Role of Parents and Annotation Sharing in Children’s Learning Behavior and Achievement Using E-Readers

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ABSTRACT

Although previous studies have highlighted the advantages of using e-books for learning, most have compared learning achieved with traditional textbooks with that achieved with e-books in a classroom situation. These studies focused on individual learning instead of on interactions among learners, learning behavior using e-books after school, and parental observations of children using e-books for learning. This research investigated the use of annotatable multimedia e-readers (AMEs) for elementary school-level English and examined the effects of annotation-sharing mechanisms inside and outside the classroom on learning and achievement. The research findings suggest that reading the annotations of high-achieving learners (HLA) via the annotation-sharing function can reinforce learning. Moreover, HLA annotate significantly more in class and after school than do low-achieving learners (LLA). We found a positive correlation among parents’ perceptions of after-school learning with AMEs, learners’ after-school annotation recording, learning behavior while listening to such recordings, and children’s learning achievement.

Keywords

Annotatable multimedia e-readers (AMEs), Annotation sharing, English learning, Learning behavior, Learning time

Introduction

Electronic readers and smart phones have fast become a part of our daily lives. In particular, the convenience of these devices and the potential for enhancing the user’s performance through their use is extraordinary. In terms of learning, e-readers allow learners to access material anywhere and anytime. In addition, e-readers with rich multimedia tools and annotation capabilities, such as those offered by Google, also assist in the learning process. Previous research has indicated that e-readers could be used to improve the quality of learning (Huang, Liang, Su, & Chen, 2012; Korat, 2010; Korat & Shamir, 2012; Li, Chen, & Yang, 2013; Shih, Chen, Cheng, Chen, & Chen, 2013). Li et al. (2013) developed an e-reader system with a visual cue map to help learners construct cognitive maps effectively. Huang et al. (2012) developed an interactive learning system with e-readers for elementary school students; their principles for designed multimedia interactive learning were adopted to help students’ personalized learning experiences with e-readers. These studies concluded that the proposed interactive learning system could create a better personalized learning experience for elementary school students.

Recently, annotation has become a popular activity in the learning process (Chen, Hwang, & Wang, 2012; Hwang, Shadiev, & Huang, 2011; Hwang, Wang, & Sharples, 2007) because annotation is associated with the output of knowledge internalization (Peverly et al., 2013). To effectively improve learners’ performance, annotation tools or activities should be added to e-readers or smart phones. Previous research has also indicated that learners using annotation can effectively improve their performance (Hwang, Chen, Shadiev, & Li, 2011; Hwang & Hsu, 2011). However, annotation belongs to personal learning and usually has personal meaning. The annotations of different learners are usually not the same. It is important to enhance peer interaction based on annotation sharing so that learners can easily review others’ annotations and exchange ideas. Research has indicated that the annotation-sharing mechanism can enhance peer interaction and learning motivations. Yang, Zhang, Su, and Tsai (2011) developed a semantic web-service-supported multimedia tool to facilitate collaborative annotation sharing in the context of computer-supported collaborative learning (CSCL). Their experimental results showed that annotation sharing can facilitate knowledge sharing and improve participating students’ reading comprehension. Su, Yang, Hwang, and Zhang (2010) also indicated that the annotation sharing mechanism can increase learners’ performance in...
collaborative learning environments. Moreover, their results showed that the influence of annotation on learning performance becomes stronger with the use of the sharing mechanism.

In addition to learning annotation, learning time (the amount of time students are actively engaged in learning) also has an effect on learning performance (Adelman, 1996; Black, 2002; Gettinger & Walter, 2012). Therefore, learning time is worth exploring. However, evaluating the effect of learning time only at school may not be enough. Students’ learning time and learning practices after school should also be considered. A key element that may enhance learning after school is parental involvement (Fan & Chen, 2001). Desforges and Abouchaar (2003) revealed that parental involvement not only improved children’s willingness to learn, but also improved children’s attitudes towards after-school learning. Hanna et al. (2011) showed that parental involvement can effectively enhance children’s learning performance. Thus, to facilitate learning performance, parental involvement with the student is essential, from an educational viewpoint (Sartor & Youniss, 2002).

Previous studies have mainly compared e-readers and traditional paper-based books (Huang et al., 2012; Korat, 2010; Li et al., 2013; Shamir, Korat, & Fellah, 2012). Wright, Fugett, and Caputa (2013) evaluated the use of reading resources available between the two reading methods, and found that vocabulary acquisition and reading comprehension were similar. Huang et al. (2012) indicated that using an e-reader or printed book made no significant difference in reading accuracy. Korat and Shamir (2012) examined the effect of e-reader use for children in the context of vocabulary and reading and found that those who read e-readers exhibited significant progress in reading and understanding the meaning of words, compared to the control group. However, all of these previous studies mostly compared the use of e-readers and traditional books in class, without investigating the effects of using e-readers after school. Parental involvement must be considered when children are allowed to bring e-readers home with them; however, few studies have addressed this issue.

