

MOBILE-ASSISTED GRAMMAR EXERCISES: EFFECTS ON SELF-EDITING IN L2 WRITING

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In this paper, we report on the development and implementation of a web-based mobile application, *Grammar Clinic*, for an ESL writing class. Drawing on insights from the interactionist approach to Second Language Acquisition (SLA), the Noticing Hypothesis, and mobile-assisted language learning (MALL), *Grammar Clinic* was designed as a series of outside-class grammar exercises in the format of sentence-level error identification and correction. 19 intermediate level ESL students at a large Midwestern American university used this mobile application in an English academic writing class during a 16-week semester. A mixed methods approach was chosen to investigate (a) the effect of *Grammar Clinic* on the efficacy of ESL students' self-editing as well as (b) their perceptions of this mobile application as a tool to improve their English writing. Our analyses show that students' performance on *Grammar Clinic* assignments reflects their progress in self-editing. This progress is seen in the positive correlation of the students' *Grammar Clinic* performance with their gains on a grammar post-test, an increase of self-editing corrections, and a reduction in errors in the final drafts of two major paper assignments. The impact of this web-based mobile application was documented using qualitative data that considered the students' use of and perception of *Grammar Clinic*.

Keywords: Web-based Mobile Application, Mobile Assisted Language Learning, Interactionist Approach to SLA, Noticing Hypothesis, Self-Editing

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INTRODUCTION

Research related to both second language acquisition (SLA) and second language writing has had as its major concern over grammatical errors in L2 writing. Accordingly, the effects of corrective feedback in L2 writing have been extensively studied (Bitchener & Ferris, 2012). Nevertheless, ESL learners' self-editing—an important self-regulatory learning step in both grammar acquisition and writing development—has not been widely investigated (Bitchener & Ferris, 2012; Diab, 2010, 2011). This study aims to fill that gap and has two purposes: (a) to outline the SLA-informed development process of a mobile application and (b) to evaluate the effect of such a mobile application on the efficacy of ESL learners' self-editing, defined as the learners' capability to identify grammatical errors and to correct them in their L2 writing (i.e., the development of their grammatical precision in academic writing). This study is situated in an intermediate-level ESL writing class that is not grammar-focused, though the needs for grammar instruction still exist. Therefore, outside-class grammar exercises—exercises that target specific errors and provide corrective feedback—serve this context well. In this paper, we report on the development and implementation of a web-based mobile application, *Grammar Clinic*, as a supplementary tool for ESL learners' self-editing activities.

BACKGROUND

The Role of Self-Editing in L2 Writing

Studies related to grammar errors in L2 writing have largely focused on written corrective feedback from teachers. However, the efficacy of corrective feedback has been challenged by Truscott, and the academic debate over the effect and use of corrective feedback continues (Ferris, 2004; Bruton, 2009; Truscott, 1999, 2007). Truscott's (1999) rejection of corrective feedback for its minor positive effects—and his assertion of potentially harmful effects—on the development of English learners' grammar competence has sparked a series of theoretical arguments and empirical studies. Recently, a number of empirical studies on both short-term and long-term effects of written corrective feedback have lent support to the proponents of corrective feedback (Bitchener & Ferris, 2012; Ferris, 2006, 2010; Sheen, 2007). Nevertheless, this does not mean that the practice of corrective feedback is without its problems.

Corrective feedback, by nature, acts as a reactive measure to highlight and address learners' weaknesses in their written production. This process can be burdensome to teachers due to time constraints and the necessity to prioritize feedback of various error types. As one potential solution, pre-emptive measures can be taken to raise learners' awareness of the typical errors made at their proficiency level, to help them avoid making the same mistakes in new pieces of writing (Long & Robinson, 1998; Ellis, Basturkmen & Loewen, 2001). At the same time, such pre-emptive measures can help complete the learning-writing-feedback-revision cycle. This is where the process of self-editing can play a role in L2 writing, because unlike passive corrective feedback, learners will be required to identify and correct errors actively in self-editing activities.

