The Effect of Intrapsychology Learning Before and After Interpsychology Activities with a Web-based Sharing Mechanism

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ABSTRACT
Learning is predominantly contributed through the approach, “first interpsychology, and then intrapsychology” called “intra- after inter-psychology.” This learning method was also defined in the “Zone of Proximal Development” from the assistance provided by others to the self, as proposed by Vygotsky. In this study, another reverse learning approach, “first intrapsychology, and then interpsychology” called “intra- before inter-psychology” was designed, so as to investigate what kind of learning sequence activities can bring about more effective learning experiences. Furthermore, the Web-based sharing annotation mechanism was employed to facilitate intrapsychology activities. Experimental results from a social course with 151 fifth-grade elementary school participants indicated that the intrapsychology activity plays an important role in students’ learning performance, regardless of whether it was structured before or after interpsychology activities. However, formulating learning concepts through textual annotations made in the intrapsychology activity, undertaken before the interpsychology activity, created a psychological tool for mediating interaction in interpsychology activities. In addition, the Web-based sharing mechanism could empower participants’ willingness to engage in the intrapsychology activity if the sharing mechanism was conducted before class. Constructing a structure for interpsychology activities has been explored for decades as an effective way to facilitate interaction among group members or to promote learning performance; however, this study further implies that conducting the learning strategy within the intrapsychology activities may be another approach worth further investigation; this is especially true for the strategy designed before interpsychology activities. Implications for practice and recommendations for future research are presented.

Keywords
Intrapsychology learning, Interpsychology learning, Web-based sharing mechanism, Annotation tool

Introduction
The central concept of Vygotsky’s theory is that individual cognition is based on the interaction among peers and their environment; the interaction is interceded by a mediator, such as tools, signs, and symbols. The mediator performs a vital role during the transformation from an inter-personal experience into an intra-personal form (Vygotsky, 1978). According to the socio-cultural approach proposed by Vygotsky (1978), learning is mainly an approach through interpsychology and intrapsychology. Vygotsky (1978) believed “every function in the child’s cultural development appears twice; first, on the social level, and later, on the individual level -- first, between people (interpsychology), and then inside the child (intrapsychology).” Interpsychology refers to interaction with others (Berge, 1999), such as “Questions and Answers” between students or between the instructor and students in class. Intrapsychology refers to the internalization, or reflection of knowledge, such as summarizing or annotating learning materials through self-study before or after class.

The sequence of learning activities described briefly above is similar to the sequence the “Zone of Proximal Development (ZPD)” stages proposed by Vygotsky (1978). This sequence is the distance between where performance is assisted by more capable students and where performance is unassisted. Learning in the ZPD could be divided into several stages, which includes the assistance and learning regulation provided from others to the learner himself. Thereby, the sequence of learning activities within a ZPD model serves as the first social interaction with capable peers (a kind of interpsychology), then self-regulation by the learner himself (a kind of intrapsychology). This sequence of learning activities is “intra- after inter-psychology” activities. For example: first the teacher presents a lecture, then interaction between peers in class takes place, and then ‘self-study’ activities (called review) follow after class.
Many literatures showed the relevance and importance of intrapsychology or interpsychology modes on learning. An “intra- after inter-psychology” learning sequence attained better learning effects than modes that only used in-class activities. For example, modes that used intrapsychology after interpsychology activities resulted in better learning achievement, facilitated better understanding and retention of learning materials, and attained higher levels of student confidence and creativeness (Cooper & Valentine, 2001; Hwang et al, 2011; Hwang, Wang, & Mike, 2007; Ongun, Altas, & Demirag, 2011).

There is another common reversed sequence in classroom learning, “intra- before inter-psychology” activities. An example of this sequence is a self-study before class (called pre-reading), followed by a lecture and peer discussion activities in class. The “intra- before inter-psychology” learning modes obtained better learning achievement than modes that employed only in-class activities. Namely, the top achievements were: students’ learning achievement levels were improved and students’ attention was more focused in class on the part previously not fully understood during pre-reading activities (Chen, 2008; Chiu & Lee, 2009). Web-based technology with a sharing mechanism into “intra- before inter-psychology” activities was also used to gauge the effectiveness of pre-reading on learning achievement and peer collaboration (Cobos & Pifarré, 2008; Hwang & Hsu, 2011).

However, few studies concentrated on further comparison between the learning sequence mode with “intra- before inter-psychology” activities and the mode with “intra- after inter-psychology” activities on learning, particularly within school classrooms. Furthermore, the effectiveness and comparison of “intra- before inter-psychology” activities and “intra- after inter-psychology” activities with/without a Web-based sharing mechanism were seldom studied.

Using the concepts of “interpsychology and intrapsychology” as a theoretical framework, this study addresses the following research objectives through a Web-based annotation system: (1) the effects of different activity sequence modes with inter/intra-psychology on learning achievement were investigated; (2) activity sequence modes with a Web-based sharing mechanism were conducted along with their influence on learning achievement and the quantity of annotations; (3) the participants’ perceptions about activity sequence modes with inter-/intra-psychology, and the sharing mechanism were also explored.

The research questions that guided the study were as follows:
1. What were the effects of the sequence modes, intrapsychology learning conducted before or after interpsychology activities, on learning?
2. What were the effects of the Web-based sharing annotation mechanism on learning?
3. What were the perceptions of the participants toward the intrapsychology learning before or after interpsychology activities and the Web-based sharing annotation mechanism?

**Literature**

**Influence of the sequence modes using an intrapsychology activity before and after an interpsychology activity on learning**

The learning sequence mode with “first pre-reading before class, then interaction in class” is an “intra- before inter-psychology” activity. Pre-reading has great influences on learning achievement. Preparation for learning before class helps students to be “learning-ready” (Paul, 1979). Ten-minute in-class preparation for the pre-test could stimulate students to work hard and get some knowledge of the learning materials before learning (Chan, 2005). Furthermore, the students who read a legal case before class displayed a greater understanding of the learning materials than the students who did not prepare for a pharmacy law course before class (Spies & Wilkin, 2004). Chen (2008) showed that pre-reading helped learners capture key points and incomprehensible concepts before class, so they could focus their attention on the parts of the lecture related to those key points and concepts previously not fully understood.