To address this gap in knowledge, we investigated learning behavior when students used e-readers both in class and after class, the effect of e-readers on learning performance, and how parental involvement influences after-school learning. In addition, we compared the differences in learning behavior and learning time between in-class and after-class learning, and with and without annotation sharing between learners with a high level of learning achievement (HLA) and a low level of learning achievement (LLA). This research addresses several key questions related to learning behavior, learning practices, and the performance of students using e-readers: (a) what are learners’ perceived attitudes toward the AME system; (b) what are parents’ perceptions toward their children’s use of the AME system after class and the relationship between parental perception and their children’s learning behavior after class with respect to learning achievement; (c) what are the effects of the learner’s behavior in class/after class on their learning achievement; (d) is there any significant difference in learning behavior and learning time between HLA and LLA students, with/without annotation sharing in class/after class; and (e) what are the effects of reviewing peers’ annotations on learning achievement?

**Literature review**

**E-readers**

E-readers have renewed the traditional concept of the book, encouraging the socialization of reading and user participation (Cordon-Garcia & Lopes, 2012). Most recently, light and mobile reading devices with high-resolution displays have become popular and have opened new opportunities for reading applications in education, business, and the private sector (Siegenthaler, Bochud, Bergamin, & Wurtz, 2012). For example, a single electronic device can be used for a variety of activities, in addition to reading a book (Siegenthaler, Wurtz, Bergamin, & Groner, 2011). More specifically, e-readers offer several major advantages, such as portability, searchability, and multimedia characteristics (Shurtz & von Isenburg, 2011). These characteristics have made e-readers very popular and useful in educational settings.

Thus, the e-reader has received considerable attention from scholars in educational settings. For example, Korat (2010) revealed how e-books facilitated learning by offering automatic dynamic visuals that dramatized the story details for a more complete story scene. In this case, the researchers focused on developing a multimedia tool for educational e-books, which was aimed at supporting elementary students who had already begun the process of learning English as a foreign language (EFL) at school. Students in the experimental EFL group who used the e-book
showed a significantly improved learning performance compared to those in the control group (without e-books and the developed multimedia support). Huang et al. (2012) designed personalized learning tools, such as e-annotation, bookmarks, content searching, and learning-process tracking for e-books. Here, the individual’s learning needs and characteristics were emphasized. The usability and functionality of the proposed system were well-suited for most students, and students obtained a better personalized learning experience. Li et al. (2013) proposed a mechanism using visual contextual cues to facilitate students’ building of cognitive maps using e-books; these e-books offered contextual cues and navigational mechanisms. Participants who used the e-book system with the visual cue mechanism spent significantly less time completing ten navigational tasks and gained a higher reviewing score than those who did not use the visual cue mechanism.

Annotation

In e-learning environments, the effect of digital annotation may be as good as paper-based annotation with regard to learning performance. In one study, no significant difference in learning achievement was observed between note-taking on paper and note-taking in a learning system (Quade, 1996). Chen and Liu (2012) investigated the effectiveness of using learner-generated as opposed to instructor-provided multimedia annotations on foreign language reading comprehension and attitudes. Students in the learner-generated annotation group showed better reading comprehension than those in the instructor-provided group, which suggests that learner-generated annotation in e-learning environments could also support reading comprehension. Hwang, Liu, Liu, and Huang (2011) constructed the VPen system, which enables students to reflect on learning material individually by creating annotations and then collaboratively by sharing annotations with their peers or teacher for in-depth discussions of their thoughts and ideas. The system facilitated writing and speaking performance, and therefore improved learning achievement. Thus, the annotation system provided the support needed for students to improve their learning performance. Hwang et al. (2011a) noted that students’ actual learning behavior was correlated with their speaking and writing performance, which in turn was correlated with their learning achievement. Hwang et al. (2007) proposed personalized tools for individual learning systems and analyzed students’ learning behavior. The influence of annotation on learning performance became stronger with the use of sharing mechanisms.

Annotation-sharing mechanism

Knowledge sharing in CSCL requires intensive social interactions among participants, typically in the form of annotations (Yang et al., 2011). Students can review the annotations of their peers using an annotation sharing mechanism. Previous research has shown the effects of the annotation on students’ ability to learn (Lee, Lee, & Leu, 2009; Su et al., 2010; Yang et al., 2011). Specifically, Su et al. (2010) demonstrated the use of a personalized annotation management system for managing, sharing, and reusing individual and collaborative annotations. Use of the system increased learning achievements in collaborative learning environments. Chen et al. (2012) found that interactivity and helpfulness were statistically significant factors for predicting the future use of an annotated system. In addition, note-taking habits also affected learners’ perceptions of using the annotated system. In summary, a significant body of research shows that the annotation-sharing mechanism supports the learner and helps improve learning performance.