The importance of self-editing during process-based writing classes has been acknowledged by many. Recently, Bitchener and Ferris (2012) described the activity of self-editing as a source of corrective feedback, and more importantly they view the competence of self-editing as an ultimate goal of providing corrective feedback. Self-editing, a learner initiated activity, has been recognized as a critical step in L2 learners' writing and grammar development, as it facilitates acquisition processes and promotes learner autonomy (Cresswell, 2000; Fathman & Whalley, 1990; Suzuki, 2008). Polio, Fleck, and Leder (1998) studied this topic when they examined the performances of two groups of ESL learners who were given extra time for self-editing. They found that even though learners showed significant improvement across the writing assignments, both experiment groups, which received grammar review and feedback, did not perform better than the control group, which had no treatment at all in terms of developing grammatical precision in their writing. This finding demonstrates the potential of self-editing in L2 writing; nevertheless, it asks us to reconsider the effectiveness of grammar instruction used in the experiment. To investigate self-editing in terms of the effects of teachers' cues on Japanese college students' self-correction in English writing, Makino (1993) compared the performance of three groups of learners. She found that when no cues were given, learners could make limited and fewer self-corrections of grammar errors, compared with the other two groups that respectively received cues on general error location or cues with specific underlines. This further suggests that training or support of self-editing for ESL learners is necessary.

Some comparative studies focusing on self- and peer-editing have shed light on learners' actual performances during each stage of the editing process. Suzuki (2008) took a qualitative approach in examining 24 Japanese university students' self- and peer-editing processes. By analyzing verbal reports, she found that peer-editing generated more episodes of negotiation whereas self-editing resulted in more text changes focused on word choice and grammar error correction. Diab (2010) also found that peer-editing helped reduce more rule-based errors, but not non-rule-based errors, compared with self-editing practice. On the whole, these studies indicate that learners generally can notice their errors during self-editing, but that supplemental instruction or training is also needed. A tailored web-based mobile application may be one option that can provide learners with opportunities to improve their self-editing practices.

In order to help students improve the efficacy of their self-editing, we designed a web-based mobile application, *Grammar Clinic*. This pre-emptive measure was implemented in an ESL academic writing class. The design of *Grammar Clinic* was informed by principles of the interactionist approach to SLA, the Noticing Hypothesis, and mobile assisted language learning (MALL).

Designing a Mobile-Assisted Grammar Application

Grammar Clinic is an application that asks users to identify sentence level errors and to correct them. It provides instant feedback for its exercises and includes a short grammar handbook. A total of 15 common grammatical error types are identified and used in this application: sentence fragments, run-on sentences, article use, verb use, noun use, adjective use, adverb use, pronoun use, preposition use, conjunction use, relative pronoun use, punctuation use, word choice, word order, and ambiguous expressions (see [Appendix A](#) and [B](#)) for sample items and for the distribution of item types). These grammatical errors, to some extent, represent the proficiency level of this ESL class because they were identified as the most prevalent error types in a learner writing corpus developed locally using writing from the same level ESL classes. All the items were piloted in an ESL class of the same level and proofread by an experienced ESL instructor in the fall semester of 2011.

Each *Grammar Clinic* assignment consists of a set of 10 items which are selected depending on the distribution of error type, error gravity, and item difficulty. Students are required to identify the only error in each item by tapping on the error and then selecting an error type from four options (see [Figure 1](#) for *Grammar Clinic* screenshots). Once students identify the error, they are required to correct it, something that usually requires minimal input. After completing a set of grammar exercises, students see their performance report in the format of 10-point score; then, they view detailed feedback about each item. The feedback page is accompanied with a messaging function for student communication with the instructor (see [Figure 1](#)).

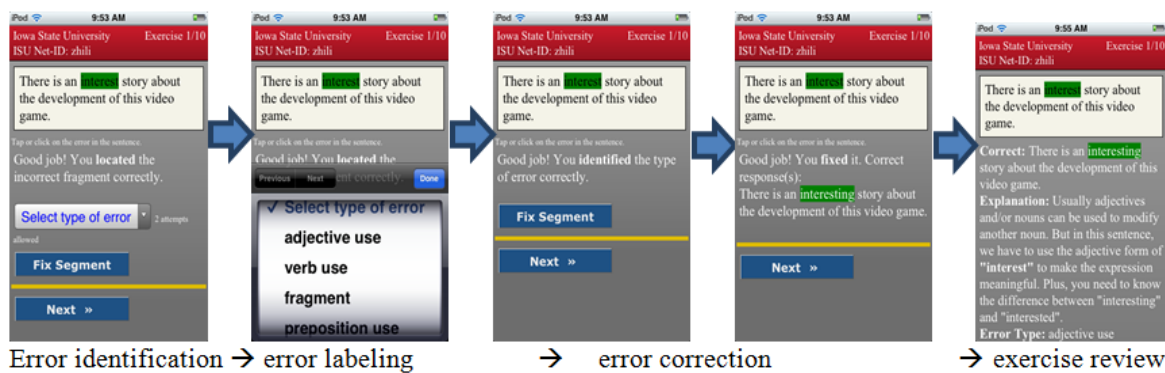


Figure 1. Grammar exercise application work flow.

