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Using an Electronic Highlighter to Eliminate the Negative Effects of Pre-Existing, Inappropriate Highlighting

The purpose of the present experiment was to determine whether using an active learning technique, electronic highlighting, can eliminate the negative effects of pre-existing, poor highlighting on reading comprehension. Participants read passages containing no highlighting, appropriate highlighting, or inappropriate highlighting. We hypothesized that the act of using an electronic highlighter could reduce or eliminate the effects of inappropriate highlighting. We measured comprehension of the passages in addition to three measures of metacomprehension: Judgment of Learning (JOL), Prediction of Knowing (POK), and confidence ratings. The results indicated that using the electronic highlighter eliminated negative effects of pre-existing, poor highlighting on both comprehension and metacomprehension.

To be successful, college students must develop effective strategies for reading large amounts of text. Common strategies include underlining or highlighting parts of the text.

Such strategies can be effective when the student is able to identify relevant parts of the text, but when another person has highlighted irrelevant material, reading comprehension and metacomprehension may be compromised. This situation may occur when college students purchase used textbooks or rent textbooks that have been highlighted by another student. In the present research, we study a simple active reading method that may overcome the effects of previous, inappropriate highlighting.

College students have numerous reading requirements that may exceed 600 pages per course (Orlando, Caverly, Swetnam, & Flippo, 1989). If a student is taking four to five courses, the reading load can be overwhelming, especially for a student with poor reading comprehension and learning strategies. Skilled adult readers, such as college students, have been found to use multiple reading strategies such as setting goals, rereading the unfamiliar parts of the text, and using studying techniques such as note-taking, underlining, writing in the margins, and highlighting the relevant parts of the text (Garner, 1990; Winograd, 1984) to enhance their reading comprehension. Additionally, Taraban, Rynearson, and Kerr (2000) reported that students with higher GPAs and ACT scores reported using more reading strategies compared to students with lower GPAs and ACT scores. The results of their study showed that college students "are aware of the utility of reading comprehension strategies, and that the strategies do make a difference in college students' academic performance" (p. 303).

Wade, Trathen, and Schraw (1990) divided study tactics into three different types. One type is mental learning tactics: rote-learning, imaging, visualization, along with self-questioning and self-testing. A second type is reading tactics: how the student reads the material, including reading, skimming the material, reading slowly, and re-reading. The third type of tactic is note-taking, which includes underlining, outlining, circling, and highlighting. Using these tactics, according to the researchers, helps the students better comprehend and remember what they have read. Similarly, Blanchard and Mikkelson (1987) reported that students underline or highlight information so they can return later to the isolated text to reread and restudy the portion of the text that they either did not comprehend the first time, or that they determined to be relevant parts of the chapter. Additionally, Kobayashi (2007) suggested that "highlighting behaviors are not as disruptive to the ongoing process of reading as other strategic behaviors such as note-taking behaviors, and therefore they allow readers to concentrate on reading the text" (p. 373). However, Pressley, Ghatala, Wolosyn, and Pirie (1990) found that students often provided the wrong answers on reading comprehension

tests, even when the comprehension test was open book, because they did not look back at the text when answering the questions. Pressley et al.'s results demonstrated that students may overestimate their reading comprehension.

In an early study on reading comprehension and underlining, Crowse and Idstein (1972) found that more information was retained from the parts of a text that had been underlined than parts that were not underlined. For example, Marxen (1996) commented, "Unfortunately, by choosing to underline what they think is important, students may be essentially granting themselves a license to ignore the majority of the assigned materials" (p. 94). If students do not underline or highlight the relevant parts of the text, this produces two negative consequences: first the students focus on information that is not needed for later recall; and secondly, the students ignore the relevant parts of the text.

One of the most common reading strategies used by college students is highlighting the relevant parts of the passages in the text (Peterson, 1992). Expert readers, according to Yang (2006), are able to correctly identify the relevant parts of the passages, which would include the parts that they highlight; however, poor readers often highlight either too much of the passage or they highlight irrelevant parts of the passage.

