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Effects of a collaborative annotation method on students' learning and learning-related motivation and affect

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ABSTRACT

Two studies tested the effectiveness of a web-based collaborative annotation system (Hy-Lighter) for learning comprehension, and learning-related affect and motivation. In an undergraduate course setting, students (*N* = 27) in study 1, (1) highlighted and annotated selected articles, and (2) highlighted and annotated selected articles and reviewed peer highlights and annotations. In a graduate course setting, students (*N* = 40) in study 2, (1) highlighted and annotated selected articles, and (2) highlighted and annotated selected articles and reviewed peer highlights and annotations. Control groups in both studies read a hard copy of the articles -without using HyLighter and engaging in its associated annotation practices. The main dependent variables included: (a) performance on quizzes, and (b) a number of affective and motivational variables related to reading assignments and academic success. Although not statistically significant, summative assessment scores were higher for students using HyLigther relative to the ones exposed to conventional instruction. HyLighter use also seemed to be associated with more positive affect in undergraduate students relative to their graduate counterparts. Somewhat equivocal findings between the two studies were attributed to the differential implementation of the software in and outside of the classroom. Recommendations for optimal use and desired outcomes were advanced.

1. Introduction

Collaborative learning refers to an array of social interactions of a group of learners and instructors to share and acquire knowledge and experiences (Su, Yang, Hwang, & Zhang, 2010). The notion of collaborative learning is significant in today's educational system given the presence of a long identified growing trend toward a student-led collaborative learning approach (Harden & Crosby, 2000). Within this approach, instructors provide support and learning resources whereas students individually produce, comment upon, and classify new knowledge (Horizon, 2007). As recently identified by Wheeler, Yeomans, and Wheeler (2008), this shift in education even though originally rooted in the social constructivist theory of learning (see Vygotsky, 1978 for review), is inherent in the new learning technologies (Richardson, 2006). Specifically, from a social constructivist perspective learners are assumed to build more knowledge through the process of sharing and discussing knowledge and experiences (Vygotsky, 1978). However, knowledge should be constructed from multiple resources of the student-led collaborative learning environment (Gale, 2003).

Relative to new technologies at the center of the student-led collaborative learning, Computer-Supported Collaborative Learning (CSCL) is a novel form of collaborative learning enabled by the expansion of the Computer Supported Cooperative Work (CSCW) (Koschmann, 1996; Ligorio & Veermans, 2005; Wang, 2009; Zurita & Nussbaum, 2004). Within the Computer-Supported Collaborative Learning (CSCL), web-based collaborative learning systems that incorporate the most updated Web 2.0 technology attract learners to participate in collaborative learning platforms (Barak, Herscoviz, Kaberman, & Dori, 2009; Jones, Blackey, Fitzgibbon, & Chew, 2010). Technology driven collaborative learning optimize learning experience and outcomes because through the technologies: (1) students seek active engagement with others which they see as valuable and fulfilling (Horizon, 2007), (2) effective mediators to enrich courses are offered via learning teams (see social-cultural activity theory; Nardi, 1996 for review), and (3) cross-platform environments and synchronous or/and asynchronous interactions enable more equal opportunities to share and retrieve information, and actively interact with one and other (Barak et al., 2009).

In addition to the notion of collaborative learning, and its online and optimized applications, yet another strategy to optimize learning is highlighting and annotating. Annotation is a useful strategy because it leads the learner to engage with the content to be

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annotated to ensure both for its relevance and significance (Su et al., 2010). Annotation practices are particularly useful for knowledge sharing within collaborative learning frameworks (Robert, 2009). Furthermore, annotation practices help collaborative learning by allowing learners to: (1) draw attention of group members to a specific content, (2) organize, index, and discuss the new material, (3) review others' thoughts in forms of annotations, and (4) improve through constructive feedback and correctives from instructors or experienced learners (Su et al., 2010); thus leading to collaborative exploration and construction of important knowledge.

While keeping the remedial programs intact, innovative approaches to promote learning can be integrated into the college curriculum. To this aim, Social Annotation Model-Learning System (SAM-LS) can provide an ideal solution. Social Annotation Model-Learning System (SAM-LS) incorporates principles from a number of research fields including instructional design, Team-Based Learning (TBL), and Computer-Supported Collaborative Learning (CSCL). Grounded within the Social Annotation Model-Learning System (SAM-LS), Team-Based Learning (TBL) is advantageous over traditional instructor-centered models because, Team-Based Learning (TBL) model allows more interactive and engaging learning processes (Lightner, Bober, & Willi, 2007). As such, Team-Based Learning (TBL) promotes significant increases in students' learning and performance outcomes (Clark, Nguyen, Bray, & Levine, 2008; Haberyan, 2007). Benefits to, Team-Based Learning (TBL) also include active problem solving, group collaboration, leadership skills, awareness of diversity, enhanced learning, and improved retention of course material (Lancaster & Strand, 2001). Social Annotation Model-Learning System's (SAM-LS) Team-Based Learning (TBL) basis further compliments a Computer-Supported Collaborative Learning (CSCL) approach. Within a, Team-Based Learning (TBL) approach, Computer-Supported Collaborative Learning (CSCL) has a number of benefits indulging, (a) enhancing self-management skills, (b) developing oral and written communication and social interaction skills, (c) increasing the sharing of ideas and understanding, (d) establishing a learning community, (e) increasing student motivation, (f) encouraging alternative perspectives, (g) promoting higher order critical-thinking skills, and (h) facilitating more comprehensive learning (Gokhale, 1995; Johnson & Johnson, 1991; Lehtinen, 2003; Srinivas, 2008). However, the effects of the use of Social Annotation Model-Learning System (SAM-LS) on learning and related motivational and affective responses to learn are not sound enough, thus necessitating further experimental evidence.