Interactionist Approach to SLA and the Noticing Hypothesis

Drawing on the Input Hypothesis (Krashen, 1985) and the Output Hypothesis (Swain, 1995), the interactionist approach to SLA emphasizes the complete learning cycle, moving from input and interaction, to feedback and output (Gass, 1997; Gass & Mackey, 2007). With an expansion of the term *interaction* to *learner-computer interaction*, the interactionist theory has been widely used in computer-assisted language learning (CALL) software design and research (Chapelle, 2009; Heift, 2004; Hegelheimer & Chapelle, 2000). In CALL program design, another important theory that has been influential and that has been adapted to include modalities beyond face-to-face communication is Schmidt's Noticing Hypothesis (1990, 1993). This hypothesis states that noticing is a necessary condition for learning. We employed the principles in the interactionist approach to SLA and the Noticing

Hypothesis to guide our design of web-based mobile application in an English academic writing class.

According to the interactionist theory, input includes materials that learners should be exposed to for language development; input is typically a target like model, which provides positive evidence to learners (Mackey, 2006). Even so, input should also include negative evidence for learners, information about ungrammatical or unacceptable linguistic production (Long, 1996). The input materials in *Grammar Clinic* are extracted from a small local learner corpus, which consists of about 100 student essays from the same level of ESL classes at the same university. To keep the input material authentic, relevant, context-independent, original erroneous sentences in the corpus were modified and then used in *Grammar Clinic* item writing. Each item in *Grammar Clinic* is a complete sentence with only one grammatical error. To make the input more noticeable to learners, only one item or sentence is displayed on the screen, and the error alone is highlighted once it has been spotted by learners. This focused visual enhancement can direct learner's attention to feedback uptake and follow-up error correction (Heift, 2009).

The term *interaction* in the interactionist approach embodies the importance of a learning environment in which a learner must both interact with input and modify his or her output based on feedback. Within the interactionist approach, an interaction can be either interpersonal or intrapersonal (Chapelle, 2001; Ellis, 1999). During the process of interpersonal interaction, learners will engage in the negotiation of meaning and should notice a linguistic gap (Schmidt, 1993). In intrapersonal interaction, as in typical CALL activities, the learners' attention is guided to certain problematic aspects of linguistic materials and is prompted by computer feedback to process the materials or reconstruct their responses with cognitive effort (Chapelle, 2001; Cotos, 2011). This can be regarded as a process of negotiation of form (Heift, 2010). As *Grammar Clinic* assignments require students to identify and correct only one grammar error per item, intrapersonal interactions are developed as students only direct their attention to the potentially erroneous part of each sentence and process this information consciously.

Feedback is usually regarded as a type of negative evidence that helps learners notice the mismatch between their linguistic performance and the target model, thus facilitating their linguistic development (Bitchener & Ferris, 2012). In CALL activities, feedback can be in the form of evaluation plus explanation, following learners' intrapersonal interaction with a task on a computer or other devices. Thus, feedback serves to enhance learners' development. In *Grammar Clinic*, feedback is provided instantaneously, so that learners know whether their error identification and correction are indeed on the right track. In addition, a detailed explanation for each item is offered to assist learners in acquiring grammatical rules. A short grammar handbook has been built into *Grammar Clinic* for learners as a supplementary resource.

Output or modified output is the phase in which learners apply what they have learned from their interactions and feedback to their production (Gass, 1997). Modified output is believed to be beneficial in terms of supporting the development of the learners' automaticity in their linguistic production (Gass, 1997). Serving as a stage for modified output in the learning cycle, *Grammar Clinic* in our ESL academic writing class is embedded into the paper writing process and is immediately followed with self-editing and peer review.