Fowler and Barker (1974) found that highlighting improves retention of selected text material and that using highlighting as an active learning technique is superior to passive reading of highlighted material. The researchers found that readers benefitted the most from the presence of highlighting when they were confident that the highlighting discriminated between important material and trivia. In a second study, Fowler and Barker found that traditional underlining was the most effective as an emphasis technique.

Students who buy used textbooks may find that the previous owner(s) highlighted the passages in the textbook inappropriately. In other words, the relevant material was not highlighted, and non-relevant material was highlighted, or, a great deal of material was highlighted indiscriminately. The literature does not establish how prevalent it is for students to obtain a book that has pre-existing, inappropriate highlighting; however, according to a university bookstore manager, students often first check to see if used textbooks are available before purchasing a new textbook. According to the manager, most students spend extra time searching through the used textbooks to find the ones that contain the least amount of highlighting. Does such pre-existing, inappropriate highlighting interfere with reading comprehension? Silvers and Kreiner (1997) found that pre-existing poor highlighting negatively impacted college students' reading comprehension. It appears that if students

buy used textbooks that contain pre-existing, poor highlighting, their reading comprehension may suffer, and ultimately affect their ability to recall the relevant information at a later date. Silvers and Kreiner (1997) wondered if warning students in advance of the possible negative effects of pre-existing, poor highlighting could have on their reading comprehension would help eliminate the negative effects of the poor highlighting. Again, the results of the study were sobering. The advance warning of the harmful effects of the pre-existing, poor highlighting by the researchers did not eliminate the negative effects. Apparently, students were unable to ignore the poor highlighting. Interestingly, Silvers and Kreiner found no significant difference in reading comprehension between their appropriate highlighting condition and a control condition in which the texts were not highlighted at all. Thus, text with pre-existing, appropriate highlighting may be no more useful for reading comprehension than text with no highlighting. This finding supports previous research indicating that students need to be dynamic, active learners, actively participating with their encoding process of material being read (Hiebert & Lefevre, 1986).

It is important for students to not only be able to gain knowledge from what they read, but to be able to monitor their level of learning. Judgment of Learning (JOL) has been used quite frequently in reading comprehension studies (Rawson, Dunlosky, & Thiede, 2000; Maki, Shields, Wheeler, & Zacchilli, 2005; Kurby, Ozuru, & McNamara, 2007). Judgment of Learning involves predicting the likelihood that studied items or passages will be recalled at a future time (Mazzoni & Nelson, 1995). Maki et al. (2005) found that students may have only a moderate ability to judge how well they will do on a test based on their understanding of the text material. Other studies have shown that students who overestimate their JOL (meaning that they believe they comprehended the relevant parts of the text when in fact they did not) are more likely to terminate their studying before mastering the material (Moore, Lin-Agler, & Zabrucky, 2005).

Research has shown that students' JOLs are negatively impacted by the pre-existing, inappropriate highlighting (Gier, Kreiner, & Natz-Gonzalez, 2009), meaning that students experience an Illusion of Knowing (IOK). In other words, they falsely believe they have studied and retained the relevant material to be tested in the future. Silvers-Gier et al. (2009) tested 180 undergraduate college students who were first randomly assigned to either high difficulty level passages or low difficulty reading passages, and to one of three highlighting conditions: (a) a control group in which none of the passages were highlighted, (b) an experimental group that read appropriately highlighted passages, and (c) an experimental group

that read inappropriately highlighted passages. In addition to measuring reading comprehension scores, the researchers measured JOLs and confidence ratings. The results showed that not only were reading comprehension scores impaired in the inappropriately highlighted condition, but that metacognitive accuracy was also impaired.

Prediction of Knowing (POK) is a metacognitive task in which participants are asked to predict how well they will be able to retrieve information at a later time and has been used in research studies using proactive interference theory manipulations (Eakin, 2005; Schreber & Nelson, 1998; Metcalfe, Schwartz, & Joaquim, 1993). For example, Eakin (2005) used POK in her study addressing metamemory and memory on a vocabulary test under conditions of retroactive interference. Eakin's participants provided POK ratings that predicted their performance on a future test. Her results showed that POKs were more positive in the interference condition even after warning the participants not to base their prediction on any information from a second list of words. In a POK reading comprehension paradigm, the participants are asked to predict how well they will be able to answer questions over passages that they are asked to read. In the current study, the proactive interference that the participants experience will be in the form of preexisting highlighting.