A few researchers applied technologies into pre-reading activities to enhance learning achievement. Viewing a video of lectures before class improved the high-school students’ basic image processing (Chiu & Lee, 2009). Engaging in pre-reading activities through a Web-based annotation tool (i.e., textual annotations are written before class using a Web-based annotation tool) could reveal students’ preparation before class as well as reflect their prior knowledge to help the instructor conduct appropriate learning activities (Hwang & Hsu, 2011). Additionally, Hwang and Hsu (2011) further indicated that the quantity of the textual annotations written before class positively correlated with
learning achievement. Furthermore, a pre-reading strategy could increase learning achievement compared with classes that did not engage in self-study before class. Sun and Huang (2005) conducted an experiment with an experimental group and a control group, employing traditional instruction with or without requesting pre-reading via Web-based learning materials. The results indicated that the pre-reading group received significantly higher scores than the group that did not self-study before class.

The learning sequence mode that featured “first interaction in class, then review by oneself after class” is an “intra-after inter-psychology” activity. Reviewing activities, such as doing homework, have a positive impact on students’ learning. Furthermore, such activities have immediate effects on the retention and understanding of the learning materials (Cooper & Valentine, 2001). Homework with problem-solving in a cyber socio-cultural environment gave students the opportunities to explore learning materials, which bolster confidence and creativity (Ongun et al., 2011). The research of Hwang, Wang, and Mike (2007) indicated that the quantity of textual annotations written after class in the high achievement group (top 27 percent of the experiment class) was significantly higher than the number of annotations written by the low achievement group (bottom 27 percent of experiment class). Meanwhile, the quantity of textual annotations written after class had a positive relationship between learning achievement. Therefore, it was implied that the more textual annotations participants created after class would affect their learning achievement whether he/she was in a low or high achievement group. Reviewing textual annotations written by original annotators has a significant influence on learning achievement. However, inexplicit annotations did not significantly influence learning achievement because textual annotations act as meaningful symbols for original annotators (Hwang et al., 2011).

Both intra- and inter-psychology learning sequence modes had positive learning effects for students. Previous research related to annotation tools seems to reveal that the quantity of textual annotations serves as a factor that correlates with participants’ learning performance when used to explore the effectiveness of Intra psychology before or after class. Detailed empirical studies are needed to further investigate the effectiveness and to compare the usefulness of different sequence modes on learning and the students’ attitudes toward the modes.

Influence of the Web-based annotation sharing mechanism in an “intra- before inter-psychology” activity and an “intra- after inter-psychology” activity on learning

Annotation refers to making extra information on documents. Annotation contains two different type forms: writing comments on a document is considered explicit annotation, and underlining or making highlights is considered inexplicit annotation (Marshall, 1997). Explicit annotations function as short notes of interpretation, reflections for a visible trace of annotators’ attention (Marshall, 1997). Therefore, explicit annotations could be a means for carrying out intrapsychology activities, either before or after interpsychology activities. Meanwhile, the previous findings also indicated that the more explicit annotations made by an annotator, the higher learning achievement they achieve because the explicit annotations create greater meaning for the annotator than the inexplicit ones in interpsychology activities (Howe, 1997; Hwang et al, 2007; Hwang et al., 2011).

Using a Web-based annotation sharing mechanism to check the learning effects of “intra- after inter-psychology” activities has been used by educational psychologists for decades to promote the following effects: to stimulate students’ motivation to engage in learning activities and to help them move forward toward learning goals (Hwang, et al., 2007); to achieve better learning performance by collaborating with peers via sharing and accessing their own ideas of the learning materials used (Hwang et al., 2007; Su, Yang, Hwang, & Zhang, 2010); to obtain the benefits of peer learning, such as offering more learning opportunities through conversation or dialogue via sharing annotations (Glover, Xu, & Hardaker, 2007); to learn a peer’s methods of how to accomplish a specific task via sharing and discussing their annotations with other peers (Cobos & Pifarré, 2008); and to support learner-center collaborative learning for adult and adolescent students via a shared document-based annotation tool (Nokelainen, Miettinen, Kurhila, Floréen, & Tirri, 2005).

Meanwhile, research of the effectiveness of a Web-based collaborative annotation system to attain better learning achievement, compared with the group using a discussion board system to read learning materials has been conducted (Su et al., 2010). However, the results by Hwang, Chen, Shadiev, and Li (2011) showed that using a sharing annotation mechanism to view classmates’ annotations marked on learning materials did not have significant positive effects on math learning achievement. This finding was due to the fact that reviewing peers’ textual annotations did not promote reviewers’ inspiration, as compared with viewing the textual annotations created by original annotators. Contrarily, reviewing peers’ textual annotations of homework solutions significantly influenced reviewers’ learning achievement.
Constructing the structure of interpsychology activities has been explored for decades as an effective way to facilitate interaction among group members, or to promote learning performance (Brown et al., 1993; Collins, 2006; Stahl, Koschmann, & Suthers, 2006; Slavin, 1996; Zhang, Scardamalia, Reeve, & Messina, 2009). Expertise was mainly distributed through two activity forms of collaborative learning, jigsaw and reciprocal teaching (Brown et al., 1993). The structures of instructional design models of jigsaw and reciprocal teaching were conducted to increase interdependence or interaction among members to facilitate rethinking and to promote the contribution of each member (Slavin, 1996). Meanwhile, social structure in collaborative learning also influences the contribution of members. For example, opportunistic collaboration based on emergent goals causes higher level contribution of each group member, as compared with the social structure with fixed groups (assign each division of the task to members and combine the contribution together at the end) or interacting groups (based on fixed groups and interaction between groups) (Zhang et al., 2009). The technology environment was applied as a tool to facilitate thinking and to shape thought in the process of interaction of disturbed expertise (Brown et al., 1993). Computer Supported Intentional Learning Environments (CSILE) Project was the first system for networked collaboration learning (Bereiter & Scardamalia, 1993), and the upgraded version is Knowledge Forum (Scardamalia, 2004). A technology with a note-taking, note-viewing, and note-sharing mechanism was provided to support the interaction of disturbed expertise (Bereiter & Scardamalia, 1993; Scardamalia, 2004). Expertise is formulated during the process of collaborative problem-solving in which continuously sharing, thinking, and redefining notes inside CSILE/Knowledge Forum by contributing pieces of their work (Bereiter & Scardamalia, 1993).

