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Reading Actively Online: An Exploratory Investigation of Online Annotation Tools for Inquiry Learning

La lecture active en ligne: étude exploratoire sur les outils d'annotation en ligne pour l'apprentissage par l'enquête

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Abstract

This study seeks to design and facilitate active reading among secondary school students with an online annotation tool – Diigo. Two classes of different academic performance levels were recruited to examine their annotation behavior and perceptions of Diigo. We wanted to determine whether the two classes differed in how they used Diigo; how they perceived Diigo; and whether how they used Diigo was related to how they perceived it. Using annotation data and surveys in which students reported on their use and perceptions of Diigo, we found that although the tool facilitated individual annotations, the two classes used and perceived it differently. Overall, the study showed Diigo to be a promising tool for enhancing active reading in the inquiry learning process.

Résumé

Cette étude vise à concevoir et à faciliter la lecture active chez les élèves du secondaire grâce à l'outil d'annotation en ligne Diigo. Deux classes avec des niveaux de rendement scolaire différents ont été retenues afin qu'on examine leur manière d'annoter et leur perception de Diigo. Nous avons voulu déterminer si les deux classes diffèrent dans leur façon d'utiliser Diigo, leur perception de Diigo, et si leur manière d'utiliser Diigo était liée à leur perception. En utilisant les données d'annotation et d'enquêtes dans lesquelles les élèves relataient leur utilisation et leur perception de Diigo, nous avons constaté que, même si l'outil a facilité les annotations individuelles, les deux classes l'ont utilisé et perçu différemment. Dans l'ensemble, l'étude a montré que Diigo est un outil prometteur pour l'amélioration de la lecture active dans le processus d'apprentissage par enquête.

Keywords: annotation behaviour, active reading, Diigo, students' perception, computer-assisted learning, inquiry learning.

Mots-clés: habitudes d'annotation, lecture active, Diigo, perception des élèves, enseignement assisté par ordinateur, apprentissage par l'enquête

Introduction

With its close theoretical links to constructivist learning perspectives, inquiry-based learning has long been endorsed by educational researchers and practitioners (e.g. Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1991; Edelson, Gordin, & Pea, 1999) and has been used by educators in a range of disciplines. Inquiry-based learning seeks to promote active learning by engaging students in authentic activities (Edelson, et al., 1999) and although, it has been referred to in different ways: discovery learning (e.g. Njoo & De Jong, 1993), problem-based learning (e.g. Savery & Duffy, 1995), and project-based learning (e.g. Blumenfeld, et al., 1991), the process of inquiry generally involves four steps: (1) formulating questions and generating hypothesis, (2) collecting data, (3) analyzing and interpreting evidence, and (4) drawing conclusions (Sung, Lin, Lee, & Chang, 2003).

Although, research has demonstrated that inquiry-based learning supports active learning, students often find the task of gathering, analyzing, and interpreting data on their own to be challenging (Edelson, et al., 1999). Students have to learn how to judge the accuracy, legitimacy and relevancy of various sources of information, and to compare and contrast information from these sources (Owens, Hester, & Teale, 2002). Thus, facilitating the process of gathering, analyzing, and presenting information is a critical issue in inquiry-based learning (Owens, et al., 2002).

Recent developments in web-based technology can support inquiry-based learning by supporting access to online information (Blumenfeld, et al., 1991), structuring problem contexts, and supporting cognitive and meta-cognitive processes (Wang, Kinzie, McGuire, & Pan, 2010). This study investigates the use of Diigo, a web-based annotation tool, to support the critical reading in the context of inquiry-based learning. Hong Kong's New Senior Secondary curriculum recently introduced Liberal Studies, a core subject designed to enable students to develop skills in critical reading and argumentative writing by engaging in inquiry-based learning. Diigo was introduced to help students engage in critical reading and we investigated how students used and perceived it.

Literature review

Pedagogical values of annotation

Educational researchers have long recognized the benefits of annotation as a reading strategy in which students mark important points in written texts and record interpretations or explanations (Marshall, 1997). The practice fosters active learning by encouraging students to construct ideas and to monitor their learning. For instance, in a review of research from the 1920s to the present,

Kiewra (1985) found that taking notes while reading had consistently been associated with learning achievement. Slotte and Lonka (1999) examined correlations between spontaneously constructed notes and text comprehension and found that both the quantity and the quality of student notes were significantly related to their learning. Since the pedagogical values of annotation can involve reading, writing, and sharing, the following literature review of the pedagogical values of annotation is structured accordingly.