Another way to measure metacomprehension is to ask readers to rate their level of confidence after they have answered comprehension questions using posttest confidence judgments. The participants rate their level of confidence after they have answered comprehension questions. For example, Pressley et al. (1990) found that when given an open book reading comprehension test, if readers did not refer back to the text when answering reading comprehension questions, they often provided incorrect answers and were overly confident that their answers were correct. Previous studies on the effects of preexisting highlighting on reading comprehension (e.g., Silvers-Gier et al., 2009) found that, when the text was inappropriately highlighted, confidence ratings tended to correlate negatively with comprehension accuracy.

Problems in reading comprehension may arise both from difficulty comprehending the relevant material and from metacognitive problems with monitoring one's knowledge and ability to respond to questions. Previous research has demonstrated that the presence of poorly done highlighting can affect both cognitive and metacognitive aspects of reading. In the present study, we explore a simple active reading method to determine if the act of highlighting can overcome the problems associated with poorly highlighted text.

The purpose of the current research study is to determine if the negative effects of pre-existing, inappropriate highlighting are present

when students use an electronic highlighter as they read a previously highlighted text. The use of an electronic highlighter may encourage active reading, which could override negative effects of previous highlighting in the text. Our focus is on the use of the highlighter rather than on what material the reader chooses to highlight. Reading comprehension, JOL, POK, and confidence judgments are used as the dependent variables, and the independent variable is highlighting: no highlighting, appropriate highlighting, or inappropriate highlighting. We predict that using the electronic highlighter will eliminate the negative effects of the poor highlighting.

Method

Integrated Multicultural Instructional Design

Ninety college students at a southeastern university volunteered to participate in the study. Participants included 17 African American, 68 Caucasian, and 5 Native American students. The mean age was 28.5 years (with a range of 20 – 50). The students were all upper level college students (i.e., juniors and seniors). The participants were given extra credit for participating in the study.

Materials

InfoScan TS Elite electronic highlighters from Wizcom technologies were provided for participants' use (see Appendix D). The electronic highlighters used in this study had multiple functions, such as the ability to scan up to 500 pages that can then be uploaded into a Microsoft Word document; access to a dictionary; and the ability to read scanned text aloud in English. Although the electronic highlighters had several functions, for the purpose of this study the electronic highlighting scanners were only used for students to "highlight" the relevant material of the passages. This highlighting function is similar to the use of a traditional highlighter; the student moves the electronic highlighter over the text, which can then be stored in the highlighter's memory. However, the electronic highlighter does not leave any mark on the paper, as does a traditional highlighter. The material scanned was not analyzed in this study. The passages used for the current study were the same text materials that were used by Maki et al. (2005). Rawson, Dunlosky, and Thiede (2000) originally used these passages, taken from a GRE preparation manual (Branson, Selub, & Solomon, 1987). The mean number of words per passage ranged from 347–604, with a mean number of 31 sentences per passage (ranging from 24 -38 sentences), a mean of 14.21 words per sentence (ranging from 10.84–15.89 words per sentence). Mean Flesch-Kincaid grade level was 9.80, with a range of

7.60–12.00. We used a yellow highlighting pen to highlight 30 copies of these passages appropriately and 30 copies of the passages inappropriately. Another 30 copies of the passage contained no highlighting. For the appropriate highlighting condition, we highlighted material in each passage that was relevant to the comprehension questions, whereas in the inappropriate highlighting condition, we highlighted an equivalent amount of text that was not relevant to any of the comprehension questions (See Appendices A, B, and C).