Mobile-Assisted Language Learning (MALL)

With the rapid growth of mobile device ownership,¹ mobile learning—also known as m-learning—has recently become a focus of attention in education (Cho, 2009; Kukulska-Hume, 2009). Not surprisingly, mobile assisted language learning (MALL) has also attracted much attention with its perceived advantages over traditional computer-assisted language learning (CALL). *Mobility* defines this relatively new trend, which includes various aspects in a learning environment, such as mobile technology, learner mobility, mobility of content, and so forth (Kukulska-Hume, 2009). In an overview of MALL, Kukulska-Hume and Shield (2008) point out that “MALL differs from computer-assisted language learning in its use of personal, portable devices that enable new ways of learning, emphasizing continuity or spontaneity

of access and interaction across different contexts of use” (p. 273).

Despite the favorable perception of MALL, few empirical studies have focused on the effect of its mobility on learners or its potential; indeed, most existing studies related to MALL have considered vocabulary-related research (Godwin-Jones, 2011). For example, Song and Fox (2008) conducted a multiple-case study to investigate how advanced undergraduates at a university in Hong Kong used their Personal Digital Assistants (PDAs) for vocabulary learning. They found that mobile devices were used in various ways for this task. In some cases, mobile device use was integrated with computer use and thus shaped learners’ vocabulary learning activities. In Taiwan, Lu (2008) conducted a quasi-experimental study on the effectiveness of English vocabulary learning through mobile phone short message service (SMS) lessons for a group of 30 high school students. After a two-week treatment, the SMS lesson group showed more gains in vocabulary recognition as reflected in the comparison of pre- and post-tests of target word recognition. In addition, students were found to hold a positive attitude towards SMS lessons via mobile phones. Unfortunately, Lu’s delayed post-test of the same target words showed that the students did not retain many of the words learned through SMS. Stockwell (2010) compared the vocabulary learning performance and vocabulary gains from pre-intermediate learners of English, when using mobile platforms and computers/laptops. His study’s results indicate that there were no consistent differences on vocabulary activity scores or vocabulary learning improvements between the two groups.

In designing *Grammar Clinic*, we adopted the principles of mobile learning advocated by Herrington, Herrington, and Mantei (2009), which centers on the key feature of mobility. Considering the nature of academic writing and the limitations related to mobile phones’ relatively small screen size, it would not be very realistic to expect learners to write or edit a paper on mobile devices. Still, it is possible to use mobile devices for grammar learning, which in turn may contribute to improvements in writing quality. Thus, *Grammar Clinic* is designed to fit mobile devices, with the features of bite-sized and situated assignment sets, simplified user operation, optimal display setting for mobile devices, and cross-platform compatibility. *Grammar Clinic* assignments were modularized into bite-sized grammar exercises to make them more accessible and to capitalize on the mobility feature of m-learning. That is, students can use their mobile devices to finish *Grammar Clinic* assignments outside classroom whenever and wherever they want.

In light of findings from a local needs assessment of educational technology, we intentionally designed this grammar application for use on various mobile devices as a web-based application, instead of a native application for a specific type of mobile device. According to a local campus-wide survey report of technology access from Kemis, Davis, and Haen (2011), over 99% of the student respondents have cell phones, and over 69% of them own a mobile smart device capable of internet access, including iPhone/iPod Touch, Droid, Blackberry, or Windows Mobile. Given the diversity in mobile devices, we discarded the plan of developing native apps for iPhone/iPod Touch or Android platforms. Instead, we opted for a web-based mobile application for its wide accessibility to student users. By using JavaScript, CSS, and HTML, *Grammar Clinic* has a flexible layout to match various mobile device displays. This decision is in line with the design principles suggested by Kwon and Lee (2010), that is, we considered mobile display characteristics when designing the graphic interfaces and the content layout (p. 1888).²

To investigate the effect of *Grammar Clinic* on ESL students’ efficacy of self-editing and the development of their grammar precision, two research questions were considered in the implementation phase of this web-based mobile application:

1. What was the effect of *Grammar Clinic* on ESL learners’ efficacy in self-editing and on the development of their grammatical precision in paper writing?
2. How did the learners perceive *Grammar Clinic* as a learning application for academic writing?

METHODOLOGY

Implementation of Mobile-Assisted Grammar Application

To investigate the effect of using *Grammar Clinic* on students' efficacy in self-editing and to capture their perceptions of this mobile application as a tool to improve their grammatical precision in English writing, a mixed-method approach with a sequential explanatory model was taken, following Creswell and Plano-Clark (2011). Quantitative data were collected and analyzed first to describe the students' performance on *Grammar Clinic* and their improvements in self-editing. Qualitative data were then gathered to help explain quantitative findings.