Learning behavior and learning time

Students have to strike a proper balance between time spent learning and free time. Time spent learning should be used effectively to increase the level and amount of learning (Wyne & Stuck, 1982). Gettinger (1985) showed a decrease in learning and retention by 11–18.5% when insufficient time was spent on or allocated for learning. Fisher (2009) investigated the distribution of learning time for senior high school students, and found that the majority of time in school was spent listening or waiting; students were engaged in reading, writing, and peer work for only a small fraction of the school day. That study suggested that if learners wanted to improve their learning performance, they had to change the way they managed their time spent learning. Black (2002) advocated that students should spend their learning time more efficiently. In summary, two key factors affecting students’ learning performance are adequate learning time and the effective use of the time spent learning.
Importance of after-school learning

Language studies, in particular, require time spent learning after school to achieve better fluency, and studies have shown that after-school learning enhances learning performance in this area (Bergin, 1996). Noam, Biancarosa, and Dechausay (2003) divided after-school education into three major categories: (1) bridging school to after school, (2) homework or extended learning, and (3) additional curricula or enriched learning. Thus, the main purpose of after-school learning is to continue or extend learning of the content presented in the classroom. A suitable learning plan facilitates effective after-school learning.

There have been several studies on the effect of after-school learning on learners’ achievement (Dairianathan & Subramaniam, 2011; Noam et al., 2003; Tran, 2011). Tran (2011) examined the relationship between students’ out-of-school experiences and various factors associated with science learning. The ability to make connections between in-school and out-of-school science experiences was associated with positive learning outcomes, such as achievement, interest in science, and effort in learning science. Dairianathan and Subramaniam (2011) investigated primary students’ learning through participation in out-of-school activities. Participation in out-of-school activities not only improved learning performance, but also enhanced the motivation to learn.

Parental involvement

In the current educational setting, after-school learning has become increasingly important as developmental support for the learner. However, parental involvement may be a key factor affecting after-school learning (Krumm, 1996). There have been several studies on the effect of parental involvement on student learning outside of class (Desforges & Abouchaar, 2003; Floyd & Vernon-Dotson, 2009; Gonzalez-DeHass, Willems, & Holbein, 2005; Sartor & Youniss, 2002). Xu (2004) showed that learning attitude was greatly affected by family involvement with homework. Parental involvement not only improved children’s willingness to learn, but also improved their attitudes towards after-school learning (Gonzalez-DeHass et al., 2005). In summary, there is a body of evidence showing that parental involvement is key for effective after-school learning.

Methods

Participants and learning material

The participant consisted of 31 sixth graders (11–12 years old; 16 males and 15 females). All participants were provided with an e-reader for learning the English language. The learning materials contained in the e-reader were the same as those in the original textbooks.

Research design

This study adopted a one-group pretest–posttest quasi-experimental research method to investigate the effects of annotatable multimedia e-reader (AME)-based English instruction on elementary school students’ learning achievement and to explore differences in the in- and after-school learning behavior and learning time of students with different learning achievements. Questionnaires soliciting parents’ perceptions and learners’ feedback were based on the technology acceptance model (TAM) proposed by David (1986). TAM introduces two perspectives: perceived usefulness and perceived ease of use, which explain and predict users’ attitudes and the factors that contribute to the use of the new technology. TAM has been applied by empirical research predicting intentions to use new information technology tools (Venkatesh & Davis, 2000).

Learners used the AME system over five weeks. During the first two weeks, they used the system without annotation sharing. From the third through to the fifth week, they used it along with annotation sharing. During the formal experiment, e-readers were used as the main learning tool (i.e., students used the e-readers in class and were allowed to take the e-readers home after school). The experimental procedure is illustrated in Figure 1.
Research tool

Annotatable multimedia e-readers (AME)

The AME system was developed to support learning, providing learners with multiple learning resources, including text anchors, image anchors, voice annotation, the ability to hear their own annotation comments, a text-to-speech function, and the ability to hear the teachers’ annotations. This learning tool included the following features:

- **Text anchors.** Learners could tag, create line drawings, and annotate in a textual content, as shown in Figure 2. They also could modify the content of their text annotations at any time.
- **Image anchors.** Learners could annotate non-text content, as shown in Figure 3. In general, the main purpose of this feature was to support learners in adding supplementary words or sentences from their teachers’ lectures.