In contrast with the Web-based sharing mechanism that was widely used in the learning sequence mode with “intra-after inter-psychology”, very little literature applied a Web-based sharing mechanism in the learning sequence mode with “intra-before inter-psychology” activities. A pre-reading sharing mechanism with Web-based annotation capabilities could stimulate and help students perform more useful pre-reading by reviewing others’ annotations, thereby enlarging the effectiveness of pre-reading as it relates to learning (Hwang & Hsu, 2011).

A Web-based sharing mechanism used in both learning sequence intra- and inter-psychology modes had positive learning effects for students. Meanwhile, previous research seems to reveal that conducting strategies with the support of a Web-based sharing mechanism may promote interaction between peers or increase the contribution of each member if conducted during interpsychology activities or intrapsychology learning after interpsychology activities. Detailed empirical studies are needed to investigate and compare the usefulness of a Web-based sharing mechanism on learning, and the interaction between peers as conducted in different sequence modes with intra-/inter-psychology activities.

**Perceived usefulness and ease of use of system**

Perceived usefulness and perceived ease of use were proposed by Davis (1986). The belief that using technology will increase and improve performance fulfilled the “perceived usefulness” category. The “perceived ease of use” category referred to the belief that using an information system will be free of effort (Davis, 1986). It was widely used to predict user attitudes toward information technology (Chang & Yang, 2010; Park, 2010). A person’s behavior toward an information system was determined by his attitude concerning perceived usefulness and perceived ease of use (Davis, 1986).

Therefore, in this study, the perceived usefulness and perceived ease of using a Web-based annotation system, called Virtual PEN (VPEN), with “intra-before inter-psychology” and “intra-after inter-psychology” activities were employed. Furthermore, the effects with/without Web-based sharing for learning in the different learning sequence modes were deeply investigated and the reasons behind findings were also analyzed.

**Research method**

**Participants**

Five classes with 151 fifth-grade elementary school students were involved in this study. As shown in Table 1, Class 1 and Class 2 were composed of pre-reading classes, where participants were asked to engage in self-study Web-based learning materials before class and to join in-class activities. Participants in Class 2, referred to as the Web-based sharing pre-reading class, were asked to self-study learning materials before class and then share their annotations with each other during pre-reading. Class 3 and Class 4 were review classes, where participants were...
asked to self-study Web-based learning materials after class. Participants in Class 4, called the Web-based sharing review class, shared their annotations with each other during a review period and then self-studied learning materials and answered guiding questions. Class 5 was a traditional class, whose participants only joined in-class activities using a paper-based textbook and students were not asked to self-study before or after class. Therefore, Class 1 and Class 2 shared a similar learning sequence mode with “intra- before inter-psychology” activities, while Class 3 and Class 4 were organized by a similar mode with “intra- after inter-psychology” activities.

Table 1. Groups, classes, and participants

<table>
<thead>
<tr>
<th>Group:</th>
<th>Group 1: intra- before inter-psychology group (Class 1 and Class 2)</th>
<th>Group 2: intra- after inter-psychology group (Class 3 and Class 4)</th>
<th>Group 3: Traditional group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class:</td>
<td>Class 1: Self-study before class</td>
<td>Class 2: Self-study with sharing mechanism before class</td>
<td>Class 3: Self-study after class</td>
</tr>
<tr>
<td></td>
<td>Class 4: Self-study with sharing mechanism after class</td>
<td>Class 5: Traditional class with only in-class activities</td>
<td></td>
</tr>
<tr>
<td>Participants:</td>
<td>30 students</td>
<td>30 students</td>
<td>31 students</td>
</tr>
</tbody>
</table>

Experimental procedures

An eight-week quasi-experiment, with each week devoting two hours to research, was conducted to investigate the effects of the treatment on learning achievement and the participants’ perception toward the approach. The experimental procedures are described as follows (and illustrated as Figure 1):

1. Training activities: According to Table 1, training courses for the use of VPEN with or without a Web-based sharing annotation mechanism, pre-reading, and review activities were provided.
2. Pre-test: Before the treatment, a pre-test was held for all classes to measure the students’ prior knowledge.
3. Treatment: Different learning sequence modes with inter-/intra-psychology activities and a Web-based sharing mechanism.
Pre-reading activities (self-study before class):

Participants in Class 1 and Class 2 were asked for making self-study before class two weeks ago. The Web-based sharing annotation mechanism was provided for those in Class 2 since the self-study activities were performed for one week. The task for self-study activities included reading and making annotations on the online textbook materials, and completing the guiding questions designed by the instructor.

In-class activities:

Classmates were divided into several groups; each one had four to five members. Each group had both male and female students with different ability levels depending on their prior knowledge, based on pre-test scores. Each class had the same structure: for the first 5 minutes was devoted to the instructor’s guiding time, the middle 25 minutes was group discussion time for a problem-based task designed by the instructor, and the final 10 minutes were dedicated to individual activities, in which students wrote down their own solutions for the tasks. The classroom for all classes in this study was the computer classroom, which was accessible for content annotation before class or to search the internet.

Review activities (self-study after class):

The review activities were organized after class for two weeks in Class 3 and Class 4. The Web-based sharing mechanism was provided for participants in Class 4 for one week after class. The task to complete for review activities is the same for pre-reading activities.