Previous research has indicated Social Annotation Model-Learning System (SAM-LS) to help promote students' discussion and improve learning (CoNote; Davis & Huttenlocher, 1995). Further support for the use of the Social Annotation Model-Learning System (SAM-LS) was also shown by the use of bulletin post systems, including E post, and WebAnn, that were shown to promote high quality of online discussions, different discussion styles, and help increase students' focus on particular points in a paper (Brush, Bargeron, Grudin, Borning, & Gupta, 2002). Additionally, CaMILE yet additional Social Annotation Model-Learning System (SAM-LS) was shown beneficial to learning and instruction because of its asynchronous communication feature allowing students to discuss contents outside of the classroom, without the quick response pressure otherwise inherent to synchronous communications (Guzdial & Turns, 2000; Veerman & Veldhuis-Diermanse, 2001). Most recently, Social Annotation Model-Learning System (SAM-LS) was also designed to help undergraduate college students to improve cognitive skills (Johnson, Archibald, & Tenenbaum, 2010), but no sound evidence for such effect was fully established.

Consequently, the two current studies tested the effectiveness of a web-based Social Annotation Model-Learning System (SAM-LS) with collaborative annotation basis i.e., the HyLighter System, on learning comprehension. Two features of HyLighter are noteworthy (1) its basis in social interaction and collaborative learning (Johnson, Khalil, & Spector, 2008) known as conducive to constructing new knowledge, and (2) its online synchronous and asynchronous annotation sharing and discussing properties potent to increase learners' motivation via increased engagement with the annotated material (Mendenhall & Johnson, 2010). As recently noted by Mendenhall and Johnson (2010), HyLighter System can be seen as a tool at the junction of the social networking tools inherent to Web 2.0. (i.e., *Facebook*, *MySpace*, *Ning*), and the more essential annotation applications including the reviewing features in Microsoft Word or Adobe Acrobat, and others available through the Internet. Central to the premises of Social Annotation Model-Learning Systems (SAM-LS), the HyLighter tool was designed to allow the user to highlight and annotate digitally, and subsequently exchange ensuing information with other users. The practice of digital annotating (i.e., making comments while reading) then remains essential to the use of the HyLighter. From an active learning standpoint, annotating allows students prioritize information (Brown & Campione, 1990), and helps with improving memory and learning (Bradley & Vetch, 2007; Glover, Xub, & Hardakerc, 2007). The use of the HyLighter in a community college has in fact indicated that the system "initiated a process that has changed the instructor's approach to teaching" (Lick & Lebow, 2003, p. 9).

The present research consisted of two studies. Study 1 examined the effect of different social annotation practices enabled by HyLighter on learning comprehension in an undergraduate course setting. Two instructional methods were implemented. Students were instructed to (1) highlight and annotate selected articles, and (2) highlight and annotate selected articles and review peer highlights and annotations. Study 2 examined the effect of social annotation practices enabled by HyLighter on learning in a graduate course setting ($N = 40$). Students were instructed to (1) highlight and annotate selected articles, and (2) highlight and annotate selected articles and review peer highlights and annotations. Control groups in both studies read a hard copy of the articles without using HyLighter and engaging in its associated annotation practices. Main dependent variables for the studies included, (a) performance on article-related formative quizzes, and (b) a number of affective and motivational variables related to reading assignments and academic success.

2. Method of study 1

2.1. Sampling

Twenty seven students (M age = 21.58 years, SD = 1.50) enrolled in a southeastern university summer semester classroom assessment course that focused on measurement and evaluation of academic achievement participated in this study. Of these participants, 63% were female, and 37% were male, 78% were Caucasian, 15% African–American, and 3% Pacific Islander; 96% were undergraduate, and 4% were graduate students.

The course was thought in three sections thus students from the three sections made up the sample for this study. Three different instructors taught the three sections. The three sections were aligned i.e., same syllabus, instructional materials, objectives, and assessment tools were used in each sections. Students in one of three sections used social annotation tool (e.g., HyLighter), while students in the remaining two sections used no social annotation tool.

2.2. Instrumentation

A number of instruments were designed to measure learning comprehension related to four reading assignments (i.e., articles).

The items for each of the task comprehension quizzes were constructed by the lead instructor (coordinator), and reviewed and edited by a team of three experts in the field. All items were scored in a multiple-choice format with one stem and four options. The final version of each quiz consisted of items that all participating instructors agreed upon. Although the items for each quiz were specific to the content of the corresponding article, all items were represented in the article's content. Additional instruments were designed to measure affective responses and motivational levels toward learning. A HyLighter specific survey was also designed to help gauge students' ease and level of comfort associated with the HyLighter use.

2.2.1. Learning comprehension quizzes (LCQ)

Four learning comprehension quizzes (LCQ) corresponded to four reading articles i.e., each article was followed by a learning comprehension quiz (LCQ). Each quiz included three multiple-choice items aimed at assessing learning comprehension for the assigned article. Responses for each item were rated as either correct or incorrect. Overall score for each quiz ranged between 0 and 3 and corresponded to the total number of correctly answered items on the quiz.

2.2.2. Learning affects questionnaire (LAQ)

The learning affect questionnaire (LAQ) included seven self-report adjectives aimed at assessing students' affect toward learning, annotating, and interacting with other learners reading the articles. Each self-report item was rated on a 6-point Likert-type scale with anchors ranging from 0 (*not at all*) to 6 (*extremely*). The 7 self-report items included 3 positive-valence emotions (e.g., *excited, optimistic*, and *happy; Cronbach* α = .80), and 4 negative-valence emotions (e.g., *worried, distress, uncertain*, and *pessimistic; Cronbach* α = .60). Learning affect questionnaire (LAQ) somewhat paralleled the Profiles of Mood States (POMS; McNair, Lorr, & Droppleman, 1971), except for a higher balance with regard to hedonic tone. Additionally, Learning affect questionnaire (LAQ) included 2 items aimed at assessing students' level of motivation for reading the articles, and desire to read further ones. The motivational items were rated on the same Likert-type scale with anchors ranging from 0 (*not at all*) to 6 (*extremely*). The 2-item shared a *Cronbach* α of .56. All three scales share high ecological and face validities.

2.2.3. Summative assessment test

The summative assessment test included 40 multiple-choice items aimed at assessing students' understanding of a number of course content areas including assessment – validity, reliability, item analysis, and response to intervention systems. Students' answers were rated as either correct or incorrect for each item. The overall score for the summative assessment test corresponded to the total number of correctly answered items and ranged between 0 and 40. Of the 40 items, two directly pertained to the HyLighter – supported articles.