The comprehension of readers improves when they underline, highlight, take notes, and summarize what they read because these activities lead them to read more actively and to engage with what they read at deeper cognitive levels (Porter-O'Donnell, 2004; Zywica & Gomez, 2008). Annotation leads readers to enter into a "dialogue with the text" (Porter-O'Donnell, 2004, p. 82) by allowing them to externalize their thinking and to connect new and old knowledge (Glover, Xu, & Hardaker, 2007). It also helps readers to identify and remember important points, to discern discourse structures, and to analyze ideas (Anderson & Armbruster, 1982; O'Hara & Sellen, 1997a; Ovsiannikov, Arbib, & McNeill, 1999; Porter-O'Donnell, 2004; Zywica & Gomez, 2008). With respect to the effectiveness of annotation on first year university students, Simpson and Nist (1990) reported that annotators outperformed non-annotators on comprehension tests. Annotators also focused on important concepts and issues, and constructed explicit relationships among them (O'Hara & Sellen, 1997b).

Highlighting and labelling structures and important points not only facilitate reading comprehension but also foster written production as well. Students in Porter-O'Donnell's (2004) reading class reported that annotation helped them locate evidence in texts and to construct useful records of their thoughts while writing. Slotte and Lonka (1999) characterized the activity of taking notes while reading as a kind of dialogue between reading and writing: taking notes can help readers understand, evaluate and compare ideas in what they are reading. This process, in turn, helps students organize important facts, issues and positions into appropriate structures in their own production. Similarly, Wolfe and Neuwirth (2001) argued that annotating was effective in bridging the gap between reading and writing as it helps readers view, select, shape and structure knowledge from different perspectives, which helped the later process of writing from sources (Wolfe & Neuwirth, 2001).

Annotating not only benefits individual learners, but also benefits groups of learners. Sharing annotations can promote useful interacting among groups of learners. Readers can benefit from insights and perspectives in the annotations of other readers, and writers can benefit from feedback from readers (Wolfe & Neuwirth, 2001). Shared annotations can foster teacher-student and student-student interaction (Xin & Glass, 2005; Xin, Glass, Feenberg, Bures, & Abrami, 2011). Thus, annotation tools can promote collaborative learning. Comparing the effects of one such tool on individual and collaborative learning, Johnson, Archibald, and Tenenbaum (2010) reported greater improvements in the reading comprehension and meta-cognitive skills of learners who annotated collaboratively than in those who annotated alone.

Annotation with web technologies

Now that web technologies can support online annotation, researchers are focusing on a growing variety of on-line annotations tools and their role in serving the needs of a growing population of users who now look on the Internet as a primary source of information. Although, the online annotation tools with which users access, manage and share information (Wolfe, 2002) across

time and space (Rau, Chen, & Chin, 2004) are becoming more common, earlier versions were cumbersome and interfered with reading processes (O'Hara & Sellen, 1997b). More recent online annotation tools, such as Diigo, Stickis and SharedCopy have been designed to overcome these limitations by better integrating annotating activities into the process of online reading. Several annotation tools are reviewed here as background and rationale for selecting Diigo.

Stickis (http://stickis.com/) are free online sticky notes that readers can use to record and share ideas about the web pages they browse. Stickis can be attached to different kinds of online content including links, text, images, audio and video. The ability to attach tags to other Stickis allows users to reflect on and categorize their own annotations. They can also use Stickies to search and identify what they want to reread, quote or summarize. Since URLs are saved before annotating them, annotations can be personalized, customized and edited. Users can edit their personal profiles on Stickis, and define colours and font sizes. They can also edit web content by dragging or cutting and pasting it from browsed web pages or indirectly by adding editor provided HTML code. Stickis support collaboration by allowing users to read and comment on the work of others. Unfortunately, Stickis do not support highlighting which somewhat limits their use.

SharedCopy (http://sharedcopy.com/) is an AJAX based web annotation tool which readers can use to mark-up, highlight, draw, annotate, cache, write and attach sticky-notes, share websites, and save work to personal URLs. It does not require a software download and can be attached to email, tweets, blogs and Delicious. Users can contextualize research comments by embedding highlighted text with attached sticky notes. They do not need to form organized groups to share their work. SharedCopy supports tagging so that users can organize annotations. Reading information on SharedCopy does not require downloading software. Unfortunately, users cannot comment on the annotations of others.

WebNotes (http://www.webnotes.net/) is a commercially available annotation tool that was designed to support online research. Users can highlight and make notes on websites and PDF files. They can organize notes, bookmarks, and documents into folders, and share annotations via email, permalink and Twitter. Again, users cannot comment on the annotations of others, which limit collaboration.