4. Post-test: After two weeks of the treatment, a post-test was held for all classes to measure the students’ learning achievements.

5. Questionnaire and interview: At the end of the experiment, open-ended questionnaires and interviews were provided to identify the participants’ perceptions toward inter-/intra-psychology activities and the sharing mechanism.

Data collection and analysis: Scores from the pre-test and post-test, the quantity of annotations that were calculated by the concept-based coding, and the open-ended questionnaire and interview were collected. Methods of analyzing the data included Analysis of Covariance (ANCOVA) (used to examine the effects of different learning sequence modes), the Pearson correlation (used to examine the correlation between learning achievement and the quantity of explicit annotation), etc.

Learning materials, questionnaire, and interview

Five classes had the same learning materials, which included a social course textbook in a fifth-grade elementary school. According to the concepts, perceived usefulness, and perceived ease of use proposed by Davis (1986), the open-ended questions designed by the researchers were the follows.

1. What do you think is the usefulness of the Web-based annotation system on learning?
2. What do you think is the ease of use of the Web-based annotation system?
3. What do you think is the usefulness of pre-reading/review on learning?
4. What do you need while you study before or after class?
5. What do you think is the usefulness of the Web-based sharing annotation mechanism on pre-reading/review and learning?

Interviews were only applied when the questionnaire responders wrote their position toward the proposed activities, but the reasons were not clearly presented. For example, “I think self-study before class was useless for my learning....”

Results and analysis

Effects of different activity sequence modes and the Web-based sharing mechanism on learning achievement

ANCOVA was adopted for examining the possible effects of different activity sequences with inter-psychology and intra-psychology and the effects of the Web-based sharing mechanism on learning achievement. First, the ANCOVA
results are presented in Table 2. These results show that Group 1, whose participants engaged in an “intra- before inter-psychology” activity sequence, significantly outperformed Group 2 (with an “intra- after inter-psychology” activity sequence) and the traditional group (Group 3); and Group 2 significantly outperformed Group 3. The results further reveal that an “intra- before inter-psychology” sequence achieves more positive effects on participants’ learning than the activities with reverse order. Self-study would be more helpful for participants if it is organized before the interaction among peers or the instructor. Additionally, the traditional group, whose students only engaged in in-class activities, demonstrated the least effect on learning achievement as compared with Group 1 and Group 2.

<table>
<thead>
<tr>
<th>Table 2. Effects of Sequence Mode with interpsychology and intrapsychology Activities on Learning Achievement</th>
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<tbody>
<tr>
<td><strong>n</strong></td>
</tr>
<tr>
<td>Intra before Inter psychology, Group 1</td>
</tr>
<tr>
<td>Intra after Inter psychology, Group 2</td>
</tr>
<tr>
<td>Inter psychology only, Group 3</td>
</tr>
<tr>
<td>* p &lt; 0.05.</td>
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</table>

Second, the analysis of ANCOVA is further applied to investigate the effect of different modes with and without a Web-based sharing mechanism. The findings, as shown in Table 3, reveal the following:

1. Self-study with a sharing mechanism before class (Class 2) did significantly better than all classes. No significant difference was found among others (Class 1, Class 3, and Class 4). Thereby, the Web-based mechanism applied in self-study before class is helpful for participants’ learning as compared with the other sequences with or without a sharing mechanism.

2. The results also reveal that in the review classes (Class 3 and Class 4) the Web-based sharing mechanism did not significantly impact participants’ learning because the learning achievement between classes with and without this mechanism was not significantly different.

3. Furthermore, Class 1, Class 2, Class 3 and Class 4 did significantly better than Class 5, which reveals that only in-class learning in Class 5 -- without applying the mechanism of self-study before or after class -- performed the poorest out of all classes.

<table>
<thead>
<tr>
<th>Table 3. Effects of different sequence modes with/without web-based sharing mechanism on learning achievement</th>
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<tr>
<td><strong>n</strong></td>
</tr>
<tr>
<td>Self-study before class and in-class activities, Class 1</td>
</tr>
<tr>
<td>Self-study with sharing mechanism before class and in-class activities, Class 2</td>
</tr>
<tr>
<td>Self-study after class and in-class activities, Class 3</td>
</tr>
<tr>
<td>Self-study with sharing mechanism after class and in-class activities, Class 4</td>
</tr>
<tr>
<td>Only in-class activities, Class 5</td>
</tr>
<tr>
<td>* p &lt; 0.05.</td>
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</table>

The above findings probably imply the following:

An intrapsychology activity plays an important role in students’ learning performance, whether it was arranged before or after interspsychology activities, as compared with the performance without intrapsychology activity. If the Web-based sharing mechanism was applied during the intrapsychology activity, the “intra- before inter-psychology” activity might obtain better learning performance than the “intra- after inter-psychology” activity. The Web-based sharing mechanism did not facilitate the majority of the effects on learning achievement, as it was applied during the intrapsychology activity, which was after the interspsychology activity. However, it might expand the significant difference of learning performance during the reverse sequence.
Correlation between learning achievement and the quantity of annotations in different sequence modes

According to the findings presented in Table 2 and Table 3, learning sequence modes with intrapsychology organized before or after an interpsychology activity would significantly effect participants’ learning achievement compared with the activity without intrapsychology activity. Therefore, further investigation of the correlation between learning achievement and the effort participants put into an intrapsychology activity (the quantity of explicit and implicit annotations in this study) is necessary.

The Pearson correlation between learning achievement and the quantity of explicit annotations showed that significant correlation existed ($r = .198, p = .030 < .05, N = 121$), while the inexplicit annotation did not ($r = .05, p = .583 > .05, N = 121$). This finding reveals that high values of participants’ learning achievement tended to be positively associated with the large values of the explicit annotation quantity in the intrapsychology activities. If students study enough through explicit annotations during intrapsychology learning, they may gain higher learning achievement.