2.2.4. HyLighter Questionnaire (HQ)

The HyLighter Questionnaire (HQ) included 18 items aimed at assessing the level of comfort and ease associated with HyLighter use. Two sample items of the questionnaire included: "I will use HyLighter only when told to do so," and "HyLighter makes it possible to learn more productively." Each item was rated on a 5-point Likert-type Scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The internal consistency (Cronbach α) of this questionnaire approached .86, and its items share high face and ecological validities.

2.3. Instructional tool

This study implemented HyLighter as the main instructional tool. HyLighter is a web-based social annotation tool that allows the readers to digitally highlight and annotate a text. HyLighter (a) allows large display of text-related commentary, despite the limited space availed in the margins, and (b) enables infinite number of contributors to highlight and insert comments. To comment on HyLighter, readers first (1) use the cursor to block the text to comment upon, and (2) add their input in the comment box that opens.

Once a text is annotated, HyLighter includes color codes on top of a web page linked to comments in the margins. This helps readers interact on specific sections of a text without encumbering the margins, or visually inspecting the text of reference. Fig. 1 provides illustration of color the coded mapping for the inputs from a group. An area highlighted by "you" (the logged-in user) only shows in yellow. Areas not highlighted by "you," but highlighted by one or more other readers show in shades of blue (the darker the shade, the more number of readers has highlighted that fragment). Finally, areas highlighted by both "you" and others show in shades of green. Additionally, comments associated with highlighted texts are displayed in the margin or comment field.

HyLighter also provides different "views" that allow the user to review the group input, or evaluate highlighted fragments and associated comments through a variety of search and sort options (e.g., by username, recommended changes, or date modified).

2.4. Instructional method

Instructional method included the completion of four instructional activities by either using or not using the HyLighter. Instructional method 1 (HyLighter Condition) consisted of students reading an article using HyLighter, and then completing the corresponding learning comprehension quiz (LCQ). Students in instructional method 1 read a given article using the HyLighter and highlighted and annotated the article to facilitate understanding. Online prompts and instructions were provided by the instructor prior to reading the article. These prompts and instructions included (1) instructor's thoughts to specific text content, and/or (2) instructor-chosen relevant web-links. Most frequently these came in forms of open ended statements to initiate further answers/comments from students (i.e., 'check this out:www..., " Is this really surprising?"). Additionally to engaging with instructor's prompts, students viewed the annotated highlights of other readers, and annotated sections individually. Instructional method 2 (No HyLighter Condition/Control) consisted of students reading the printed hard copy of the article without using HyLighter, and interacting with peers on the article. No prompts or instructions were provided for this condition.

2.5. Procedures

Prior to the implementation of the two instructional methods (including the control), three instructors for the course's three sections were introduced to HyLighter and to its features. The instructors reviewed software instructions along with the instructional methods and the study's procedures. The lead instructor (course coordinator) selected the articles and developed the instruments. Next, the articles and instruments were reviewed and approved by section instructors. The study started once the article selection and instrument development was finalized. In each course section, articles were read in the same order, and with identical time lapse in between articles. Prior to instructional methods implementation, students within each section signed a consent form and completed a demographic questionnaire. Also, students within

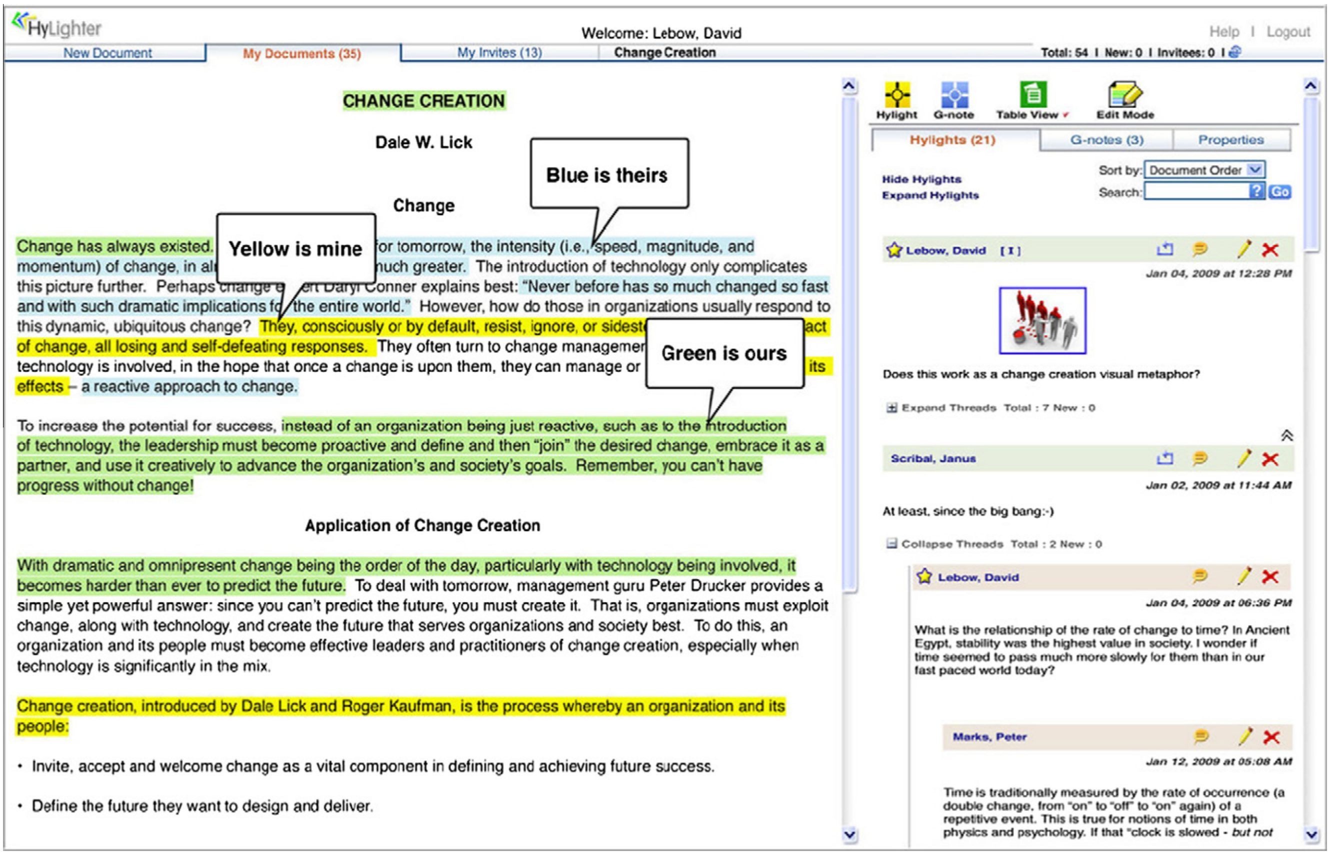

Fig. 1. Color-coded distribution map including comments in the margin (need to change).