Participants

This classroom-based study was conducted in an intermediate level ESL writing class. This intact class formed a convenience sample in our study as *Grammar Clinic* was integrated in the syllabus in that class and all the students were required to use this tool. There were no stand-alone grammar lessons in this course. The writing class met three times a week for the 16-week spring semester of 2012. All 19 undergraduate ESL students in this class voluntarily participated in this study, including 10 male students and 9 female students. Students' first languages included Chinese (14), Malay (2), Arabic (1), Korean (1), and Urdu (1). Student ages ranged from 19 to 22, and their length of stay at the university ranged from one to three semesters, with 50% of them being in their first semester in the United States. All participants were classified as high intermediate learners because they had met English proficiency requirements for university admission based on standardized English proficiency tests (TOEFL iBT, 71 or IELTS, 6.0). Their scores on an institutional English Placement Test (EPT) had placed them into this preparatory course of English academic writing. All students were competent users of computers and Internet services. 18 out of 19 students owned a smart phone or internet-enabled mobile device, such as iPod Touch, iPad or other tablets.

Materials

Grammar Clinic

As previously described, *Grammar Clinic* was integrated into the course syllabus as a pre-emptive measure before students started self-editing all first drafts of major course papers. Accordingly, students were required to use *Grammar Clinic* regularly as an out-of-class-assignment and external resource. Students were encouraged to use their mobile devices for the *Grammar Clinic* assignments, but they were permitted to use computers to finish the assignments. Students were permitted multiple attempts on any of the *Grammar Clinic* assignments, though the data reported here are from their first attempt of each exercise.

From a set of ESL learner performance data in a study of an automated writing evaluation tool (AWE) at this same university (Li, Lee, Lee, Karakaya, & Hegelheimer, 2011), fragment, run-on sentence, verb use, article use, and preposition use were found to be the most frequent errors among ESL learners at the intermediate proficiency level. Therefore, considering the frequency differences among various error types and the treatability of these errors, only five rule-based error types were investigated in this study, namely, sentence fragments, run-on sentences, verb use, article use, and preposition use.

Grammar Pre/Post Test

A 20-item grammar quiz was used as an in-class activity at the beginning and at the end of the semester to gauge students' development in grammatical precision. The items in the grammar quiz were in the same format as in *Grammar Clinic* assignments. They were taken from piloted *Grammar Clinic* assignments, which were not used in the spring semester of 2012. The reliability coefficients (Cronbach's alpha) for the pre- and post-test quizzes were .726 and .723, respectively, which are acceptable for a 20-item test

(Alderson, Clapham, & Wall, 1995).

Major Paper Assignment

There were four major paper assignments in this academic English writing class, a course designed to help ESL learners develop academic writing skills. These assignments included a personal essay (Paper 1), a cause-and-effect essay (Paper 2), a compare-and-contrast essay (Paper 3), and an argumentative essay (Paper 4). Starting at 400 words, the length requirement for each paper increased by an increment of 150 to 200 words. To form a longitudinal comparison of students' self-editing activity and writing accuracy—and to highlight the possible immediate and long-term effects of students' use of *Grammar Clinic*—only the first major assignment (Paper 1) and the last major assignment (Paper 4) were analyzed.

Student Questionnaire

In order to understand the ESL learner's actual use and perception of *Grammar Clinic*, an online questionnaire was implemented at the end of the semester. The perception questions were constructed either in the format of statements accompanied by a six-point Likert scale or as open-ended questions (see [Appendix C](#)). This questionnaire only elicits students' general responses (self-reports) and does not address or record students' actual behavior using *Grammar Clinic*. Records tracking user behavior could be collected either through paper-based weekly reports as in Manochehri, Gromik, and Aw (2012) or using an online behavior tracking tool.

Procedures

The ESL academic writing class in this study followed a process-based approach, which required students to go through several rounds of revision and editing, writing multiple drafts for each major assignment (see [Figure 2](#)). In all the revision and editing work students carried out, the “Track Changes” and “Comment” functions in Microsoft Word were used to record all changes. In terms of the purpose of *Grammar Clinic*, this was made clear to students at the beginning of the semester.