The usefulness of a Web-based sharing mechanism, which was applied in intrapsychology activities, on the quantity of explicit annotations was further investigated. The Post Hoc comparison of ANOVA shows that with the exception of the significant difference between those engaged in self-study with a sharing mechanism before class (Class 2) and those who engaged in self-study before class (Class 1) ($Mean\ Difference = 9.27, Standard\ Error = 2.877, p = .019 < .05$), no significant difference was found among other classes. The quantity of explicit annotation in each class was ranked from high to low: the Web-based sharing pre-reading class, the review class, the Web-based sharing review class, and the pre-reading class (Class 2: $Mean = 24.27, SD = 15.2, N = 30$; Class 3: $Mean = 21.07, SD = 10.907, N = 30$; Class 4: $Mean = 17.48, SD = 7.953, N = 31$; Class 1: $Mean = 15, SD = 9.24, N = 30$).

The findings reveal that the more students were engaged in intrapsychology learning through the creation of more explicit annotations, the higher learning achievement attained. The quantity of explicit annotations in self-study before class was ranked the least, which reflects that self-study before class without a sharing mechanism may be not easy for some participants. The Web-based sharing mechanism could help participants make more explicit annotations compared with the self-study before class without a sharing mechanism. No significant differences between the review class and the Web-based sharing review class reveal that during the review period, the Web-based sharing mechanism did not assist participants in making more explicit annotations. Based on the open-ended questionnaire and interview, participants felt that reading annotations made by classmates was unnecessary due to the perception that some concepts about learning materials were understood after hearing the lecture or after discussion in class.

After investigating the influence of intra-/inter-psychology activities on learning achievement and the correlation between learning achievement and the quantity of annotations written during intra-psychology activities, it is necessary to further explore the usefulness of a Web-based sharing annotation mechanism and explicit annotations written in different intrapsychology activities (before or after interpsychology activities) on learning.

Analysis of the open-ended questionnaires and interviews

The questionnaire was given to four classes with 121 participants, and 101 completed questionnaires were received (an 84 percent return rate). A total of 40 participants were interviewed to verify their attitudes toward the treatments.

Integrated analysis of perceived usefulness of intrapsychology annotation for learning performance

The usefulness of pre-reading was perceived as follows:

1. The process of reading and creating explicit annotations during pre-reading activities facilitated participants to acquire some concepts, to think, or to find some questions before class. Their learning concepts formulated before class, which may be different from or conflict with others, led to further discussion in class, which, in turn, resulted in better learning achievement. For example, some participants (who were in a self-study class without a sharing mechanism before class) responded to the usefulness of explicit annotation on learning:
“I annotated some learning questions, abstracted in each paragraph before class. The learning questions or abstract (in textual annotations) written by me or my classmates before class could be a topic or guideline to help us effectively discuss in class. I think effective discussions help me grasp the key points and leads to an increase in my score on the final exam.”

“I wrote down some reflections after I read the lesson on VPEN before class. I thought I already knew some key points, but after discussion in class I found part of them were not correct, thanks to my friends’ suggestions. It helps me a lot.”

Other participants responded to the process of creating explicit annotations led to more active interaction in class and resulted in better learning achievement. (The following perceptions come from some participants whose scores were higher through the use of self-study with a sharing mechanism before class.)

“After I read the annotations written by my classmates, I found they were different from mine sometimes. It made me think again and again. Carefully rethinking about what is different between them before class helped me be able to describe my opinions and to more actively discuss with my classmates in class. The active discussions help me to clarify some misunderstandings about the lives of aborigines. Therefore, I get better scores.”

Another participant had a similar response.

“After I read the textual annotations written by some classmates before class, they considered aborigines in our county who like to dance and drink. My classmate’s opinion about how the aborigines use dance and drink to fight with enemy interested me. What kind of crazy guy wrote this comment? It is impossible to use them against an enemy...After a long discussion, we finally came to the conclusion that aborigines like to dance, drink, and draw on their faces because they like to make themselves appear brave to fight with enemies. They also use these things to celebrate victory. A colorful drawing, like a bridge, brings them to heaven and forces the enemy to hell. I think it’s their culture and custom. We should respect it. The discussion also let me better understand the colorful lives and customs of aborigines, and it helped us get better scores on the final exam.” (This lesson pertained to colonial expansion and aborigines)

However, another culture and custom is not easy experience, particularly for the new generation that did not have the context to experience. Their diverse learning concepts formulated in the process of writing explicit annotations before class further contributed to formulate the abstract concept of culture and custom in the class discussion. For example, some classmates used some annotations about aborigines’ objects written before class (a ship with totems, a symbol of snakes, clothes with colorful symbols) to cooperatively compose a story.

“The totems on the ship look like a star or sun. These symbols take us to the ocean and safely return us back. The totems are like eyes for the ship to direct the way home. The totems on the ship look like fishing net to catch fish. The totems are like eyes for the ship in search of fish. Snakes are monsters in the ocean. Beautiful totems on the clothes resemble a net to prevent the attack of a water snack. The totem net looks like the skin of the snack and it drives us home safely and directly.... I thought the story was an example of how to reply to the open questions related to the life of aborigines in the final exams.”

The story the students composed likely did not completely match the original spirit of the culture. But it might imply that the aborigines’ objects came alive again in their story, and social meanings were reinterpreted, reshaped by them, but the spirit is the same, telling the new generation to have respect for their ancestors and nature.

2. Finding some key points before class and interacting with classmates and the teacher in class deeply impressed participants (the first time involved writing explicit annotations in pre-reading, and interaction in class was the second) and produced better learning achievement. For example, some participants responded:

“Reading materials, writing some main points before class, and then listening and discussing these points in class makes me remember the materials.”
3. The more preparation the participants had before class, the more confidence participants had during the activities designed in class. For example:

“I have confidence to correctly answer the questions asked by peers or the teacher if I have annotated enough comments after reading the materials before class.”