Marginalia (http://webmarginalia.net/) is an annotation tool designed for online discussion forums. It allows users to highlight and annotate ideas that they encounter in forums and to save them either privately or publicly to share with others. It provides users with a fixed vocabulary of tags for margin notes and allows free-form text entry. Tagging is pedagogically effective reading strategy that can involve labelling questions and making summaries. It is also useful for content analysis and for retrieving annotations on various topics (Xin, et al., 2011).

Diigo (Digest of Internet Information, Groups and Other stuff) supports the development of critical reading skills by allowing students to highlight web pages and attach comments as sticky notes, and to browse the online annotations of others (Greenhow, 2009). Diigo supports highlighting and several ways of attaching notes to web pages. Diigo also allows students to collaborate by interacting with and commenting on the annotations of peers. The group feature also makes the sharing of annotated page very easy. After comparing above online annotation

tools, we selected Diigo as it was a powerful, free, easy to use tool that supports highlights, adding notes, and commenting, which fit the requirements of the course selected in this study.

Research on online annotation tools is in its infancy and has thus far focused mainly on technical issues such as systems design and development (Glover & Hardaker, 2007; Rau, et al., 2004). Of the few studies focusing on pedagogical design, implementation, and impact of annotation tools, several have shown their positive impact on learning. For example, Nokelainen and associates (2005) found that students' engagement with EDUCOSM (a web-based document annotator) was connected to their learning performance. Hwang, Wang, and Sharples (2007), through an experimental study, showed that the use of an online annotation tool enhanced students' learning achievement and motivation. However, there is lack of investigation on how annotation tools were used in details. Besides, do students differ in academic performance also differ in their online behavior? Will high performance students make more use of online features because they have the strategies of doing so or they use less because they do not need them? Grabe and Sigler (2002) found that general text comprehension as measured by the Nelson-Denny predicted voluntary use of online study tools. However, Bures, Abrami and Schmid (2010) found that the text comprehension did not predict which graduate students chose to use a labelling or tagging feature in online discussion forums while the annotation behavior was determined by the level of structure of the online dialogue. On the whole, there is a dearth of studies that explore students' experiences and perceptions of using online annotation tools and how and if students at different ability levels use them differently. Our study then will focus on this aspect.

Research questions

This study examined how students in two secondary four (equivalent to grade 10) classes of different academic abilities used Diigo to support active reading and how they perceived Diigo. We focused on three research questions.

1. How do students use Diigo for annotation and peer commenting?
2. How do students perceive Diigo?
3. How are students' online annotation behavior related with their perceptions of Diigo?
4. Do the annotation behaviours and perceptions of students in two classes differ and if so how?

Methods

Participants and context

Two classes of secondary four students, a high academic performance class (Class A) and an ordinary academic performance class (Class B), at a local, public, mid-ranked Hong Kong secondary school, were recruited for this study. The two classes were chosen to determine whether high and ordinary performing students used, perceived, and benefited from Diigo in different ways. Originally, there were 44 students in Class A and 37 in Class B, but after excluding those who did not use Diigo (due to their absence from the session), there were 42 in Class A and 27 in Class B.

The study focused on a new secondary school subject, Liberal studies (LS), in which the students engaged in inquiry-based learning which called for them to read critically and to write arguments. LS is designed to train students to be critical consumers of information from various

sources, especially when it involved controversial issues. The LS curriculum is organized into units covering specific issues. The study focused on a unit that dealt with building high-speed rail in Hong Kong. The unit was collaboratively designed by six teachers, thus Classes A and B used the same teaching materials, activities, and tasks.

Procedure

Diigo was integrated into a three-week unit of 6 sessions. The unit had four-stages. The teachers put students into groups of 3 or 4 and used Diigo educator accounts to create an account for each student. In stage 1, the teachers gave students an article introducing basic concepts and knowledge of high-speed rail travel in Hong Kong. In stage 2, they gave students an article outlining different views on high-speed rail travel in Hong Kong for students to identify the views of different stakeholders. The students were required to use Diigo to accomplish the annotation tasks. In stage 3, students searched for other relevant online articles on their own and analyzed and evaluated the information they found.