The Judgment of Learning scale included possible responses of 0%, 20%, 40%, 60%, 80%, and 100% and was printed on a separate page after each of the passages. The POK measure was at the top of the page of the six multiple-choice questions for each of the passages. The POK question was, "How many of the six questions do you think you will get correct (predictions) on a given test. Please write the number of questions that you think you will get correct between 0 (zero correct) – 6 (all correct)." Six multiple-choice questions over the passages were used in the study (See Appendix C). The passages and questions were taken from a GRE study manual (Branson et al. 1987).

Procedure

The participants were randomly assigned to one of three conditions: (a) appropriate highlighting, (b) inappropriate highlighting, or (c) no highlighting. Instructions on how to use the electronic pen were given after the participants read and signed the consent form. Once the participants were confident in using the electronic highlighter, they were given the following instructions: "You will have six passages to read during this study. We are asking you to ignore any preexisting highlighting that may be on your reading passages, and highlight what you consider to be the relevant parts of the passage. After reading each passage, we then want you to make a Judgment of Learning on the percentage of the text you understood. The Judgment of Learning is based on a scale of 0%, 20%, 40%, 60%, 80%, and 100%. You are to write one of these percentages in the space provided. The following page contains six multiple-choice questions. You are asked to read over the six multiple-choice questions and predict how many of the questions you think you will get correct, 0–6. Do not answer the questions at this time. After reading all of the passages, return to the first set of multiple-choice questions and answer them. After answering the multiple-choice questions, we want you to give us a posttest confidence judgment on how many of the questions you think you got correct. After you have repeated this procedure for each of the passages, you will be debriefed to the purpose of the study."

Results

We conducted a one-way ANOVA comparing the three highlighting conditions on each dependent variable: accuracy (percent correct on the comprehension questions), JOL, POK, and confidence ratings. For significant *F*-tests, the Bonferroni method was used for post hoc comparisons.

There was a significant effect of the highlighting condition on accuracy, $F(2, 87) = 3.59$, $p < .03$, partial $n^2 = .08$. Bonferroni comparisons indicated a significant difference between the appropriate highlighting ($M = 82.59$, $SD = 10.16$) and inappropriate highlighting conditions ($M = 75.39$, $SD = 9.97$), but no significant difference between the inappropriate highlighting condition and the no highlighting condition ($M = 80.00$, $SD = 11.40$). There was no significant difference between the appropriate highlighting and no highlighting conditions.

All metacomprehension ratings were calculated as percentages. There was a significant effect of the highlighting condition on JOL, $F(2, 87) = 3.37$, $p < .04$, partial $n^2 = .07$. Bonferroni comparisons indicated no significant difference between the inappropriate highlighting ($M = 63.24$, $SD = 17.30$) and no highlighting conditions ($M = 69.35$, $SD = 15.89$), but a significant difference between the appropriate ($M = 73.76$, $SD = 13.84$) and inappropriate highlighting conditions. The appropriate highlighting and no highlighting conditions did not differ significantly on JOL. There was not a significant effect of the highlighting condition on either POK, $F(2, 87) = 1.51$, $p = .23$, partial $n^2 = .03$, or confidence ratings. $F(2, 87) = 1.22$, $p = .30$, partial $n^2 = .03$.

We computed relative metacomprehension accuracy for each participant as the gamma correlation between the metacognitive rating (JOL, POK, or confidence) and accuracy on the comprehension questions across the six passages. These measures indicate the degree to which participants' metacomprehension ratings correlate with their accuracy in responding to comprehension questions. Each of the gamma measures was entered as a dependent variable in a one-way ANOVA comparing the three highlighting conditions. The ANOVA on the JOL-accuracy gammas indicated no significant effect of the highlighting condition, $F(2, 86) = 2.25$, $p = .11$, partial $n^2 = .05$. Likewise, there was not a significant effect of highlighting condition on either the POK-accuracy gammas, $F(2, 76) = 0.64$, $p = .53$, partial $n^2 = .02$, or on the confidence-accuracy gammas, $F(2, 73) = 0.34$, $p = .72$, partial $n^2 = .01$.