- **Voice annotation.** We developed a voice-recording tool for the AME system that enabled learners to record their pronunciation, as shown in Figure 4.
- **Text-to-speech (TTS).** Learners could use the TTS tool to support their understanding of how to pronounce words or sentences, as shown in Figure 5.
- **Dictionary.** We developed a multimedia dictionary tool to translate words or sentences quickly and to provide suitable sentences for learners. The multimedia dictionary tool could also perform word translations offline to support learning after class.
- **Teacher lecture annotation.** We developed a lecture-annotation feature to record the lectures given by teachers in class, enabling students to listen to them after class, as shown in Figure 6.
- **Parental signature.** The parental signature could be used as a communication link between parents and teachers. Thus, parents and teachers could have more opportunities to understand students’ learning progress or problems and could better monitor their learning in Figure 7.
Annotation sharing. The annotation-sharing mechanism can facilitate knowledge sharing and improve student comprehension (Yang, Zhang, Su, & Tsai, 2011) as well as increase learning achievement (Su, Yang, Hwang, & Zhang, 2010; Yang, Tseng, Shih, & Liang, 2012). Annotation sharing mechanisms can be divided into two types: Full annotation sharing and group annotation sharing (Hwang, Wang, & Sharples, 2007). The former allows all students to review one another’s annotations, whereas the latter allows only group members to review one another’s annotations. We adopted the full annotation-sharing mechanism to obtain a more complete understanding of learning behavior, and we generated a list of students ranked by the number of annotations they made. Thus, students were able to review one another’s annotations (e.g., text and voice annotations) and improve their own annotations when they encountered problems or difficulties after class. More importantly, our annotation-sharing mechanism allowed students to review but not modify the annotations made by others. This may encourage students to make more annotations, as shown in Figure 8.
Parents’ perception questionnaire

We used paper-and-pencil questionnaires to investigate parents’ observations of their children’s after-school learning using the AME system. The questionnaire was verified by three experts in the e-learning field who revised or eliminated items with ambiguous meanings. Twelve questions remained, and these had a Cronbach’s α of 0.946. The questionnaire was divided into three sections: parental perceived ease of use, parental perceived usefulness, and learning behavior observed by parents. All questions were scored using a five-point Likert scale: strongly agree, agree, neutral, disagree, and strongly disagree. Definitions of the three sections are presented in Table 1. All questions are provided in the Appendix A.

<table>
<thead>
<tr>
<th>Parts</th>
<th>Operational definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parental perceived ease of use</td>
<td>Parents think that children can learn English more easily by using an AME system as the main learning tool.</td>
</tr>
<tr>
<td>Parental perceived usefulness</td>
<td>Parents think that the functions of the AME system help children learn English at home.</td>
</tr>
<tr>
<td>Learning behavior observed by parents</td>
<td>Parents identify children’s learning behaviors at home in terms of their after-school learning activities.</td>
</tr>
</tbody>
</table>

Learners’ feedback questionnaire

We solicited feedback from learners using a questionnaire investigating their thoughts about learning via an AME system. The questionnaire was validated by three experts in the e-learning field who revised or eliminated questions with ambiguous meanings. The final instrument consisted of 23 questions with a Cronbach’s α of 0.854. The questionnaire was divided into five sections: perceived ease of use, perceived usefulness, intention to use, perceived usefulness after school, and intention to use after school. All questions were scored using a five-point Likert scale: strongly agree, agree, neutral, disagree, and strongly disagree. Definitions of the five sections are presented in Table 2. All questions are provided in the Appendix B.

<table>
<thead>
<tr>
<th>Parts</th>
<th>Operational definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived ease of use</td>
<td>Learners think that the AME system is easy to use.</td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td>Learners think that the AME system can enhance their learning in English.</td>
</tr>
<tr>
<td>Intention to use</td>
<td>Learners intend to use the AME system in class.</td>
</tr>
<tr>
<td>Usefulness after school</td>
<td>Learners think that the AME system can enhance their English learning after school.</td>
</tr>
<tr>
<td>Intention to use after school</td>
<td>Learners intend to use the AME system after class.</td>
</tr>
</tbody>
</table>

Data analysis

The data sources of this study were participants’ learning behavior and learning time by using AME system in class and after school in e-book learning and English learning scores of pretest and posttest. Data analysis was based on SPSS statistical software. Reliability analysis of questionnaire designed was validated by Cronbach α to test the internal consistency of the questionnaire. Pearson correlation coefficient was used to test the correlation among the dimensions and correlation between learners’ learning behavior and learning achievement. Simple linear regression was conducted to probe into the prediction of one independent variable on one dependent variable. The value of explanatory power can be found to realize if annotation behavior can predict learning achievement. We conducted a t-test of independent to find out if, with and without annotation sharing, learners of different learning achievements have significantly different learning behavior and learning time in class and after school. The interview script includes two primary opinions. First, parents want to be able to let their children use e-readers to learn English again. Secondly, learners agreed that e-readers, which provide a lot of multimedia tools, can help learners easily learn English.
Result

Questionnaire analysis

Result of parents’ perception questionnaire analysis

The data obtained from the questionnaires was applied to identify parents’ perceptions and attitudes towards their children use of the AME system. Table 3 shows the results of the mean score and standard deviation of each part of the parents’ questionnaire. The result shows that the most of parents agreed that their children can learning English by using the AME system.

The result of the parents’ open-questions also showed that the most of parents want to be able to let their children use e-readers to learn again. Most of parents made comments similar to the following:

- “My children use e-readers to learn again, because e-readers can learn easily when my children reviewing after class.”
- “I’m willing to let my children use e-readers to learn again, because e-readers can provide a lot of learning resources like teacher’s lecture annotation and text-to-speech.”