Table 1: ***Stages of Annotation Activities***

Stages	Task	Materials
1. Material preparation	Clarify key concepts and grasp the background information	Teacher-provided article 1
2. Posing questions	Explore the issues and pose questions for inquiry.	Teacher-provided article 2
3. Information search and analysis	Search for relevant articles, analyze and evaluate these information	Self-selected article(s)
4. Discussion and report	Share and comment on each other's annotation work; Synthesize the information into a final summary table	

Design of the online annotation tasks was guided by both teaching plans and critical reading strategies. First, identifying and understanding relevant concepts and issues are prerequisites of any inquiry, and are supported by Diigo's highlighting and sticky notes features. Students first identified and highlighted the important concepts in the teacher assigned articles and then added sticky notes to define or comment on them. Second, distinguishing facts from opinions and identifying different positions on an issue are also critical reading strategies students were expected to develop. To distinguish different positions, different colours of highlighters were used. To assist the process of reading and analyzing, the teachers also provided students with an analytical matrix that included tags such as "Pro position (support)" and "Con position (against)" to further scaffold their efforts at distinguishing different positions. Students were encouraged to add these tags as sticky notes attached to highlighted texts. In Figure 1 the sticky note attached to the highlighted pink passage contains the tag "con". Students were also encouraged to use sticky notes to express their opinions, comments, and conclusions.

Figure 1: **Screenshot of an annotated page**

In stage 4, after annotating the articles, students posted their work in Diigo's group space so that other members in their groups could view and comment on each other's work. Students also used sticky notes to post messages and engage in online discussions with other group members.

Data collection and analysis

Surveys and student online annotation data were collected. At the completion of the units, students filled out online surveys in which they were asked how they liked using Diigo and how they perceived the different uses of sticky notes in relation to learning. The survey was composed of Likert-scale questions grouped into three sections: (1) reading habits, (2) perceptions of Diigo, and (3) likelihood of using Diigo in the future.

Highlighted passages, sticky notes and comments were manually extracted from Diigo. Numbers of highlights and sticky notes were calculated. To understand how students used sticky notes, we did a bottom-up content analysis. To further determine how students in Classes A and B differ in annotation behavior and perception, descriptive analysis, T-tests and Multivariate Analysis of Variance (MANOVA) tests were performed. Correlational analysis was run to examine the relationship between annotation behaviours and perception of Diigo.

Results

Annotation behaviours

Students in both classes made more highlights (M = 20, SD = 9) than sticky notes (M = 9, SD = 6.5). T-tests showed Class A produced significant more highlights ($M_{classA} = 22$, $M_{classB} = 16$, $p < .05$) and sticky notes ($M_{class\ A} = 12$, $M_{classB} = 5$, $p < .05$) than Class B. The ratio of highlighting to sticky note for Class A is 1.8 which is lower than that of class B (ratio is 3.2) indicating high performance class tend to add more notes while highlighting. The analysis of the sticky notes showed that students used this feature in four ways: (1) DEFINE a term, (2) add a teacher-suggested TAG, (3) RECORD a thought, and (4) state a CLAIM. For example, a DEFINE note attached to "the Greater Pearl River Delta" reads "Comprising Hong Kong, nine municipalities

of the Guangdong Province in the mainland of China and Macau." Students used TAG notes to identify and analyze positions as pro or con. Students used RECORD notes in different ways. For instance, one student used a RECORD note to explain why a conflict occurred: "The reasons for the conflict were due to the short consultation period." A sticky note stating a CLAIM attached to "the rail to benefit at most 400000 people at Hong Kong" read "the practical implication is rather limited." Table 2 shows that Class A used DEFINE notes most frequently while Class B used RECORD notes most frequently. Students in both classes used CLAIM notes least frequently.

The MANOVA test showed two classes differed in annotation behaviours (Wilks' Λ= .463, $F(4, 64)= 18.58$, $p<0.001$). Class A created significantly more sticky notes than those Class B. When the dependent variables were considered separately, significant effects were detected for DEFINE notes ($F(1, 67) = 70.13$, $p<0.001$) and CLAIM notes ($F(1, 67) = 6.26$, $p=0.015$) indicating that Class A students used significantly more sticky notes to define terms and to state claims than Class B students.

In groups, students could view each other's highlights and sticky notes, and leave comments on sticky notes. Altogether, students in the two classes posted 77 comments on the highlights and notes of other group members (64 from Class A and 13 from class B). Since too few notes were made from Class B, statistical analysis was not run for comparison. However, we can tell as a whole, Class B students made fewer comments.

Perceptions of Diigo

With respect to their existing reading habit, both classes reported that they tended to highlight when reading print materials ($M = 2.86$, $SD = .9$). Fewer students in both classes reported they took notes while reading ($M = 2.71$, $SD = .97$), but no significant difference was found between two classes. Overall, students in both classes considered the highlighting and sticky notes features of Diigo to be easy to use (Figure 2).