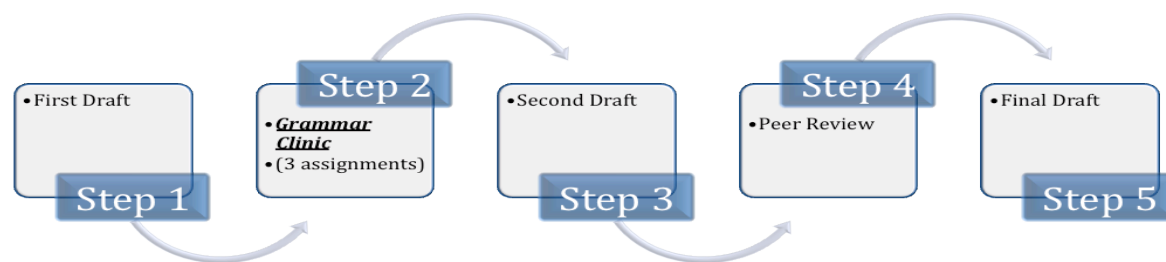


Figure 2. Paper writing process in the ESL writing class.

A short in-class demonstration of and training on the use of *Grammar Clinic* was carried out at the beginning of the semester. The instructor used an iPod Touch and a document camera to demonstrate how to open and add *Grammar Clinic* to the home screen of the students' mobile devices. The instructor explained and showed the functions of *Grammar Clinic* with a flow chart and then asked the students to explore the specific functions of *Grammar Clinic* on their own devices. The instructor also briefly repeated the demonstration throughout the first three weeks to make sure students felt comfortable using *Grammar Clinic*. *Grammar Clinic* assignments were embedded in the writing processes of the major papers. Between the first draft and second draft of each paper, students were asked to finish three sets of *Grammar Clinic* assignments on their mobile devices or computers outside class. The interval between the first and the second draft writing was usually three to four days. Peer review, which focused on content revision, was typically carried out three to five days after the completion of the second draft.

In order to answer the research questions in this study, multiple sources of data were utilized for quantitative and qualitative analyses. Students' performance on *Grammar Clinic* was automatically recorded in a server-side database and their self-editing efforts on the second drafts of two major paper assignments—Paper 1 and Paper 4—were manually coded in terms of error type and accuracy by the researchers. Qualitative data concerning students' use and perception of *Grammar Clinic* were gathered to triangulate quantitative findings in this study.

Analysis

To study quantitatively the immediate effect of *Grammar Clinic* on the ESL students' efficacy of self-editing and on their development of grammatical precision, we compared students' self-editing behavior and correction rate of self-editing in the second drafts of Papers 1 and 4. Then, to shed light on the long-term effect of *Grammar Clinic*, the learners' performance on *Grammar Clinic* was correlated with their score gains between pre and post test measurements, and differences in error rates between students' final drafts of Papers 1 and 4. Error rates for each error type were calculated using the formula suggested by Chandler (2003): $(\text{error number}/\text{essay word count}) \times 100$. Errors in students' papers were identified by the instructor of the ESL class using the same set of error codes as found in *Grammar Clinic*. A second trained rater coded 20% of the data set (Gass & Mackey, 2005). The inter-coder reliability, calculated as the complete agreement of coding, was 0.84, which is considered to be acceptable in social science studies (Neuendorf, 2002). Responses concerning students' perceptions were tallied. Their responses to two open-ended questions were identified and coded into attitudes towards *Grammar Clinic* and other concerns, which help explain quantitative findings.

RESULTS AND DISCUSSION

Learners' Performance on *Grammar Clinic*

To help them better self-regulate their grammar learning, students were permitted multiple attempts or reviews of each *Grammar Clinic* assignment during the semester. 10 out of 19 students tried to practice *Grammar Clinic* assignments more than once. This may be indicative of their effort to get a higher score on *Grammar Clinic* or to review the items. For the students who did not try multiple attempts, they may have found it unnecessary to redo items either because of low item difficulty or lack of interest. Only the scores of students' first completed attempt in each set of assignments are reported in Table 1, because scores from later attempts could be inflated due to a practice effect. As shown in Table 1, the learners generally scored higher in error identification (8.82 out of 10) and relatively lower in error correction (7.29 out of 10). This is not surprising considering that error correction usually requires productive

Table 1. Students' Performance on *Grammar Clinic*

Assignments	Error identification	SD	Error correction	SD	Overall	SD
1–3 (Paper 1)	8.28	1.52	6.92	2.28	7.60	1.55
4–6 (Paper 2)	8.62	1.12	7.44	1.27	8.03	1.04
7–9 (Paper 3)	8.79	1.05	7.03	2.36	7.91	1.34
11–13(Paper 4)	9.55	.53	7.95	1.62	8.75	.98
Total	8.82	.79	7.29	1.39	8.05	.86