the experimental section (HyLighter Condition) received a HyLighter training. The training lasted approximately 30 minutes and focused on how to use the software for best reading practices of the assigned articles. Next, each course section began the instructional activities. All four reading articles were covered over a period of 10 weeks. Students in Section 3 used the HyLighter, while the students in Sections 1 and 2 did not use it. The later was because the instructor in Section 3 was the most familiar with the software use thus the rest of sections were assigned to be control. A week after reading each article, the students completed the learning comprehension quiz (LCQ) corresponding to the article. For each section, learning comprehension quizzes (LCQ) were administered at the onset of courses-prior to actual teaching period. Following the completion of all four learning comprehension quizzes (LCQ), students in all sections were asked to complete the learning affect questionnaire (LAQ) and a summative assessment test were administered to all students nearing end semester. Lastly, a HyLigther specific questionnaire (HQ) was completed by the students in the HyLighter group only.

3. Results of study 1

3.1. Manipulation check

3.1.1. HyLighter Questionnaire (HQ)

Students using the HyLighter strongly disagreed (i.e., ratings $\leqslant 2$) with statements such as, "Given the opportunity to use HyLighter in the future, I am afraid that I might have trouble in navigating through it," "I would avoid learning a topic if it involves Hylighter," and "I would hesitate to use HyLighter in case I look stupid." In contrast, students strongly agreed (i.e., ratings $\geqslant 4$) with statements including, "HyLighter can enhance the learning experience," "I will use HyLighter only when told to," "Using HyLighter does not scare me at all, and "If I get problems using Hylighter, I can usually solve them one way or the other." Moderate endorsement (i.e., rating = 3.5) was noted for the statement, "HyLighter makes it possible to learn more productively." Thus, students' rating indicated that the HyLighter was perceived as highly helpful, and viewed as an important learning tool.

3.2. Main findings

3.2.1. Learning comprehension

A Mixed Repeated Measure (MRM) ANOVA was performed to elicit the HyLighter effect on learning comprehension levels across four quizzes. The results indicated non-significant mean differences for instructional methods, and instructional method by quiz interaction effects, $F\ (1,19) = 1.76$, $p = .20$, $\eta_p^2 = .09$, and *Wilk's* $\lambda = .99$, $F\ (3,17) = .03$, $p = .99$, $\eta_p^2 = .01$, respectively. Fig. 2 illustrates learning comprehension levels of students through the four quizzes and instructional methods (e.g., HyLighter Condition vs. No-Hylighter Condition). As compared to the No-HyLighter instruction, the HyLighter instruction students scored higher on all RCQs: the first ($M_{HyLighter} = 2.14$, $SD = .90$, $M_{No\text{-}HyLighter} = 1.71$, $SD = 1.14$, *Cohen's* $d = .42$), second ($M_{HyLighter} = 1.14$, $SD = 1.07$, $M_{No\text{-}HyLighter} = .93$, $SD = 1.00$, *Cohen's* $d = .22$), third ($M_{HyLighter} = 1.86$, $SD = .90$, $M_{No\text{-}HyLighter} = 1.57$, $SD = .85$, *Cohen's* $d = .35$), and the fourth ($M_{HyLighter} = 2.29$, $SD = .76$, $M_{No\text{-}HyLighter} = 1.93$, $SD = .73$, *Cohen's* $d = .51$).

3.2.2. Summative assessment

A one-way between subjects ANOVA for summative assessment test scores revealed a non-significant effect for instructional method, $F\ (1,23) = 1.47$, $p = .24$, $\eta_p^2 = .06$. Students in the HyLighter instruction performed higher on average ($M = 83.29$, $SD = 6.37$)

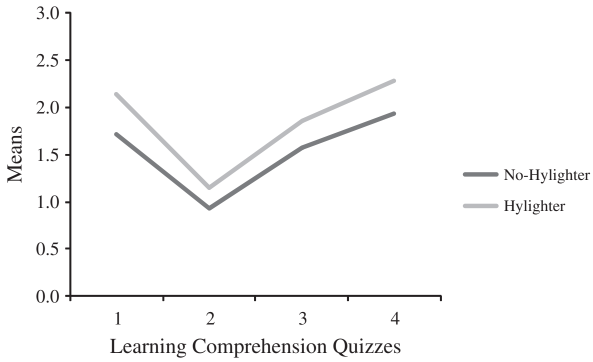

Fig. 2. Mean performance on four quizzes by instructional method.

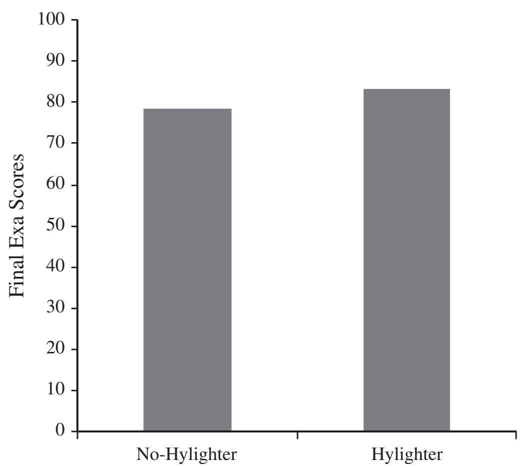

Fig. 3. Means for summative assessment by instructional method.

Table 1
Means, *SD*, and *ESs* between instructional methods on positive and negative emotion valence and motivation to learn.