“If I read materials before class, it helped me more easily realize what my classmates discussed in class. It is good for me and I can express my opinions about the questions. It is exciting for me.”

“I am nervous to express my opinions in public because I have no confidence in my opinions. But after I read the annotations written by my friends, I am not nervous anymore because some of their opinions are similar to mine and I felt my opinions are better than theirs.”

4. The limitation of class time causes participants to have limited opportunities to explain their opinions that conflict with peers. Meanwhile, only offering guiding questions and arranging pre-reading learning schedules by the teacher were not useful or they did not satisfy some participants. For example, some participants did not feel at ease during self-study before class. Another participant, with high prior knowledge, felt bored and frustrated that the other students’ learning progress was not known. Also, those with low prior knowledge described that they needed more help from others to learning the concepts (this analysis was from the pre-reading class without using a Web-based sharing annotation mechanism).

“Where can I find resources or solutions to solve the guiding questions? I need some direction on how to handle this.”

“It is boring. I have already written my solutions or comments. But I want to know what my classmates wrote and whether they study hard.”

The responses provided in the open-ended questionnaires and interviews probably reveal the participants’ perceived usefulness of review on learning in the following ways:

1. Reviewing learning materials and annotations helps participants to remember what they learned in class. The lecture from the teacher or the opinions of peers helps participants to quickly determine main ideas. Reviewing the annotations made in class helps the students memorize the main ideas of the learning materials.

2. The review activities offered participants opportunities to confirm what they learned. The process of completing some guiding questions designed by the teacher gave the participants the opportunity to ensure that they accurately realized the concepts and confirm what they learned. Some participants responded that they still did not understand the concepts, or they did not grasp the main ideas despite the opportunity to review the learning materials. They need more guidance from peers or the teacher.

3. The learning schedule designed by the teacher for one class may be different for a subsequent class. Some participants feel embarrassed to ask for help in one class due to the timing of finding the learning questions; they may be unable to catch up with the learning schedule in class even though the teacher offered some time to ask for help in class.

Integrated analysis of a Web-based sharing annotation mechanism on facilitating intra-/inter-psychology learning

The usefulness of a sharing mechanism applied in intra-psychology learning before inter-psychology activities:

1. The sharing mechanism facilitates the engagement of participants’ interaction in class.

   (1) Reading the explicit annotations shared by classmates not only helped participants grasp more main ideas, but it also helped them identify some learning problems that needed further verification. That made them pay attention to the teacher’s lectures or peers’ opinions in class.

   “It helps me more easily and quickly joins the discussion with my classmates. Before the discussion, I read my classmates’ annotations and they remind me of something I did not pay attention to before and they also let me know there are some topics I should further discuss and make clear in class.”
(2) Reading the explicit annotations written by classmates helped participants to grasp the structure of materials before class, which helped them to catch up with the pace during interaction activities. For example:

“Reading the annotations made by my classmates helped me know the structure of the lessons before class, which helped me to actually know what we are discussing right now, and what would be discussed next in class discussion.”

2. The sharing annotations mechanism motivated participants to be more engaged in intrapsychology activities.

(1) The mechanism provided opportunities for improving the contents of annotations: Peers’ explicit annotations might contain some related learning resources, such as references of websites. These annotations gave some participants a new direction to improve their answers to the pre-reading guiding questions. For some low prior knowledge participants, classmates’ annotations served as annotation practice models. Therefore, sharing, and viewing an annotation mechanism supported some participants to continue to study learning material before class.

“My classmates would annotate some questions to remind or guide themselves when something is unclear. The annotations also provided some direction on what I need to improve. Particularly, the references they annotated guided me to a website that helped me to better understand how to answer the guiding questions.”

Another participant responded that reading others’ annotations inspired him to find more useful information before class.

“I saw textual annotations written by my friends before class. A classmate said she interviewed her grandfather to gain a better understanding of the culture of aborigines. Another friend expressed that he watched a television program to realize the customs of aborigines. I went to the museum of aborigines to access their dedicated collections. Watching the concrete collections help me experience the daily life of aborigines. I heavily depend on the internet to search for information, but after reading classmates’ annotations, I found it was not always the case, culture, and custom of aborigines’ lives. After discussion in class with my classmates, we thought the best way to experience the culture and custom was to access their life stories.”

(2) The mechanism enabled a way to easily monitor the learning process of classmates: Participants could easily monitor how many annotations classmates had written through the “Switch Users” menu of the VPEN system, as shown in Figure 2. For some high prior knowledge participants, reading peers’ annotations gave them insight to their competitors’ learning progress, which motivated them to dedicate more time to study the learning materials before class. For example, some participants responded:

“I could use it to watch how much effort my competitor put into studying and what they did. This made me study harder to get a better learning achievement. It is inconvenient to read all competitors’ annotations written in paper-based textbooks before class.”

(3) The mechanism helped participants reflect on annotations. Participants thought twice before making annotations and they reflected on what they annotated. This reflection motivated them to be eager to join the discussion among classmates in class.

“Sometimes I found annotations made by my classmates were not the same as mine and sometimes I am not sure mine is correct. I would rethink the details. I know what part of my annotation may have errors. I am eager to join the discussion in class and tell others about my opinions. I thought checking and reflecting made me get a better score.”
The usefulness of sharing mechanism applied in intrapsychology learning after interpsychology activities: Few participants were satisfied with the usefulness of the Web-based sharing mechanism in the intrapsychology activities after class. This was because after the teacher’s lecture and open discussion with peers in class, some participants perceived that they obtained some key ideas. As a result, it was not necessary to read others’ annotations. Meanwhile, the participants thought the main ideas found by peers were not better than the explanations provided by the instructor; therefore, they paid attention to their own annotations made in class instead of reading peers’ annotations.

Integrated discussion of relationship among aspects

According to the results above, the relationship among aspects (a Web-based sharing annotation mechanism, intrapsychology learning, perceptions among participants, quantity of explicit annotations and learning achievement) is presented in Figure 3.