As shown in Figure 3, students of both classes found Diigo a useful learning tool and all the features were rated similarly. No significant differences were identified between the two classes, though the rank of order of helpfulness was different between the two. Both classes agreed that highlighting was the most useful feature. Class A students perceived viewing the annotations of peers as the second most useful feature, and adding sticky notes and receiving comments from peers as the third most useful. Class B perceived adding sticky notes, viewing the annotations of peers and receiving comments to be the second, third and fourth most useful features respectively. Class A seemed to appreciate the social functions of Diigo more than Class B.

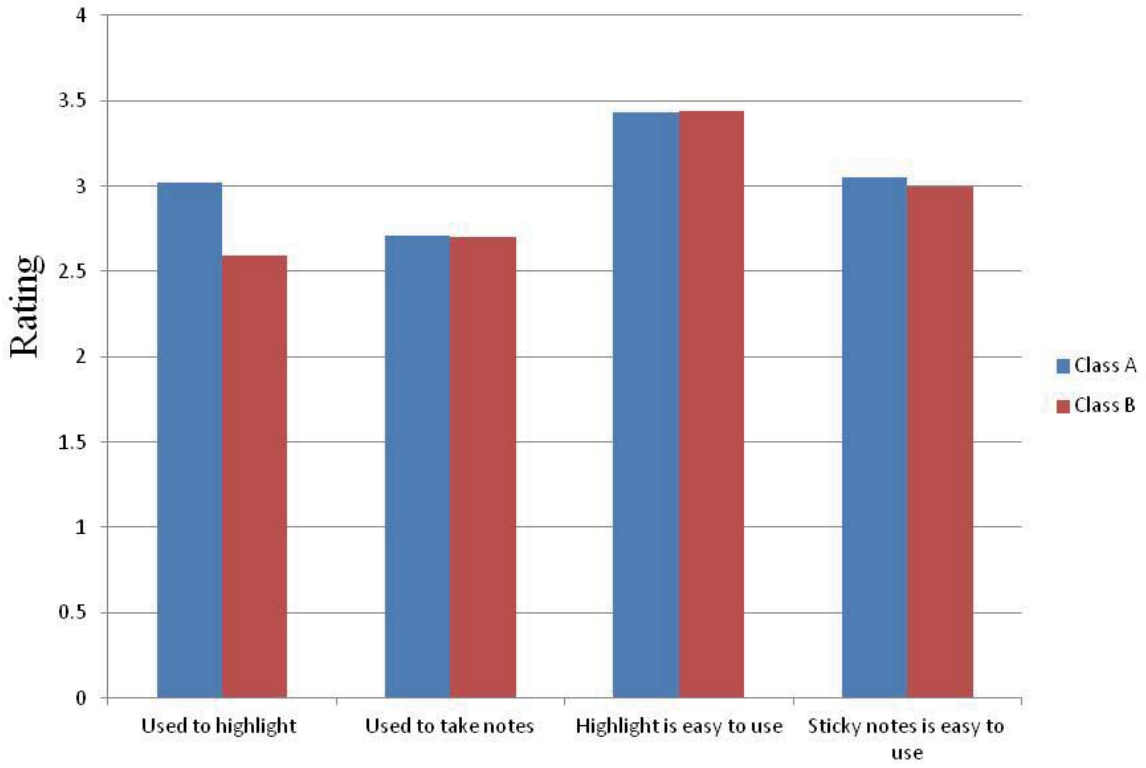

Figure 2: **Reading habit and experience with Diigo**

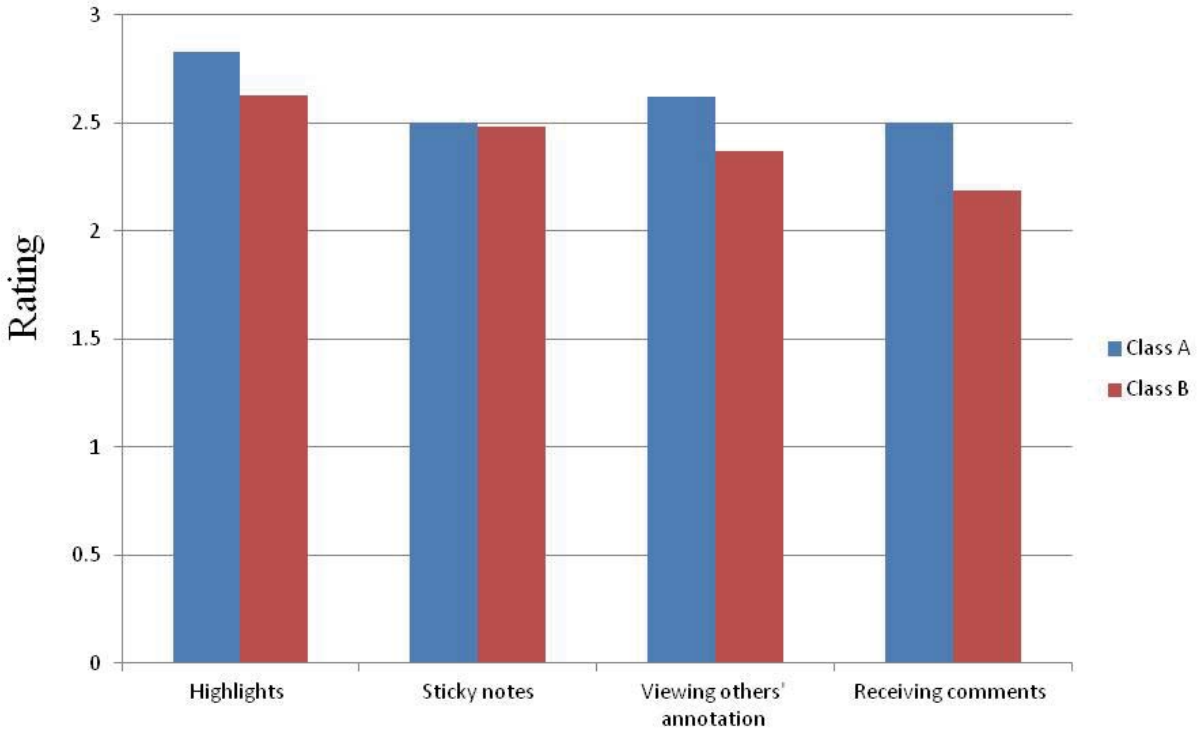

Figure 3**: Perception on the usefulness of Diigo**

Students were also asked to evaluate the four types of sticky notes in terms of their value for enhancing learning (Figure 4). MONOVA test shows Class A responded more positively than Class B (Wilks'Λ= .727, F(4, 