	No-Hylighter		Hylighter		*ES*
	Mean	*SD*	Mean	*SD*	
Positive-valence					
Excited	2.00	1.23	3.00	1.55	.80
Optimistic	2.82	1.19	3.83	1.17	.89
Happy	2.06	.90	3.17	1.47	1.09
Negative-valence					
Worried	1.65	.79	1.00	.00	−.99
Distressed	1.35	.49	1.17	.41	−.40
Uncertain	1.88	.99	1.67	.82	−.23
Pessimistic	1.67	.70	1.35	1.03	−.42
Motivation					
To read	3.06	1.30	3.57	1.27	.41
To read more	2.65	.98	3.00	1.16	.35

than students in the No-HyLighter instruction ($M = 78.61$, $SD = 9.33$, *Cohen's* $d = .56$) (see Fig. 3).

3.2.3. Affect toward Learning

Three separate multivariate analysis of variance (MANOVAs) were conducted for positive-valence emotion, negative-valence emotion, and motivation to learn. The two instructional methods failed to vary significantly on positive-valence emotions, *Wilk's* $\lambda = .79$, $F(3,19) = 1.65$, $p = .21$, $\eta_p^2 = .21$, negative-valence emotion, *Wilk's* $\lambda = .75$, $F(4, 18) = 1.51$, $p = .24$, $\eta_p^2 = .25$, and motivation to learn, *Wilk's* $\lambda = .96$, $F(2,21) = .46$, $p = .64$, $\eta_p^2 = .04$. Though only strong tendencies toward significance were noted for positive and negative emotions' valence, the students using HyLighter instruction reported more positive emotions (*Cohen's d* range: .80–1.09), and less negative emotions (*Cohen's d* range: −.23 to −.99) than students not exposed to Hylighter. Mean differences between the two instructional methods are presented in Table 1.

4. Discussion of study 1

Study 1 examined the effects of social annotation technology on learning comprehension performance of undergraduate students. Consistent with the Social Annotation Model-Learning System (SAM-LS) framework, HyLighter instructional tool was used to allow students to highlight, annotate, and exchange information with peers digitally and asynchronously while completing learning assignments.

Findings revealed non-significant differences, but strong descriptive tendencies (i.e., effect sizes) on three outcome variables. Specifically, descriptive comparison of HyLighter and control groups indicated a strong tendency for the HyLighter students to achieve higher grades on learning comprehension quizzes. These results are consistent with previous findings indicating positive effects associated with Social Annotation Model-Learning Systems (SAM-LS) including enhanced learning (Davis & Huttenlocher, 1995), and improved critical thinking and meta-cognitive skills in task-specific assignments (Johnson et al., 2010). In addition, the use of HyLighter failed to produce significantly superior summative assessment scores, though the HyLighter and control groups' means showed clear tendency for students using HyLighter to perform higher on average on the summative assessment. These seemingly positive results can be traced back to the Team-Based Learning (TBL) component of Social Annotation Model-Learning System (SAM-LS), and thereby the HyLighter use. Recent research has proposed Team-Based Learning (TBL) models as superior over traditional ones in that they allow more interactive and engaging learning processes (Lightner et al., 2007). As such Team-Based Learning (TBL) was already shown to result in significant learning and performance gains (Clark et al., 2008; Haberyan, 2007), enhanced learning, and improved retention of the course material (Lancaster & Strand, 2001).

Finally, HyLighter use failed to significantly enhance emotions and motivations associated with learning. Descriptive comparison of HyLighter and control groups however, indicates that students using HyLighter reported higher frequency of positive, and lower frequency of negative emotions for learning. Descriptively, students using HyLighter also reported higher motivation for learning. Relative to students learning in conventional instruction, students using HyLighter on average reported higher levels of excitement, optimism, happiness, motivation to read, and motivation to read more. Additionally, these students also reported lower levels of worry, distress, uncertainty, and pessimism related to the assigned reading materials.

Several explanations may account for these findings. Because of its asynchronous communication properties, HyLighter may have helped to reduce the immediate response pressure (otherwise common to synchronous/traditional communications), hence improving affective responses to learning. Asynchronous communication features of learning promote more optimal "outside of classroom" learning, and minimize quick response pressure inherent to synchronous communications (Veerman & Veldhuis-Diermanse, 2001). Alternatively, because of its discussion-oriented feature, HyLighter may have also eased the comprehension of the learning material whereby creating a smoother learning environment. This suggestion is in line with research indicating the effectiveness of alternative Social Annotation Model-Learning System

(SAM-LS) applications (e.g., WebAnn) that seemed to increase online discussions by twice, promote different discussion styles, ease the focus on particular points in the material, generate high quality online discussions (Brush et al., 2002), thus possibly leading to a pleasant learning environment.

Overall, students using HyLighter perceived HyLighter as enhancing their learning experience, as a simple tool to use, and felt using HyLighter was relatively effortless to work through in cases of technical problems. The small sample size may have precluded the detection of a significant group difference in our sample. However, the effect sizes' magnitudes call for attention to the potential of such method in promoting and enhancing reading comprehension. Thus, positive perceptions of the tool taken together with strong tendencies for superior and positive outcomes are promising and encouraging for further investigation of HyLighter with larger populations and in diverse learning settings.

In addition to undergraduate students having deficient skills in learning comprehension, it was suggested that post-secondary students also exhibit lack of adequate competence in learning-related skills (Adelman, 1996; Hartman, 2001; Mendelman, 2007). Adequate competence and use of these skills is essential for students to perform well during post-secondary education (Cox, Freisner, & Khayum, 2003; McCabe, 2000; Oudenhoven, 2002). Thus, of particular significance for study 2 was the question of whether the use of a Social Annotation Model-Learning System (SAM-LS) would also help learning outcomes and motivation for learning in post-secondary/graduate students. On-line educators were encouraged to provide differential support to undergraduate and graduate learners (Green & Azevedo, 2007). Furthermore, Schunk, Pintrich, and Meece (2008) argued that graduate students elect to pursue an advanced degree rather than "have a degree," and Artino and Stephens (2009) expected them to be more intrinsically motivated to learn and complete their assignments in an on-line course. Thus, motivation should be further studied in SAM-LS environment. More specifically, study 1 was aimed at eliciting differences between the instructional methods on positive and negative affect-related learning, in undergraduate level students. In contrast motivation and self-efficacy were more salient in the second study in accord with the earlier postulation of Pintrich, Smith, Garcia, and Mckeachie, 1991, 1993. Test-anxiety was the only affective/emotional variable used in study 2 because of its major role in the graduate level. Along with the construct of motivation, mastery and performance orientation are of outmost importance, and thus were of major interest in study 2 (Elliot & Murayama, 2008). Arguably, if Social Annotation Model-Learning System (SAM-LS) could help promote more optimal students' comprehension and learning, it can also aid students' test-anxiety thereby increase students' self-efficacy for learning the course material, and possibly affect students' goal orientation (see Elliot, 1997 for review). In the aim of exploring these assertions, study 2 examined the effects of HyLighter use in a graduate course setting.

