the lift
6. A scientist builds a tower that's 50 k.m. tall. He puts a cannon on top of the tower and fires a cannon ball parallel to the surface of the Earth. Describe the path of the cannon ball and why?
7. Suppose you are on a roller coaster. The rid accelerates to the first peak where it is traveling at the rate of standard gravity. What is the healthiest position for you to be in: sitting down, lying on your back, standing up or being upside down. in this state of absence of gravity why your choice is healthy in terms of blood flow?

8. Volunteers at Canadian Space Agency were requested to spend time in the microgravity chamber to monitor physiological changes. From the list below check only the symptoms you would observe and tell why you would observe them:
    a. Puffy face (The veins of the neck and face stand out more than usual; the eyes become red and swollen)
    b. Slow heart rate
    c. Bird legs (thinner legs)
    d. Hypoxia (deficiency in amount of oxygen reaching the tissues)

Part 2: (Recall questions)

1. Define gravity?
2. How is weight different from mass?
3. What influences an object's weight on Earth?
4. Why a sock in your house falls more slowly than a shoe?
5. What property keeps a spacecraft in orbit around the Earth?
6. Why would an astronaut see loose objects floating around the spacecraft?
7. For a person who is standing why is blood pressure higher in the feet than in the arms?
8. How does the heart respond when a person is in microgravity?

Appendix D.

Grading Rubric

D1. Recall Questions

RQ1	0	A force only, a description on how it increases or decreases …etc.
	1	Gravity is a force that attracts objects
RQ2	0	Mentions nothing or a wrong answer
	1	Mentions only one
	2	Weight is mass X gravity, weight is not constant, mass is
RQ3	0	Mentions nothing or provides a wrong answer
	1	Mentions one thing and not 2
	2	Square of objects distance from center of earth (1), mass & gravity (1)
RQ4	0	Nothing or wrong answer
	1	Mentions one thing only
	2	Shoes weigh more than socks (1) in presence of air resistance (1)
RQ5	0	Nothing or wrong answer
	1	Speed
RQ6	0	Mentions nothing or wrong thing
	1	Mentions one thing only
	2	All falling together (1) in a state of zero gravity (1)
RQ7	0	Nothing or wrong answer
	1	Mentions one detail
	2	Vertical columns of blood (1) increases with depth (1)
RQ8	0	Nothing or wrong answer
	1	Increases volume of blood it pumps

D2. Transfer Questions

TQ1	Out of 2	
	0	Nothing or both parts wrong
	1	Mentions one or gives wrong answer for one
	2	Yes (1) at a high altitude (1)
TQ2	Out of 2	
	0	Nothing or both wrong
	1	Mentions one correctly
	2	The green planet (1) mass is more (1)or radius is smaller
TQ3	Out of 2	
	0	Nothing or both wrong
	1	Mentions one correctly
	2	Both (1) no air resistance (1)
TQ4	Out of 2	
	0	Nothing or both wrong
	1	Mentions one correctly
	2	Both (1) same weight (1)….or accelerate at the same rate (implies equal weight) ..or same "g"
TQ5	Out of 2	
	0	Nothing, both are wrong
	1	Mentions one correctly
	2	Both will be floating (1) because its only the force of gravity acting on the object, free fall
TQ6	Out of 2	
	0	Mentions nothing or wrong answer
	1	Mentions one part
	2	Out of space if velocity exceeds standard gravity or, in orbit, if velocity equals gravity or fall to the ground if velocity is less
TQ7	Out of 2	
	0	Nothing or wrong
	1	Mentions one thing
	2	Lying on the back (1) reason (1)
TQ8	Out of 4	(Note: each learner can only choose one option)
Choice 1	0	Does not choose it
	1	Choose this option
	2	Check (1) because no gravity blood flows upward (1)
Choice 2	0	Chooses it
	1	Does not choose it
Choice 3	0	Does not choose it
	1	Choose this option
	2	Check (1) because no gravity blood flows upward (1)
Choice 4	0	Chooses it
	1	Does not choose it

Appendix E.

Parts in Reading Text Central to Answering Questions

E1. Parts Central to Answering Transfer Questions:

Transfer Questions	Categories
TQ1	T3, F1, F2, EP 1
TQ2	EP 2
TQ3	F3
TQ4	D1, F3
TQ5	T5, T6, R1
TQ6	EP3, Con
TQ7	MI9, C3, R6
TQ8	MI8, MI10, C3

E2. Parts Central to Answering Recall Questions:

Recall Questions	Categories
RQ 1	MT1
RQ 2	MT3
	MF1
RQ 3	MEP2
RQ 4	MF3
RQ 5	MR4/ con
RQ 6	MR2
	MT7
RQ 7	MR5
	ME8
RQ 8	MC4