64)= 6.0, p<0.001). Post hoc ANOVA analyses showed students in Class A are more positive than class B in DEFINE notes ($M_{classA} = 2.95$, $M_{class\ B} = 2.22$, $p < .05$), TAG notes ($M_{classA} = 2.74$, $M_{class\ B} = 2.22$, $p < .05$), RECORD notes ($M_{classA} = 2.69$, $M_{class\ B} = 2.33$, $p < .05$), and DISCUSSION ($M_{classA} = 2.50$, $M_{class\ B} = 1.89$, $p < .05$). Both Class A and B found accommodating online discussions to be the least useful function. Figure 4 contains students' perceptions of the usefulness of sticky notes. It was also noted that student perceptions of the value of sticky notes were related how they used them. Thus, Class A students not only created more DEFINE notes than Class B students but they also perceived them as more valuable. Class B not only created more RECORD notes but also perceived them as more valuable.

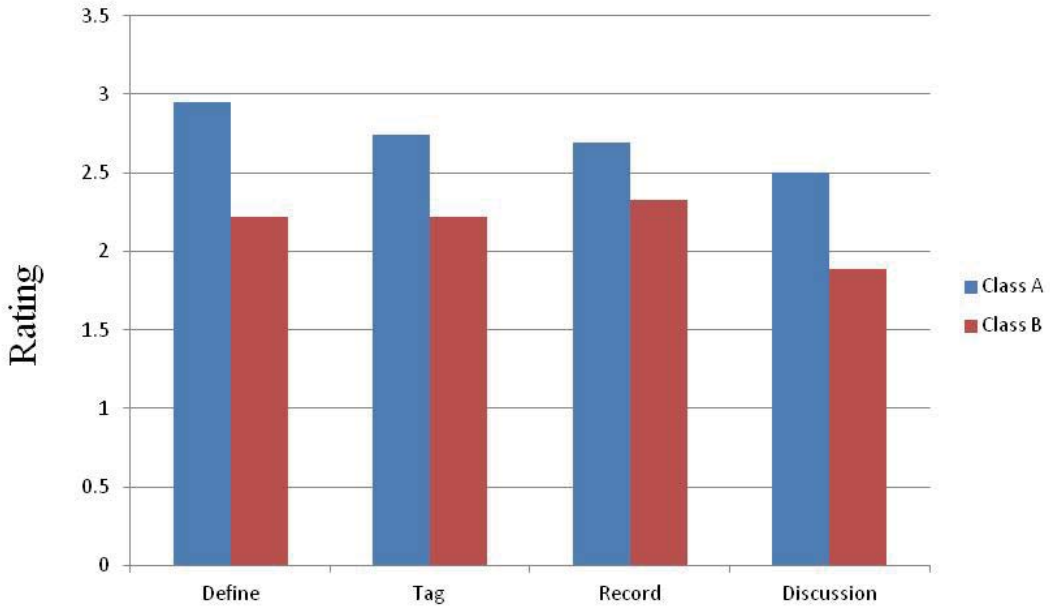

***Figure 4*: Perception on the usefulness of sticky notes**

With respect to their willingness to use Diigo in the future, T-test showed Class A students were more willing to continue using Diigo (M= 3.17) than Class B (M=2.74) ($p < .05$).