5. Method of study 2

5.1. Sampling

Forty students (M age = 26.46 years, SD = 5.37) enrolled in a southeastern university spring semester graduate classroom assessment course that focused on measurement and evaluation of academic achievement participated in this study. Of these participants, 65% were female, 32.5% were male, and 2.5% were unidentified; 82.5% were Masters, 10% were PhD level, and 7.5% were unidentified.

The course contents, syllabus, objectives, materials, and assessment tools were highly similar between studies 1 and 2. For this study, the students were assigned to two groups within the class. Students in group 1 used the social annotation tool (e.g., HyLighter–No-HyLighter) for the first three articles (i.e., learning tasks), while students in group 2 did not use any social annotation tool during this phase. In the subsequent phase, students in group 2 used the social annotation software for the next three articles, while the students in group 1 did not use any social annotation tool (i.e., No-HyLighter–HyLighter).

5.2. Instrumentation

Similar learning comprehension quizzes (LCQ) and additional motivational questionnaires were used for testing the effects of the use of HyLighter in Study 2. Similarly to Study 1, each of the learning comprehension quizzes (LCQ) were constructed by the instructor of the course, and consisted of multiple-choice items. All items included one stem and four options. Although the items for each instrument were specific to the content of the corresponding article, all items were relevant to assessing students' learning skills. Additional instruments were administered to measure students' motivation (i.e., academic goal orientation), test-anxiety, and self-efficacy questionnaires. Additionally, the HyLighter Questionnaire (HQ) was administered to evaluate students' ease and level of comfort associated with the HyLighter use.

5.2.1. Learning-comprehension quizzes (LCQ)

Each of the six *learning-comprehension quizzes* (*LCQ*) included 10 multiple-choice items aimed at assessing learning comprehension on the assigned reading material. Responses for each item were rated as either correct or incorrect. The overall score for each *learning-comprehension quiz* (*LCQ*) ranged between 0 and 10, and corresponded to the total number of correctly answered items on the quiz.

5.2.2. Achievement goal questionnaire-revised

(AGQ-R; Elliot & Murayama, 2008). The AGQ-R included 12 items aimed at assessing students' achievement goals within the hierarchical model of approach–avoidance mastery/performance achievement goals (Elliot, 1997). Each self-report item was rated on a 6-point Likert-type scale with anchors ranging from 0 (*not all important*) to 6 (*extremely important*). From a 2×2 achievement goal framework, 4 subscales corresponded to 4 four different types of achievement goals: (1) mastery-approach (focused on attaining task-based competence), (2) performance-approach (focused on attaining normative competence or performing higher than others), (3) mastery-avoidance (focused on avoiding task-based incompetence), and (4) performance-avoidance (focused on avoiding normative incompetence). The structural validity and model fit of the scale were evident through the use of confirmatory factor analysis. All four subscales were also shown to possess high levels of internal consistency (Cronbach's α = .84, .88, .92, and .94, respectively; Elliot & Murayama, 2008).

5.2.3. Motivation strategies for learning questionnaire

(MSLQ; Pintrich et al., 1991, 1993). The MSLQ included 81 self-report items and is aimed at assessing the nature of motivation and use of learning strategies in students. MSLQ consists of 15 subscales. Out of 81 self-report items, 11 most relevant were selected and used for the purposes of this study; 11 items corresponded to 2 subscales: (1) self-efficacy for learning and performance, (2) test-anxiety, and (3) control of beliefs about learning. Each self-report item was rated on a 6-point Likert-type scale with anchors ranging from 0 (*not at all true for me*) to 6 (*extremely true for me*). The internal consistency for self-efficacy, test-anxiety, and control of beliefs subscales were moderate to high (Cronbach's α = .93, .80, and .68, respectively). The correlations among the subscales showed test anxiety was negatively correlated with self-efficacy beliefs and control of learning ($r = -10$, and $-.37$, respectively).

5.2.4. HyLighter Questionnaire (HQ)

Identical to study 1 (see details in method of study 1).

5.3. Instructional procedures for HyLighter activities

Similar to study 1, the instructional method for HyLighter activities consisted of students reading an article with or without use of the HyLighter then completing the learning-comprehension quizzes (LCQ). Students in instructional method 1 read highlighted and annotated the relevant portions of the article digitally. Students in instructional method 2 read the printed copy of the articles and did not engage in digital annotation practices. However, in the study 2, the instructor did not provide online prompts or instructions prior to students reading the articles. Instructional prompts were *not* provided specifically to determine if the HyLighter use alone facilitates the expected outcomes. Therefore, in study 2, the instructor was not involved in the HyLighter activities, beyond facilitating regular class discussions following the completion of learning-comprehension quizzes (LCQ).

Similarly to study 1, each student highlighted and annotated sections individually. As the students highlighted, they also viewed the peer highlighting of students who read the article. As each student used HyLighter individually, each new highlight was added to the previous ones. Similarly to study 1, students using HyLighter could post comments and questions throughout the reading of the article. Instructional method 2 (No HyLighter Condition) consisted of students reading the printed copy of the article without using HyLighter or interacting with peers digitally.