First, both the engagement in intrapsychology activities through the creation of explicit annotations and the sequence modes with intra-/inter-psychology activities would likely affect learning achievement:

- In this study, the quantity of annotations was referred to as the effort of participants engaged in an intrapsychology activity. The positive significant correlation between the quantity of explicit annotations and learning achievement probably implies that if participants were more engaged in intrapsychology activities through the creation of explicit annotations, better learning achievement was likely to follow. This may partly explain why the Web-based sharing pre-reading class had the highest learning achievement -- its quantity of explicit annotations ranked first among all classes.

- However, an interesting phenomenon was found in that no significant difference in the quantity of explicit annotations was found between different sequence intrapsychology activities (the Web-based sharing pre-reading class and other review classes), however, the significant difference of learning achievement occurred between them. It perhaps also implied explicit annotations written during intrapsychology learning before interpsychology activities may more effectively increase learning achievement than those written during intrapsychology learning after interpsychology activities. The more engagement in intrapsychology activities before interpsychology, the higher the learning achievement attained.
Figure 3. The relationship of aspects

Note. A bold solid line refers to the state of significant effect. A bold dotted line refers to the state of insignificant effect. The solid line refers to the state of facilitation participants perceived. The dotted line refers to the state of ineffective facilitation.

- The survey of perceptions reveals that explicit annotations and learning concepts formulated before class may act as a mediator to facilitate the rethinking of learning concepts and to prompt interaction among participants in class, which would likely prompt increased learning achievement. However, intrapsychology learning after interspsychology activities helps participants to master or adjust learning, but it does not effectively inspire learners to interact among members in class. Therefore, it seems that two factors (one is the learning concepts formulated in the intrapsychology learning; another is the different sequence modes of intra- and interpsychology learning) might influence the interaction between peers in interspsychology activities. The analysis of perception might explain why an “intra- before inter-psychology” activity sequence significantly outperforms “intra- after inter-psychology” activity sequence and an “intra- after inter-psychology” activity sequence significantly outperforms the activity with “interspsychology only,” as shown in Table 2.

Second, the factor (the Web-based sharing mechanism) facilitated the engagement in intrapsychology activities conducted before interspsychology activities and promoted discussion during interspsychology activities:

- The Web-based sharing mechanism applied before class could be a factor that affected the positive attitude of participants towards introspsychology learning. For example, participants, who scored higher in the pre-reading class without using the Web-based sharing annotation mechanism, felt bored. On the contrary, some high prior knowledge participants, who were from the pre-reading class that used the Web-based sharing annotation mechanism, were interested in monitoring the learning process of competitors and they were incited to be fully engaged in creating more annotations. The perceived positive attitude could explain why the quantity of annotations in Class 2 (self-study with sharing mechanism before class) was significantly greater than those who self-studied on their own without the sharing mechanism before class.

- This sharing mechanism, however, would not effectively inspire participants to be more engaged in intra-/interspsychology learning if it was conducted after class. For example, participants felt embarrassed to ask for help in the next class or they felt they should have been able to get the main points after interaction in class. Thus, it was not necessary to read classmates’ annotations via the Web-based sharing mechanism. This survey of perception explains the results -- why no significant difference in the quantity of explicit annotations between the self-study after class with/without Web-based sharing mechanism (Class 3 and Class 4) existed.

- Furthermore, the survey of participants’ perceptions reveals that the explicit annotations written before class would be suitable materials for further discussion in class. The Web-based sharing mechanism conducted before class likely prompted interaction in class. For example, reading explicit annotations shared by classmates likely caused concept conflicts before class, which led to them to rethink their annotation and to be eager to discuss opinions in class.

- Therefore, it seems that with the exception of the two factors (learning concepts formulated in the intrapsychology learning and the different sequence modes), which were discussed above, a Web-based sharing
A mechanism would be another factor that might influence the interaction between peers in interpsychology activities. This analysis explains why the “intra- before inter-psychology” activity sequence with a Web-based sharing mechanism outperformed the most, which was probably because this sequence mode included these three factors to engage in formulating learning concepts, stimulating interaction between classmates, thereby, resulting in the best learning achievement.

**Conclusion and implications**

This study is aimed at exploring the effects of intrapsychology activities arranged before and after interpsychology activities. Meanwhile, the effects and the participants’ perceptions of a Web-based sharing mechanism, which was used in intrapsychology activities, were also explored on learning. The major findings and conclusions are as follows.

First, learning concepts formulated through intra-psychology learning before inter-psychology activities acted as a mediator to facilitate interaction among members, resulting in better learning performance:

Previous researchers indicated that learning activities combined with intrapsychology activities arranged before or after interpsychology activities attain better learning performance than the activity sequence mode that use only interpsychology activities (Chiu & Lee, 2009; Cooper & Valentine, 2001; Hwang & Hsu, 2011; Hwang et al., 2011; Hwang et al., 2007; Ongun et al., 2011; Sun & Huang, 2005). The finding in this study further indicated that the intrapsychology activities arranged before class resulted in significantly better learning effects than the activities arranged after class. According to Vygotsky’s theory, mediation is the key to facilitating human learning and the psychological process (Kozulin, 2003). If a learner masters the important concepts (mediators) written by the instructor before teaching, they might gradually transform the cultural of the social world (Hall, 2007). In this study, the concepts in the guided question and the pre-reading activities before class acted as a mediator for personal mental activity and to promote the willingness to interact with members in a community. If participants engage in learning preparation for the key instructional concepts through explicit annotations before class, they might formulate learning concepts. However, such preparation did not guarantee that all learning concepts constructed by learners before class were effective. In contrast to that, the concepts from participants were diverse and some learning problems were perceived. The opportunity for textual annotations and concept formulation before class could be regarded as one of the symbolic tools of mediation in mental activities and to mediate the interaction between individuals and the group members. Therefore, those who engage in learning preparation before class might potentially clarifies learning concepts and get better learning effects than those who do not perform pre-reading activities.