As a result, it was found that the most of parents prefer to let their children use e-readers for learning at home.

Table 3. The mean score and standard deviation of each part of the parents’ questionnaire

<table>
<thead>
<tr>
<th>Parts</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parental perceived ease of use</td>
<td>3.95</td>
<td>0.57</td>
</tr>
<tr>
<td>Parental perceived usefulness</td>
<td>4.10</td>
<td>0.52</td>
</tr>
<tr>
<td>Learning behaviors observed by parents</td>
<td>3.68</td>
<td>0.94</td>
</tr>
</tbody>
</table>

Result of learners’ feedback questionnaire analysis

Table 4 shows the means and the standard deviations of the learners’ perception. All items in parental perceived ease of use ($M = 4.10$), perceived usefulness ($M = 3.95$), perceived intention to use ($M = 3.90$), perceived usefulness after class ($M = 4.04$) and perceived intention to use after class ($M = 3.81$) of the AME system dimensions were ranked with a high score. It indicated that most of learners agreed that using the AME system was easy and useful.

The result of the learners’ interviews also showed that the most of learners agreed that e-readers, which provide a lot of multimedia tools, can help them easily learn English. Most learners made comments similar to the following:

- “When I want to review English at home, it is convenient to listen to the teacher’s lecture by using e-readers.”
- “E-readers are useful, because they provide a lot of functions, like text-to-speech, dictionary.”
- “I can take notes easily using e-readers.”

As a result, it was found that the most of learners agreed that e-readers can help them easily to learn English. This may be the reason why learners prefer to use e-readers to learn.

Table 4. The mean score and standard deviation of each part of the learners’ questionnaire

<table>
<thead>
<tr>
<th>Parts</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived ease of use</td>
<td>4.24</td>
<td>0.779</td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td>3.95</td>
<td>0.910</td>
</tr>
<tr>
<td>Intention to use</td>
<td>3.90</td>
<td>0.778</td>
</tr>
<tr>
<td>Usefulness after class</td>
<td>4.04</td>
<td>0.959</td>
</tr>
<tr>
<td>Intention to use after class</td>
<td>3.81</td>
<td>0.845</td>
</tr>
</tbody>
</table>

Note. Correlation between parents’ perceptions and learning achievements.

As shown in Table 5, the results showed that learning behaviors observed by parents have significant correlation with quantity of voice annotation ($r = .393^*, p < .05$) and listening one’s own voice annotation ($r = 0.458^{**}, p < 0.01$). This implies that the learners made more voice annotations. Listening to own voice annotation, their learning
behaviors would more easily observed by their parents after the class. On the other hand, the results showed that the learning behaviors observed by parents have significant correlation with learning achievement \((r = 0.424^*, p < 0.05)\). This implies that the learners’ learning behaviors more observed by their parents will have high learning achievement. In other words, the parents play an important role in their children’s learning achievement.

### Correlation between learning behavior and learning achievements in and after class

This section presents the results that the correlation between learners’ learning behavior in and after class and learning achievement. Pearson’s correlations were used to examine the relationships between learning behavior and learning achievement. As showed in Table 6, the results shows that learning behavior in which learners made text annotations in class is significantly correlated with their learning achievement \((r = 0.433^*, p < 0.05)\). It indicated that the more learners used text annotation in class, the better their learning achievement.

In order to examine whether the quantity of text annotation in class are significant predictors for learners’ learning achievement, we conducted a simple regression analysis. As showed in Table 7, the results demonstrate that quantity of text annotation in class were the significant predictors for students’ learning achievement \((p < 0.05)\). It indicates that learning behavior in which learners made text annotations in class can facilitate their learning achievement.

On the other hand, the result of Pearson’s correlation analysis showed that learners’ learning behavior after class had no significant correlation with learning achievement \((p > 0.05)\). It implies that the quantity of annotation after class may not be enough to predict learners’ learning achievement. As mentioned before, “learning behaviors observed by parents” have significant correlation with learning achievement. It implies that only the outputs of learners’ learning behavior after class could facilitate their learning achievement (Fisher, 2009).

### Table 5. Correlation analysis of parents’ perceptions and learners’ learning behavior after class

<table>
<thead>
<tr>
<th>Learning behaviors observed by parents</th>
<th>TA</th>
<th>VA</th>
<th>OVA</th>
<th>TTS</th>
<th>TVA</th>
<th>LA</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA</td>
<td>.255</td>
<td>.393*</td>
<td>.458**</td>
<td>.192</td>
<td>.218</td>
<td>.424*</td>
</tr>
</tbody>
</table>

Note. TA = Text annotation after class; VA = Voice annotation after class; OVA = Listening of own voice annotation after class; TTS = Text-to-speech after class; TVA = Listening to a teacher’s voice annotation after class; LA = Learning achievement. *\(p < 0.05\). **\(p < 0.01\).