Discussion

The results of the present study indicate that the act of using an electronic highlighter can reduce or eliminate the negative effects of pre-existing, inappropriate highlighting. Previous research indicated that the presence of inappropriate highlighting interfered with measures of both comprehension and metacomprehension (Silvers & Kreiner, 1997; Silvers-Gier et al., 2009). In the present study, when students used an electronic highlighter while reading the passages, accuracy in responding to comprehension questions was not significantly lower in the inappropriate highlighting condition compared to the control condition. Similarly, the presence of inappropriate highlighting did not significantly decrease any of the measures of metacomprehension (JOL, POK, or confidence ratings) or any of the measures of how well metacomprehension ratings predicted comprehension performance.

The present results are similar to those of the Gier et al. (2010) study in which participants highlighted using a different-colored highlighter or pretended to highlight with their fingers. The common thread among these methods is that the students used an active reading procedure that involved considering what material was relevant. Previous research indicated that simply warning students of possible negative effects of pre-existing highlighting was not sufficient to avoid those effects (Silvers & Kreiner, 1997). We believe that the present results contribute to the literature by showing an additional way in which the negative effects of pre-existing inappropriate highlighting may be reduced. In particular, the act of deciding what material to highlight with an electronic highlighter appears to be sufficient to override the negative effects of previous highlighting. The combination of the present results and those of Gier et al. (2010) provide strong support for the claim that active reading methods in general can be helpful for readers faced with pre-existing highlighting.

Several limitations should be noted with the present studies. First, the sample included only upper-level students, so it is not clear whether the electronic highlighting method would be equally effective for other types of students. Secondly, the reading materials were samples based on the GRE reading comprehension materials. Although this reading material is likely to be representative of the content in many students' reading assignments, it would be worthwhile to explore the effects of highlighting in actual textbooks. Thirdly, we asked participants to make three metacomprehension ratings for each passage. While this provided interesting information about students' metacomprehension, it is possible that continuously asking students to reflect on their knowledge may in fact change their reading behaviors.

We did not focus on the content of what students chose to highlight. Instead, the focus of the present research was on whether the simple act of using the electronic highlighters might overcome the effect of previous highlighting. Another fruitful line of research might be to examine the content that students choose to highlight. Individual differences in ability to select relevant information and to ignore less relevant information may be related to both comprehension and metacomprehension.

There are several reasons why a student may choose to use an electronic highlighter in class and in independent study: (a) the electronic highlighter, based on our study, helps to eliminate the negative effects of preexisting, inappropriate (poor) highlighting; (b) the relevant material highlighted by the electronic highlighter can be uploaded into a document allowing the student to study the important points of the text and to keep the materials for future reference; (c) the electronic highlighter would be helpful when reading primary sources in a journal or book from the library; (d) using the electronic highlighter helps in creating a connection between the material highlighted and the brain by being an active reader; and (e) leaves the textbook free of markings for better resell value. From a research standpoint, the electronic highlighter allows the researcher to see what areas of the text a student deems important and whether the material highlighted was beneficial in retaining the information for recall when tested over the material read.

The present results provide evidence that the comprehension problems associated with reading previously highlighted texts may be reduced or eliminated with the use of active reading methods. A key aspect of effective reading strategies appears to be the active selection of information by the student.

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Appendix A
Example of Inappropriate Highlighting
(Passage from Branson et al., 1987)