Students also ranked their preference for using the four types of sticky notes (Figure 5). Overall, students were most willing to use sticky notes to DEFINE terms or concepts. The use of sticky notes to TAG and RECORD thoughts were ranked second and third. The least preferred use of sticky note was to exchange ideas and to have online DISCUSSION with fellow students. MONOVA tests showed no significant difference between two classes on the preferences of using different sticky notes features.

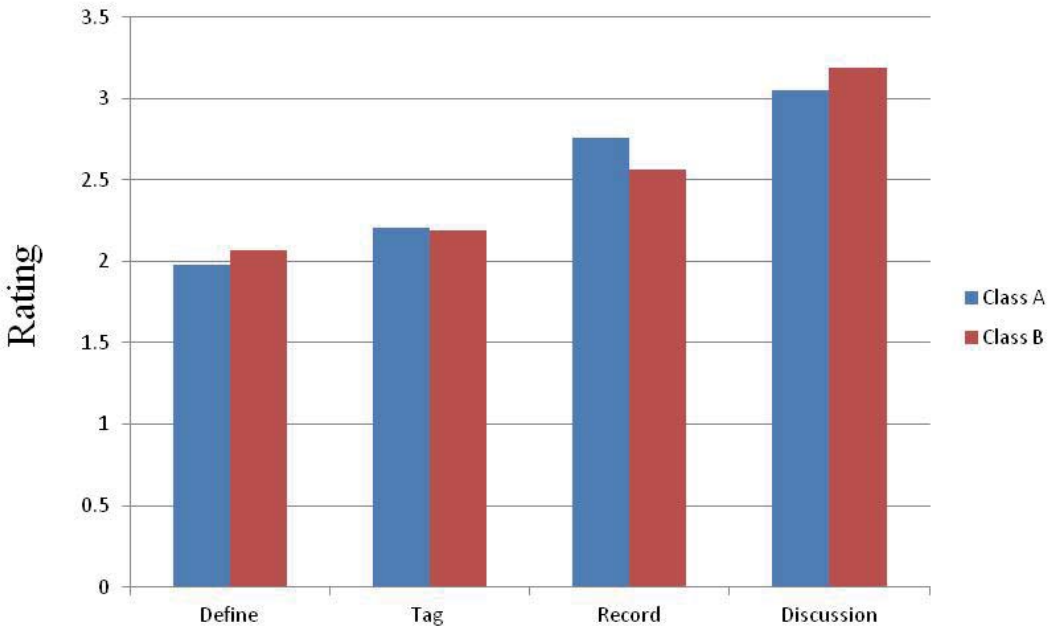

***Figure 5*: Preference of using sticky notes**

Annotation behaviour and perceptions of annotation

To better understand the association between how students used and how they perceived Diigo, separate correlations were run between use and perceptions of the two groups. For Class A, highlighting and sticky notes frequency were correlated with perceptions on usefulness of highlighting and tagging.

Table 3: ***Correlation of Class A Students' Perceptions and Annotation Behaviours***

	No. of highlights	**No. of SNs[1]**	**DEFINE**	**TAG**	**RECORD**	**CLAIM**
Highlight is helpful	.394**	.336*	0.086	0.147	0.264	0.296
SNs for tagging is helpful	.366*	.340*	0.144	0.125	.380*	0.206
SNs is helpful for recording thoughts	0.175	0.231	-0.099	.357*	0.012	0.099

[1]SNs: Sticky notes
* p < .05, ** p < .01

For class B students, number of sticky notes used was significantly correlated with their perception that sticky notes were easy to use and helpful and that receiving sticky note comments was helpful. An examination of the types of sticky notes produced revealed that the number of

RECORD notes was significantly correlated with their perception of sticky notes. Students who produced more RECORD notes also felt that sticky notes were easy to use ($r = .504$, $p < .01$), and recording thoughts were helpful ($r = .452$, $p < .05$). Teacher suggested TAG were only positively correlated with the perception that sticky notes were easy to use ($r = .447$, $p < .05$).