### Table 6. Correlation analysis of learning behavior in/after class and learning achievement

<table>
<thead>
<tr>
<th>Learning achievement</th>
<th>In class</th>
<th>After class</th>
<th>In class</th>
<th>After class</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA</td>
<td>.433*</td>
<td>.149</td>
<td>.257</td>
<td>.322</td>
</tr>
</tbody>
</table>

Note. *\(p < .05\). **\(p < .01\).

### Table 7. Simple regression analysis for learning achievement

<table>
<thead>
<tr>
<th>Predicting variables</th>
<th>B</th>
<th>SE</th>
<th>Beta</th>
<th>t</th>
<th>R2</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning achievement</td>
<td>Text annotation in class</td>
<td>.223</td>
<td>.086</td>
<td>.433</td>
<td>2.583</td>
<td>.159</td>
</tr>
</tbody>
</table>

Note. *\(p < .05\). **\(p < .01\).

### The effect of sharing to learning behavior and learning time in and after class

We classified the participants into two groups based on their average score gained from their post-test. More specifically, those who gained higher scores than the average were assigned to the HLA group \((N = 15, M = 95.13, SD = 3.16)\), whereas those who gained lower scores than the average were assigned to the LLA group \((N = 16, M = 64.56, SD = 19.08)\). Furthermore, this section focuses on the differences of learning behavior and learning time in class and after class, with and without annotation sharing between HLA and LLA learners.
Learning behavior and learning time in class with/without sharing

In this section, a series of t-test analyses were conducted to examine the difference in learners’ learning behavior and learning time in class, with and without annotation sharing between the HLA and LLA learners.

No significant difference on learning behavior in class without annotation sharing was found between the HLA and LLA learners ($p > 0.05$). However, Table 8 revealed significant differences between the HLA and LLA learners on quantity of text annotation ($t = 1.789, p < 0.01$) in class with annotation sharing. This implies that the HLA learners’ frequencies of using text annotation in class with annotation-sharing mechanisms were significantly higher than those of the LLA learners.

Table 8. Independent-sample t-test analysis in class with sharing

<table>
<thead>
<tr>
<th>Learning achievement</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity of text annotation in class</td>
<td>High</td>
<td>15</td>
<td>14.30</td>
<td>6.32</td>
<td>3.392</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>16</td>
<td>8.03</td>
<td>3.71</td>
<td>6.32</td>
</tr>
<tr>
<td>Quantity of voice annotation in class</td>
<td>High</td>
<td>15</td>
<td>2.10</td>
<td>2.28</td>
<td>1.789</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>16</td>
<td>0.98</td>
<td>1.02</td>
<td>1.789</td>
</tr>
</tbody>
</table>

Note. * $p < .05$. ** $p < .01$.

Figure 9 shows the line charts of different learners’ learning time in class. As shown in this figure, the HLA and LLA learners have different learning time by using the AME system with annotation sharing in class.

In order to examine the differences in learners’ learning time by using the AME system with/without annotation sharing in class between the HLA and LLA learners, analyses were undertaken between the HLA and LLA learners for the learning time. The result revealed that the difference level of learning achievement learners did not show any significant difference on their learning time by using AME system without annotation sharing in class ($p > 0.05$). However, there were significant differences in learners’ learning time by using the AME system with annotation sharing in class between the HLA and LLA learners ($t = 2.318, p < 0.05$), as shown in Table 9. These results indicated that the HLA learners were continuous learning in class, but the LLA learners didn’t.

Figure 9. The difference level of learning achievement learners’ learning time in class of line charts

Table 9. Independent samples t-test analysis in class with sharing

<table>
<thead>
<tr>
<th>Learning achievement</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning time in class</td>
<td>High</td>
<td>15</td>
<td>39.11</td>
<td>15.04</td>
<td>2.318</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>16</td>
<td>27.86</td>
<td>11.89</td>
<td>1.881</td>
</tr>
</tbody>
</table>

Learning behavior and learning time after class with and without sharing

In this section, we discuss a series of t-test analyses conducted to examine the difference in learners’ learning behavior and learning time after class with and without annotation sharing between the HLA and LLA learners. No significant difference was found between different levels of learning achievement learners on learning behavior after
class without annotation sharing ($p > 0.05$). However, the results from Table 10 show significant differences between the HLA and LLA learners on quantity of text annotation ($t = 3.017, p < 0.01$), voice annotation ($t = 2.625, p < 0.05$), and listening to one’s own voice annotation ($t = 2.662, p < 0.05$) after class with annotation sharing. This implies that the HLA learners’ frequencies of using text annotation, voice annotation, and listening to one’s own voice annotation after class with annotation-sharing mechanisms were significantly higher than those of the LLA learners.