5.4. Procedures

Prior to the implementation of the two instructional methods (i.e., HyLighter–No-HyLighter and No-HyLighter–HyLighter Conditions) the course instructor was introduced to HyLighter and its features. The instructor reviewed software instructions along with the instructional methods and the study's procedures. The instructor selected the articles and developed the instruments. Once the article selection and instrument development was finalized the study commenced. Prior to instructional methods implementation, students signed a consent form and completed a demographic questionnaire. Students then received HyLighter training. The training focused on how to use the software for best learning practices of the assigned articles and lasted 30 min approximately. Next, the instructional activities started. Articles 1 through 6 were covered over a period of 10 weeks. Students in group 1 were instructed to read the first three articles using the social annotation tool while the students in group 2 were instructed to read the same articles in hard copy without using the social annotation tool. This order was switched for the reading of the next three articles, e.g., students in group 2 read the next three articles using the social annotation tool while the students in group 1 stopped using the social annotation tool and read the articles in hard copy. A week following the reading of each article, each student completed the learning comprehension quizzes (LCQ) at the onset of class time. Students' achievement goal orientations (AGQ), and Motivation Strategies for Learning Questionnaire (MSLQ) were administered at three time points: (1) prior to any HyLighter use, (2) following the 3rd article, and (3) following the 6th article. Additionally, the students answered the HyLighter Questionnaire (HQ) at the completion of the study.

6. Results of study 2

To test the efficacy of HyLighter use on students' learning and motivational/affective states, the data was re-arranged to allow contrasting the two instructional methods. HyLighter vs. no-HyLighter was considered the first grouping factor and the beginning (quizzes in HyLighter or no-HyLighter instruction first) vs. last (quizzes in HyLighter or no-HyLighter instruction last), was considered a second grouping factor. Each of these 2×2 categories has been given three quizzes. Thus, learning comprehension was subjected to two-way ANOVA (group: HyLighter vs. no-HyLighter, time phase: beginning vs. last) with repeated measures over three examinations (e.g., examination order). All the other variables were subjected two-way ANOVA as these were not repeated.

6.1. Manipulation check

6.1.1. HyLighter Questionnaire (HQ)

Mixed MANOVA performed for the HQ using instructional condition as a between subject factor indicated that the two instructional groups did not significantly differ on the levels of comfort and ease associated with the HyLighter use, *Wilk's* λ = .39, $F(18,17) = 1.50$, $p > .05$, $\eta_p^2 = .61$. On average students showed dissatisfaction with HyLighter and its use to promote learning and comprehension.

6.2. Main findings

6.2.1. Learning comprehension

The analysis revealed non-significant effect for the instructional method factor, $F(1,60) = 1.32$, $p = .255$, $\eta_p^2 = .022$, as well as for the instructional method interaction with time phase and examination order. Fig. 4 illustrates the mean learning comprehension levels of students in the two instructional methods across time phase and examination order. As one can notice, descriptively, students exposed to the Hylighter method scored higher than the students exposed to no-Hylighter instruction ($M = 6.69$, $SD = .22$ vs. $M = 6.34$, $SD = .22$, respectively, *Cohen's d* = 1.62).

6.3. Goal achievements

6.3.1. Mastery approach

The two-way ANOVA revealed non-significant instructional method and time phase main effects, $F(1,60) = .62$, $p = .434$, $\eta_p^2 = .010$, and $F(1,60) = 1.40$, $p = .242$, $\eta_p^2 = .023$, respectively as well as non-significant interaction between the two, $F(1,60) = .29$, $p = .593$, $\eta_p^2 = .005$.

6.3.2. Mastery avoidance

The results revealed non-significant instructional method and time phase main effects, $F(1,60) = .09$, $p = .772$, $\eta_p^2 = .001$, and F

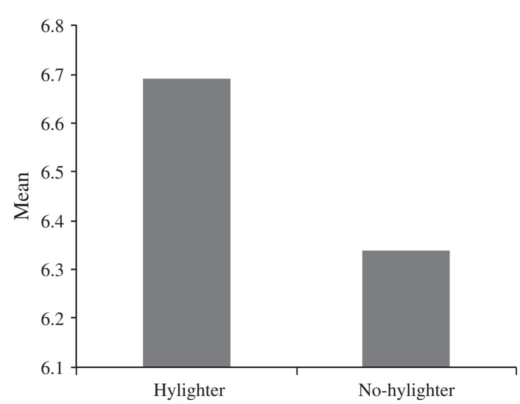

Fig. 4. Mean performance of students learning with HyLighter and non-HyLighter instructions methods.

(1,60) = 2.71, p = .105, $\eta_p^2 = .043$, respectively, and non-significant interactional effect, F (1,60) = .75, p = .390, $\eta_p^2 = .012$.

6.3.3. Performance approach

The analysis resulted in non-significant instructional method and time phase main effects, F (1,60) = .33, p = .570, $\eta_p^2 = .005$, and F (1,60) = .04, p = .839, $\eta_p^2 = .001$, respectively as well as non-significant interaction between the two, F (1,60) = 2.76, p = .102, $\eta_p^2 = .044$.

6.3.4. Performance avoidance

The analysis revealed non-significant group and phase main effects, F (1,58) = .03, p = .866, $\eta_p^2 = .000$, and F (1,58) = .20, p = .653, $\eta_p^2 = .003$ respectively. The interaction effect tended, but failed, to reach significance, F (1,58) = 3.77, p = .057, $\eta_p^2 = .061$.

6.3.5. Self-efficacy

Since self-efficacy was measured following the 3rd and 6th articles, a 2 (instructional method – HyLighter vs. no-HyLighter) by 2 (time phase – following the 3rd vs 6th article) ANOVA was performed to elicit instructional method effect. The results revealed non-significant group and time phase main effects, F (1,60) = 2.12, p = .151, $\eta_p^2 = .034$, and F (1,60) = .04, p = .847, $\eta_p^2 = .001$ respectively. The interaction effect for group by time phase also failed to reach significance, F (1,60) = .55, p = .460, $\eta_p^2 = .009$.

6.3.6. Test anxiety

A two-way ANOVA (instructional method – HyLighter vs. no-HyLighter, by time phase – following the 3rd article vs. following the 6th article) revealed non-significant instructional method and time phase main effects, F (1,59) = 2.13, p = .150, $\eta_p^2 = .035$, and F (1,59) = .00, p = .984, $\eta_p^2 = .000$, respectively. The interaction effect was also non-significant, F (1,59) = .56, p = .459, $\eta_p^2 = .009$.