Table 4: ***Correlation of Class B Students' Perceptions and Annotation Behaviours***

	No. of SNs	DEFINE	TAG	RECORD	CLAIM
SNs[1] are easy to use	.436*	0.155	.447*	.504**	0.076
SNs are helpful	.387*	-0.094	0.119	0.25	0.187
SNs are helpful for recording thoughts	0.305	0.044	0.228	.452*	-0.036

[1]SNs: Sticky Notes
* $p < .05$, ** $p < .01$

Discussion and conclusion

Annotation behaviours

An exploratory method was used to examine how two classes of secondary four students used and perceived the highlighting and sticky note features of Diigo to support the active reading and analysis of online articles. As with paper-based annotation (Ovsiannikov, et al., 1999), students highlighted most frequently. They used different colours to highlight important ideas and to compare the positions and perspectives of different stakeholders. The combination of highlighting and sticky notes was especially powerful as highlighting served to contextualize the sticky notes. Learners were able to construct notes to express personal meanings while reading. This is especially the case of high performance class who tend to add notes while highlighting.

When learners take notes on what they read they engage in a deeper cognitive process than when they simply highlight what they read (Anderson & Armbruster, 1982). We agree with Higgins (1993) in that adding notes is more important to critical reading than highlighting as it is more closely connected with formulating conclusions based on evidence. In our study, students used sticky notes to define terms, analyze different positions, record thoughts, and make claims and draw conclusions. To elaborate, an essential first step in active reading is the understanding of key concepts and students used sticky notes to define important terms, clarify important issues and connect old and new knowledge. Second, labelling different positions involved students in understanding and comparing different theories and perspectives. Third, identifying evidence and formulating explanations involved students in condensing, paraphrasing, and interpreting original texts. This is an important step in the process of constructing their own claims (Kuhn, 1991; Toulmin, 1958). Finally, making claims or drawing conclusions are involved in moving beyond simply tagging and clarifying evidence to drawing conclusions in the inquiry learning process. To sum up, students used sticky notes to define, understand, link, compare, explain, and infer in the process of reading.

The two classes in our study showed different annotation behaviours. On the whole, average performance group (Class B) highlighted less than high performance group (Class A), and produced even fewer notes than class A. This might be because that adding sticky notes is more cognitively demanding since it involves higher order thinking skills such as comparing, explaining, and inferring. Our results tend to support the work from Grade and Sigler (2002) in that competence in reading comprehension facilitates the use of online learning tools, in our case, the annotation tools. Class A students tended to use sticky notes to define keys terms and concepts and making claims. Again, this might be associated with the academic abilities of students. More able students might be better at searching for relevant information and linking them with the key terms and concepts. Meanwhile, claim making as argumentation skills has been found very weak among most students (Kuhn, 1991), which might pose as a great challenge for lower ability students.

Student perceptions & behaviours

Students of both classes were positive about Diigo as an online reading aid and perceived highlighting as its most valuable feature. Different annotation behaviours of the two classes were correlated with the different perceptions of Diigo. Students in Class B tended to use sticky notes to make more justifications when they found that sticky notes were easy to use, and useful for recording justification. Thus what students thought about sticky notes was consistent with how they used them. For Class A, correlations were found between the total number of sticky notes used and perceptions of their usefulness in tagging. Those who thought tagging was useful made more notes. Through adding tags such as “pro” or “con” to highlighted text, students could better comprehend articles. The annotation behaviour of high performance students might be affected by instructions by the teacher who created tags for reading. Furthermore, “pro” and “con” are key elements in understanding and producing arguments, which asks for high cognitive skills. High performance students who are better in argumentation seem to bring such skills in annotation. The annotation behaviour of ordinary performance students was affected by multiple factors, particularly ease of use and perceived helpfulness to record their own thoughts. The students in Class B might have varied abilities in dealing with the technical features of Diigo, thus it might help them use sticky note functions by making it easier to use.

In this study, we have explored the experiences and perceptions of two classes of secondary students who used an online annotation tool (Diigo) in the process of inquiry-based learning. The findings have shown that highlighting is the most popular and recognized as the most useful feature. The sticky notes feature has been used flexibly to serve for a range of purposes including identifying, contrasting, and commenting. We consider adding sticky notes more important for critical reading as it entails higher order thinking skills such as analyzing, comparing, explaining, or making a claim. This might help to explain why the high performance group created more sticky notes than the ordinary performance group, especially for defining terms and making claims. Our study can shed some lights on how an online annotation tool can be used to support critical reading. The comparison of two groups of students with different academic abilities can let teachers to be more aware of the individual differences of students and to meet their needs accordingly.

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