The result of the learners’ interviews showed that their learning behaviors of using annotation-sharing tools are different. The HLA learners stated:

- “I would like to choose HLA students to review their annotation, because their annotations were usually great quality.”
- “I would like to choose students that made a lot of annotations.”

We found that the HLA learners preferred to use annotation-sharing tools to review learners who made more great annotations, because the HLA learners agreed that those reviewable annotations could help them learn. However, the LLA learners stated:

- “I would like to choose my friends’ annotation to review.”
- “I would like to arbitrarily choose other students to review their annotation, because I don’t know who to choose.”

We found that the LLA learners don’t prefer to use annotation-sharing tools to review HLA learners. In summary, there were differences in learning behavior that learners used annotation-sharing tools between HLA and LLA learners. This is why different learners’ after-class learning behaviors are different.

<table>
<thead>
<tr>
<th>Table 10. Independent-sample t-test analysis after class with sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning achievement</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>Quantity of text annotation after class</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Quantity of voice annotation after class</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Quantity of listening one’s own voice annotation after class</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

The different level of learning-achievement learners’ learning time after class is shown in Figure 10. The HLA and LLA learners have different learning times by using the AME system with annotation sharing after class.

To examine the differences in learners’ learning time by using the AME system with or without annotation sharing after class between the HLA and LLA learners, we conducted a $t$-test analysis. The results from Table 11 show that the different level of learning achievement learners did not show any significant difference on their learning time by using the AME system without annotation sharing after class ($p > 0.05$). However, there were significant differences in learners’ learning time by using the AME system with annotation sharing after class between the HLA and LLA

| Figure 10. The difference level of learning achievement learners’ learning time after class of line charts |
learners ($t = 2.619$, $p < 0.05$). These results indicate that the HLA learners continuously learned after class, but the LLA learners didn’t.

**Table 11.** Independent-sample $t$-test analysis after class with sharing

<table>
<thead>
<tr>
<th>Learning achievement</th>
<th>High</th>
<th>15</th>
<th>8.26</th>
<th>9.17</th>
<th>2.619</th>
<th>.019$^*$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning time after class</td>
<td>Low</td>
<td>16</td>
<td>1.90</td>
<td>2.12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Correlation between reviewing peers’ annotation and learning achievements with annotation sharing**

As shown in Table 12, the results of Pearson’s correlation analysis showed that the quantity of review HLA learners’ text annotation is related to learning achievement ($r = 0.413$, $p < 0.05$). In addition, we also conducted a simple regression analysis to examine the learners’ learning behavior with an annotation-sharing mechanism as predictors for their learning achievement. The results demonstrate that the quantity of review HLA learners’ text annotation were the significant predictors for their learning achievement ($p < 0.05$). It indicates that learning behavior in which learners review HLA learners’ text annotation can facilitate their learning achievement.

**Table 12.** Relationship between reviewing peers’ annotation and learning achievement with annotation sharing

<table>
<thead>
<tr>
<th>Annotation sharing</th>
<th>High learning achievement</th>
<th>Low learning achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text annotation</td>
<td>.413</td>
<td>.252</td>
</tr>
<tr>
<td>Voice annotation</td>
<td>.289</td>
<td>.049</td>
</tr>
</tbody>
</table>

Note. $p < .05$. $^*$ $p < .01$.

**Implications and suggestions**

Consistent with the results of previous research, our data reflect the advantages of using annotation for learning. For example, annotation for learning helps students recall teaching materials (Peverly et al., 2013), understand the content of the teaching materials more easily (Bohay, Blakely, Tamplin, & Radvansky, 2011), and focus on teachers’ explanations (Hwang et al., 2011). This study also demonstrated that annotation-sharing mechanisms effectively enhance learning, which is consistent with the findings of Chen and Liu (2012), Su et al. (2010), and Yang, Tseng, Shin, and Liang (2012).

Furthermore, we suggest that learning behavior and learning achievement after class may be affected by parental input and supervision. Therefore, we recommend that parents are provided with the means to supervise and be involved in their children’s learning to enhance after-class learning. There is also a need for a suitable incentive for children to improve their learning after class. One example of this is the annotation-sharing mechanism, which can motivate pupils and help them to engage in active learning after class. Our results also indicate that the annotation-sharing mechanism has significant positive effects on learning achievement. There is, however, a need to provide guidance for peer-to-peer reviews of annotations. It is particularly important to provide learners with good annotations as references, thereby enhancing their learning.

**Conclusion**

**Summary of findings**

Our major findings pertain to the following five key areas:

- **Learners’ perceptions.** The results from the questionnaire revealed that most learners had a positive experience with the AME learning system. Most students agreed that the multimedia tools provided by the e-readers helped them to learn English.