Furthermore, in this study the finding -- interaction between peers in Inter psychology activities potentially promoted learning performance -- was in line with the previous studies related with collaborative learning of distributed expertise (Bereiter & Scardamalia, 1993; Collins, 2006; Stahl et al., 2006; Slavin, 1996). Constructing the structure of interpsychology activities has been explored for decades as an effective way to facilitate interaction among group members, or to promote learning performance (Brown et al., 1993; Collins, 2006; Stahl et al., 2006; Slavin, 1996; Zhang et al., 2009). This study further indicated that learning concepts formulated within intrapsychology learning before interpsychology activities, using a Web-based annotation sharing mechanism, also be another effective way to facilitate the engagement of interaction in a classroom or it may potentially increase learning performance.

Second, intrapsychology learning after inter-psychology activities helps one to master or adjust learning, but it does not effectively inspire learners to interact among members:

The intrapsychology activities promoted the participants to master their learning, to confirm what have them learned, and to adjust their learning according to its confirmation. This result can be interpreted, according to the ZPD theory proposed by Vygotsky (1978), as learning regulated by others and the self also facilitates the level of capacity that might be developed. Therefore, in this study the intrapsychology activity after interpsychology activities achieves better learning performance than activities, which only include interpsychology in class, which is consistent with previous studies (Hwang et al., 2007; Su et al., 2010). However, the intrapsychology activity after interpsychology activities likely does not effectively inspire participants to join discussion activities in class because a lack of formulating learning concepts before class leads participants to spend too much time discussing what should be
prepared before class. Participants might feel embarrassed to ask for help in the next class with a different learning schedule.

Third, the sequence mode with a Web-based sharing mechanism conducted before class potentially produces a more effective influence on learning achievement:

The finding reveals that the engagement in intra psychology learning positively correlated with learning achievement. No significant difference in the engagement occurred between these classes (intrapsychology activities before class with Web-based sharing mechanism and two classes with a self-study activity after class); however, the learning achievement between them was significant difference. It reveals that the engagement in intrapsychology before class potentially produces a more effective influence on learning achievement as compared with the engagement in intrapsychology conducted after class. Although the findings in this study indicated that engaging in intrapsychology learning before class help to formulate learning concepts, which the act as a mediator to facilitate the interaction among members, the survey of perception from the pre-reading class without a Web-based sharing mechanism revealed that self-study before class (intrapsychology learning before interpsychology activities) was not easily satisfied by all participants. The further analysis indicated that a Web-based sharing mechanism was more helpful for engaging participants in the process of formulating learning concepts (stimulated rethinking before class and facilitated further interaction in class) while it was conducted in intrapsychology activities before class than that used in intrapsychology activities after class or the pre-reading without a Web-based sharing mechanism. This analysis of the role of a Web-based sharing mechanism not only explains the phenomenon, that a Web-based sharing annotation mechanism enlarged the effectiveness of pre-reading on learning as compared with pre-reading without conducting a Web-based sharing mechanism (Hwang & Hsu, 2011), but it also enhances the findings in this study: the “intra- before inter-psychology” activity sequence mode outperformed the activity sequence mode with “intra- after inter-psychology.”

Based on the results and discussion above, the following implications were provided:

Implication of designing interaction activities in classroom:

Previous studies have demonstrated that forming fixed groups, interacting groups or flexibly combining groups based on emergent goals would facilitate interaction during discussion (Zhang et al., 2009). Meanwhile, organizing sequence steps to require all members involved would be an effective way to promote the interaction and contribution of every member during discussion, such as the sequence steps in jigsaw and reciprocal teaching (Slavin, 1996). However, this study further implies that conducting the learning strategy within the intrapsychology activities may be another method worth further investigation, especially the strategy designed before interpsychology activities. Therefore, it was recommended that conducting an intrapsychology activity before class to formulate learning concepts (act as a psychology mediator) would be an effective strategy for designing interactive classroom activities and to potentially increase learning performance.

Implication to compose annotations (acting as a psychological mediator in interpsychology activities):

This research indicated that annotations written in intrapsychology learning would serve as a psychological mediator to rethink and facilitate interaction in class. Additionally, it was demonstrated that explicit annotation has more positive effects on learning achievement than inexplicit annotation. Therefore, it can be inferred that a teacher might encourage students to put more emphasis on composing explicit annotations rather than inexplicit annotations as they engage in the process of formulating learning concepts during intrapsychology activities.

Implication for motivating students engaging in the process of formulating learning concepts before class:

The VPEN annotation system in this study mainly supported the intra- and inter-psychology activities. The production of explicit annotations was mainly influenced by the Web-based sharing annotations mechanism of VPEN, or the activities sequence modes in this study. Therefore, it implied that designing some learning strategies that use some sharing technologies before class would be an effective way to increase the engagement of students in the process of formulating learning concepts during intrapsychology activities. For example, the “Switch Users” menu item, as depicted in Figure 2, could be used to monitor the learning process of classmates during intrapsychology activities, which motivated students to be engaged in making more explicit annotations during intrapsychology learning.
This study has shown the importance of psychology mediators formulated before or after class in the relationship among the aspects (i.e., a Web-based sharing annotation mechanism, the activity sequence modes with intra-/inter-psychology, and learning achievement). In this study, it was indicated that a Web-based sharing mechanism could be an effective mechanism to facilitate engagement in intrapsychology learning, but a few classmates need more mechanisms to help them regulate their learning in the process of formulating learning concepts during intrapsychology activities. Therefore, an important direction for future research is to match more advanced mechanisms, such as learning monitors, to the needs and preferences of each individual to help students and instructors efficiently evaluate, monitor, and regulate learning in the process of formulating learning concepts during intrapsychology activities before or after class. Furthermore, the influence of a learning monitor strategy, with different sequence modes (intra-/inter-psychology activities) on students’ contribution and interaction in a classroom and subsequent learning achievement, warrants further investigation.

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