6.3.7. Control of Beliefs about Learning

The analyses revealed non-significant instructional method and time phase main effects, F (1,60) = 3.04, p = .086, $\eta_p^2 = .048$, and F (1,60) = 2.39, p = .127, $\eta_p^2 = .038$, respectively. The descriptive data showed that starting from the outset through the end of the 3rd article, levels of beliefs' control about learning dropped for participants in both instructional methods. HyLighter and No-HyLighter methods resulted in approximately 10% and 15% decrease in levels of control of beliefs about learning, respectively. From the end of the 3rd article until the end of 6th article levels of control of beliefs about learning dropped for participants in both instructional methods. No HyLighter and HyLighter methods resulted in 24% and 1% decrease in levels of control of beliefs about learning, respectively.

7. Discussion of study 2

Study 2 examined the effects social annotation technology (e.g., HyLighter) on task-related outcomes pertaining to learning comprehension in a graduate course setting. Given that in some graduate samples students may already possess some higher-order cognitive skills, additional outcome variables for this study included: (a) academic goal orientation, and (b) levels of motivation, self-efficacy, test-anxiety, and controls of beliefs about learning. These variables were included specifically because, assuming that HyLighter tasks encourage students to learn interdependently (Johnson & Johnson, 1991), we expected that (1) students' motivation for mastering tasks (compared to being motivated by grades or being motivated to avoid performance situations) would increase, (2) students' self-efficacy for academic performance would improve, thus (3) students' test anxiety would lower.

The results of study 2 failed to reveal any significant effect of the social annotation technology on both the cognitive and motivational outcomes related to learning the six tasks. Descriptively however, HyLighter improved learning comprehension by a strong effect size (*Cohen's d* = 1.62). These results support the Social Annotation Model-Learning System (SAM-LS) principle which is central to the HyLighter technology, and is designed to support students' learning comprehension. Social Annotation Model-Learning System (SAM-LS) has already received some support for enabling higher levels of thinking in undergraduate settings (Johnson et al., 2010), and the clear tendencies for positive outcomes in studies 1 and 2 have confirmed these effects.

The results also shed light on the ineffective use of HyLighter in the current study despite the superior descriptive learning outcomes. For example, students reported that they were reluctant to highlight over others' highlighting. Unlike the previously tested undergraduate samples, students in this study expressed a strong preference not to view other students' highlights until after they have completed their own. Such feature would allow individual students complete their highlights and compare afterwards between theirs and others.

In this study, HyLighter use failed to result in enhancing students' mastery goal motivation. Motivation of graduate-level students may be relatively less affected by technological advances than those of undergraduate students. Specifically, within graduate settings, students are most often required to demonstrate a fairly high level of learning comprehension to be admitted into graduate programs, thus Social Annotation Model-Learning System (SAM-LS) may not be needed to help graduate students with learning comprehension since reading and learning articles may not be the highest challenge for this population. Social Annotation Model-Learning Systems (SAM-LS) Team-Based Learning (TBL) basis as supported by a Computer-Supported Collaborative Learning (CSCL) approach was otherwise shown to benefit students' motivation in scholastic environments (Gokhale, 1995; Johnson & Johnson, 1991; Lehtinen, 2003; Srinivas, 2008).

Students using HyLighter in this study did not also report different level of self-efficacy than students exposed to conventional instruction. It is important to note, however that self-efficacy levels dropped for students in both instructional groups, i.e., for all participating students. Similarly, HyLighter use did not seem to affect students' test anxiety levels. These results could be due to the fact that the articles assigned for the purpose of this course were advanced-level research articles, and could be somewhat difficult for students to understand, thus arguably, the use of HyLighter may not have provided sufficient assistance with an already too advanced learning material in increasing self-efficacy and decreasing test anxiety.

8. General discussion

Perhaps one of the most important aspects in the effective use of advanced educational technologies is the instructors' active guidance and involvement in the use of these tools. In herein study 1, students were provided with online prompts, guiding inquiries, and constant instructor-assistance, while students in study 2 did not receive any form of instructor support. Thus the mere fact of providing an advanced tool may not automatically render the tool effective. Further research is needed to examine whether or which aspects of instructor support are non-negotiable for enabling advance technologies to effectively promote students' learning comprehension and outcome achievement. Drawing upon the results of two present studies, online prompts and guiding inquiries, as initiated by the instructor may be among the most important factors to promote the intended effects of the HyLighter program. It is plausible to expect that these tools, when implemented alone, may facilitate comprehension but not necessarily the associated affects, such as self-efficacy, and test-anxiety. In fact much similar to non digital interactive education settings, without guiding questions and prompts, students may interact, but on irrelevant or tangential topics.

Robust follow up discussions and instructional feedback are important for students' learning process. In the absence of these elements students' skills and subsequent performance may suffer. Johnson et al. (2010) suggested that allowing discussion and providing feedback to learners must be present to challenge passive reading – more so for undergraduate than graduate students. Thus, when discussion and instructional feedback are absent, a collective knowledge is suffers, resulting in students' paying attention to the technology rather than to the learning material or processes. Based on the present observations, however, graduate students may prefer to remain more passive in their learning endeavors than undergraduate students.

Also important to consider, graduate students may on average possess higher motivation for their individual performance. Graduate students may arguably hold both mastery achievement goals and performance achievement goals in their academic approach. Indeed, Harackiewicz and colleagues (Harackiewicz, Barron, Tauer, Carter, & Elliot, 2000) have indicated that college students holding mastery orientations tend to be highly interested in their course content, while those holding performance orientations tend to achieve higher. However, as Harackiewicz et al. have also revealed students who possess simultaneously both mastery and performance orientations may have an advantage over others in that they will both maintain interest and achieve higher in academic settings. Thus, possessing both goal orientations may explain graduate students' relatively unaffected levels of test-anxiety and self-efficacy regardless the use of the HyLighter tool.

The results of the two studies suggest that to promote content comprehension and enable more optimal affects HyLighter must allow students to interact, and maybe selectively (instead of all together) view peers' highlights to self-compare and elaborate. Social annotation technologies may be beneficial to that extent that they allow effective communication, and rely on consistent peer and instructor-drawn feedback to enable significant cognitive, affective, and motivational outcomes.

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