- **Parents’ perceptions.** Most parents believed that the AME system helped their children learn English. Additionally, most parents indicated that they would allow their children to use e-readers again as they believed...
the e-readers helped their children to study outside of the classroom. The learning behaviors observed by parents were significantly correlated with the learning behaviors outside of the classroom, as evidenced by the quantity of voice annotations and the time pupils spent listening to their own voice annotations. This indicates that parental involvement plays a key role in the frequency with which voice annotations are created and listened to after school. Students were more likely to practice outside of class under the guidance and support of their parents. Thus, the learning behaviors observed by parents were highly correlated with learning achievement.

- **Learning behavior using the AME system.** Learning behavior involving text annotations in class was significantly correlated with learning achievement. Additionally, the quantity of the text annotations made in class was a significant predictor of learning achievement. Therefore, effective text annotations in the classroom setting improved learning achievement.

- **Differences in learning behavior and learning time in/after class.** We found no significant difference between the in-class learning behavior of high-achieving learners (HLA) and that of low-achieving learners (LLA) when annotation sharing was not included in the analysis. However, significant differences between HLA and LLA learners regarding the quantity of text annotations made in class were observed when annotation sharing was included in the analysis. HLA learners used significantly more text annotations in class than did LLA learners. This suggests that HLA learners were better at using annotation-sharing mechanisms than were LLA learners, resulting in more efficient in-class use of this learning tool by the former.

Similarly, we found no significant differences in the learning behavior of HLA and LLA learners outside of class when annotation sharing was not included in the analysis. However, significant differences in the quantity of text annotations, voice annotations, and time spent listening to one’s own voice annotations after class were observed when annotation sharing was included in the analysis (i.e., these behaviors were more frequent in HLA learners). This again suggests that HLA learners may be better at using the annotation-sharing mechanism than are LLA learners, rendering the former more likely to use this tool outside of class.

We also found significant differences between HLA and LLA learners in the time spent learning using the AME system with annotation sharing both in and after class. HLA learners learned continuously, whether in or outside of class, whereas LLA learners did not. These results imply that the annotation-sharing mechanism is efficient and facilitates learning for HLA learners. This may be due to the fact that additional help is needed for LLA learners to learn English; for example, they may need to use the recommended tools and have access to the high-quality annotations made by HLA learners. This may help LLA learners learn English after class on their own.

- **Learning behavior with annotation-sharing mechanisms in the AME system.** A Pearson’s correlation analysis showed a relationship between learning achievement and how much or how often HLA learners reviewed their text annotations. This indicated that effective review of these annotations facilitated learning achievement for HLA learners.

**Limitations**

The present study has several limitations. First, only a small sample was used. Further work with a larger sample is needed. Another limitation is the method of calculating the amount of time spent learning; a more effective method would enable a more detailed analysis.

**References**


Appendix A

Parents' perception questionnaire

**Parental perceived ease of use**

PE1. By AME system, children can learn English easily.
PE2. By AME system, children can easily read the vocabulary.
PE3. By AME system, children can easily review content in class.
PE4. By AME system, children can easily have conversation by English.

**Parental perceived usefulness**

PEU1. Learning by AME system enhances children's English learning.
PEU2. Learning by AME system helps children repeatedly practise English words.
PEU3. Learning by AME system allows children to listen to teachers’ explanation of class at home.
PEU4. By writing assignments with AME system, children can practise dialogue in simple English at home.

**Learning behavior observed by parents**

LBP1. My children learn English by AME system at home.
LBP2. My children practise reading English words by AME system at home.
LBP3. My children review content of class by AME system at home.
LBP4. My children practise simple English conversation by AME system at home.

Appendix B

Learners' feedback questionnaire

**Perceived ease of use**

PE1. With the AME system, I can easily obtain system operation information needed.
PE2. It is not difficult to use AME system.
PE3. When using the AME system, the operation and interaction with the system are easy.

**Perceived usefulness**

PEU1. Use of the AME system enhances my English proficiency.
PEU2. Use of the AME system effectively enhances my English learning.
PEU3. Use of the AME system enhances my learning English.
PEU4. Use of the AME system allows me to have English learning rapidly.
PEU5. Use of the AME system enriches my annotation content.

**Intention to use**

IU1. I intend to accomplish English learning with the AME system.
IU2. In English learning, I frequently learn with the AME system.
IU3. Generally speaking, I am satisfied with learning English with the AME system.

**Usefulness after school**

EUS1. By using the AME system after school, I can learn English rapidly.
EUS2. Using the AME system after school reinforces my English proficiency.
EUS3. Using the AME system after school effectively enhances my English learning.
EUS4. Using the AME system after school helps my English learning.
EUS5. By using the AME system after school, I can learn English rapidly
EUS6. Using the AME system after school enriches my annotation content.
EUS7. Using the AME system after school considerably enhances my English learning.

**Intention to use after school**

IUS1. I intend to learn English with the AME system after school.
IUS2. I intend to accomplish English learning activities with the AME system after school.
IUS3. In English learning after school, I frequently learn with the AME system.
IUS4. Generally speaking, I am satisfied with English learning with the AME system after school.
IUS5. If possible, I will learn English with the AME system after school.