A majority taken collectively may be regarded as a being whose opinions and, most frequently, whose interests are opposed to those of another being, which is styled a minority. If it is admitted that a man, possessing absolute power, may misuse that power by wronging his adversaries, why should a majority not be liable to the same reproach? Men are not apt to change their characters by agglomeration; nor does their patience in the presence of obstacles increase with the consciousness of their strength. For these reasons we should not willingly invest any group of our fellows with that unlimited authority which we should refuse to any individual. One social power must always predominate over others. But liberty is endangered when this power is checked by no obstacles which may retard its course and force it to moderate its vehemence. Unlimited power is, in itself, a bad and dangerous thing, and no power on earth is so worthy of honor for itself or of reverential obedience to the rights which it represents, that we should admit its uncontrolled and all-predominant authority. When the right and the means of absolute command are conferred on a people or a king, upon an aristocracy or a democracy, a monarchy or a republic, there has been implanted the germ of tyranny. The main evil of the present democratic institutions of the United States does not arise, as it is often asserted in Europe, from their weakness, but from their overpowering strength. The excessive liberty which reigns in that country is not so alarming as is the very inadequate security which exists against tyranny. When an individual or a party is wronged in the United States, to whom can he apply for redress. If to public opinion, public opinion constitutes the majority. If to legislature, it represents the majority, and implicitly obeys its injunctions. If to the executive power, it is appointed by the majority and remains a passive tool in its hands. The public troops consist of the majority under arms; the jury is the majority invested with the right of hearing judicial cases, and in certain states even the judges are elected by the majority. However iniquitous or absurd the evil complained about, no surer barrier is established to defend against it.

Appendix B
Example of Appropriate Highlighting
(Passage from Branson et al., 1987)

A majority taken collectively may be regarded as a being whose opinions and, most frequently, whose interests are opposed to those of another being, which is styled a minority. If it is admitted that a man, possessing absolute power, may misuse that power by wronging his adversaries, why should a majority not be liable to the same reproach? Men are not apt to change their characters by agglomeration; nor does their patience in the presence of obstacles increase with the consciousness of their strength. For these reasons we should not willingly invest any group of our fellows with that unlimited authority which we should refuse to any individual. One social power must always predominate over others. But liberty is endangered when this power is checked by no obstacles which may retard its course and force it to moderate its vehemence. Unlimited power is, in itself, a bad and dangerous thing, and no power on earth is so worthy of honor for itself or of reverential obedience to the rights which it represents, that we should admit its uncontrolled and all-predominant authority. When the right and the means of absolute command are conferred on a people or a king, upon an aristocracy or a democracy, a monarchy or a republic, there has been implanted the germ of tyranny. The main evil of the present democratic institutions of the United States does not arise, as it is often asserted in Europe, from their weakness, but from their overpowering strength. The excessive liberty which reigns in that country is not so alarming as is the very inadequate security which exists against tyranny. When an individual or a party is wronged in the United States, to whom can he apply for redress. If to public opinion, public opinion constitutes the majority. If to legislature, it represents the majority, and implicitly obeys its injunctions. If to the executive power, it is appointed by the majority and remains a passive tool in its hands. The public troops consist of the majority under arms; the jury is the majority invested with the right of hearing judicial cases, and in certain states even the judges are elected by the majority. However iniquitous or absurd the evil complained about, no surer barrier is established to defend against it.

Appendix C
Example of Multiple Choice Questions
(Branson et al., 1987)

1. Of the following statements or phrases, the one which best summarizes the meaning of the passage is:
    a. the domination of the majority *
    b   democracy, the triumph of the people
    c. the pluralist way to govern
    d. the ballot box and the bullet

2. The statement that is supported by the passage is that:
    a   majority rule safeguards the rights of all people
    b. individual freedom is incompatible with government
    c. majority rule, even under a democracy, should have some checks on its power *
    d. no government should be trusted since all governments equally dominate others

3. According to the author of the passage,
    a. the main trouble with the United States is the weakness of its government *
    b. the legislature not only represents the governed but also obeys their commands, which is why it can be responsive to complaints
    c. one social power must always dominate over others, and for that reason there is no point in providing checks and balances in government
    d. the trouble with our government is that nothing holds the majority in check

4. The passage directly states that freedom is in danger when
    a. men are made conscious of their strength
    b. a dominator exercises complete power
    c. power is hindered by obstacles
    d. power is not checked by any obstacles *

5. As mentioned in the text, the main evil of the present government in the United States is often stated
    a. in Asia
    b. in Europe *
    c. in Germany
    d. in Japan

6. Which governmental body is referred to as an inactive tool in the hands of the majority?
    a. the executive *
    b. the judiciary
    c. the legislature
    d. the military

Appendix D
Photo of an Electronic Highlighter

Note. Pre-existing highlighting was in yellow.