Note. All scores were averages out of 10 possible points. Assignment 10 was a bonus assignment, focusing on ambiguous expressions found in the students' own writing. Assignment 12 was a special assignment, specifically focusing only on run-on sentences and fragments.

grammar knowledge and more cognitive effort (Diab, 2010). It is encouraging that students improved their Grammar Clinic performance in both aspects: error identification (from 8.28 to 9.55) and correction (from 6.92 to 7.95). However, only three comparisons show statistical significance in a series of paired sample t-tests: error identification scores for Paper 1 and Paper 4 ($t = -4.11$, 95% CI [-2.08, -0.67], $p = .001$; Cohen's $d = -1.12$), error identification scores for Paper 2 and Paper 4 ($t = -4.43$, 95% CI [-1.49, -0.53], $p = .000$; Cohen's $d = -1.06$), and error identification scores for Paper 3 and Paper 4 ($t = -3.338$, 95% CI [-1.35, -0.30], $p = .004$; Cohen's $d = -.91$).

The Effects of *Grammar Clinic*

In order to investigate the effect of *Grammar Clinic* assignments on the efficacy of learners' self-editing and the development of their grammatical precision, we examined three related sets of variables: the students' performance of self-editing on the second drafts of Papers 1 and 4, grammar pre/post-tests, and error rates in the final drafts of Papers 1 and 4.

In the ESL writing class, students were required to use the Microsoft Word function "Track Changes." All cases of self-editing³ were coded by the instructor using the same error code system as used in *Grammar Clinic* (see Appendix A). Table 2 shows the averaged occurrences of learners' self-revisions and correction rates in the second drafts of Papers 1 and 4. Among the five rule-based error types, the most frequent revision type when editing in Paper 1 is verb use (5.3), (including verb tense, verb form, and subject-verb (SV) agreement), followed by article use (1.4) and preposition use (0.9). The most frequent revision type in Paper 4 is also verb use (1.5). Article use (1.4) is another major area of self-editing. This frequency pattern, to some extent, matches the item type distribution in *Grammar Clinic* (See Appendix B), which includes 30 verb items, 20 article items, 13 run-on sentence items, 10 fragment items and 10 preposition items. It is noteworthy that the highest average occurrence of editing in Table 2 falls in the category of meaning-based revision "Rewrite" in Paper 1 (8.7) and 4 (7.9) and "Word Choice" in Paper 1 (4.9) and 4 (3.7). This high frequency of meaning-based revision reflects the students' awareness of writing as a process and their efforts to make more accurate expressions.

Comparing students' self-editing practice in Paper 1, we find that the students tended to make fewer changes in Paper 4 in general (26.2 vs. 19.5), especially in verb-related types (5.3 vs. 1.5). This may

Table 2. Students' Self-Editing in the Second Drafts of Papers 1 and 4

Editing type	Paper 1		Paper 4	
	Average occurrence	Correction rate	Average occurrence	Correction rate
Run-on sentence	0.2	100%	0.3	100%
Fragment	0.1	100%	0.1	100%
Word choice	4.9	87%	3.7	90%
Article use	1.4	85%	1.4	70%
Verb use	5.3	84%	1.5	94%
Preposition use	0.9	76%	0.7	85%
Rewrite	8.7	N/A	7.9	N/A
Total	26.2	88.3%	19.5	92.7%

Note. The error type "Verb use" includes the cases of verb tense, verb form and SV agreement in learners' self-revision process. The category of "Rewrite" consists of learners' insertions of new content, deletions of sentence(s), and/or rewriting of certain paragraphs. The category of Rewrite was not rated in this study.

suggest that the quality of the learners' fourth paper had improved by the end of the semester and that they found fewer grammar problems in their own first draft paper. This finding will be further explained in conjunction with the results of error rates in their final drafts of Papers 1 and 4. The only slight increase of self-editing occurrence is in the case of run-on sentences (0.2 vs. 0.3). A closer look at the students' revision record reveals that only two student made revisions on run-on sentences in Paper 1 and four learners in Paper 4. This suggests an increase of learners' awareness of sentence-level grammar problems.

There are also some distinct differences between students' performance of self-editing in terms of overall correction rate (88.3% vs. 92.7%). The category of rewrite was not rated in this study. Except for the categories of article use, an increase of correction rate can be found in two categories (verb tense and prepositions), while the correction rate of run-on sentence and fragment remains 100%. A series of paired sample *t*-tests were conducted in SPSS 19.0 to investigate whether there were any significant changes in the students' self-editing practices between Papers 1 and 4. Despite clear patterns shown in Table 2, no statistically significant differences were found in the comparisons of error categories.

To investigate the long-term effect of *Grammar Clinic* assignments on the development of students' grammar ability, the relationship between *Grammar Clinic* performance and grammar pre/post-test scores was also analyzed. As shown in Table 3, the means for pre-test and post-test were 8.23 and 8.79 out of 20, respectively, indicating a relatively poor performance on both tests and a small improvement from pre-test to post-test.

Table 3. Descriptive Statistics of Grammar Pre-Test and Post-Test

	Mean (out of 20)	SD	Minimum	Maximum	α
Pre-test	8.23	3.56	2.5	15.0	.726
Post-test	8.79	3.45	2.5	15.5	.723

The descriptive statistics of the two tests reveal that compared with their scores on pre-test, 11 out 19 students obtained higher scores on the post-test, whereas two students obtained the same scores on both tests and six students got lower scores at the end of the semester. Table 4 shows a series of correlation coefficients (Pearson's *r*) between the learners' performances on pre/post tests and on *Grammar Clinic* assignments. The correlation coefficients associated with pre-test scores and *Grammar Clinic* performances are low and not statistically significant. These negative correlations between averaged *Grammar Clinic* performance and pre-test scores (-.101 to -.138) suggest that two different developmental trends existed in the ESL class. Some learners who started with low pre-test scores performed well on *Grammar Clinic* assignments, whereas some learners who gained higher scores in pre-test performed poorly on *Grammar Clinic* assignments. This finding calls for a closer look at students' self-editing and revision processes.

Table 4. Correlations Between Grammar Clinic Performance and Grammar Pre-/Post Test Scores

	Identification score	Correction score	Total score
Pre-test	-.101	-.136	-.138
Post-test	.267	.051	.140
Test gains	.510*	.114	.390

Note. Test gains were obtained by subtracting pre-test scores from post test scores. *Correlation is significant at the 0.05 level (2-tailed).

It is noteworthy that learners' performance on *Grammar Clinic* assignments positively correlated with grammar post-test, even though the magnitudes are small and not statistically significant. The highest correlation in Table 4 is from averaged total identification score on *Grammar Clinic* and test gains (0.510). The positive correlations suggest that students made some progress in grammar ability.

This progress is further supported by the analysis of students' error rates in the final draft of Papers 1 and 4. As shown in Table 5, there is a decreasing tendency in the total error occurrence from Paper 1 to Paper 4 (25.8 vs. 20.0). Reductions in normalized error rate were found in three categories from the final drafts of Paper 1 to that of Paper 4: verb use (1.2 vs. 0.6), preposition use (0.3 vs. 0.2), and run-on sentences (0.2 vs. 0.05). The sharp drop of error rates in run-on sentences is very encouraging given the difficulty of this sentence-level error. This indicates that the learners may have gained a better meta-linguistic awareness and made fewer mistakes in their writing. Results of a series of paired sample *t*-test indicates that the error rate decrease in run-on sentence category is statistically significant ($p = .016$, $t = -2.65$ (18), 95% CI [-1.51, -0.17]), whereas all other differences are not.

Table 5. Error Rates in Students' Final Drafts of Papers 1 and 4

Error type	Paper 1		Paper 4	
	Average occurrence	Normalized Error rate ^a	Average occurrence	Normalized error rate
Article use	1.4	0.2	1.8	.23
Preposition use	2.1	0.3	1.6	.20
Verb use ^b	6.8	1.2	4.3	.60
Run-on sentence	1.3	0.2	0.4	.05
Fragment	1.4	0.2	1.2	.20
Total	25.8	N/A	20.0	N/A

Note. a) The error rate is calculated by (error number/essay word count) x 100. b) The error type "Verb use" includes the cases of verb tense, verb form and SV agreement in learners' self-revision process (Table 2).

Only the categories of article use and ambiguous expression show a slight increase in occurrence from Paper 1 to Paper 4 (0.2 vs. 0.23; 0.4 vs. 0.5). Article use has been recognized as notoriously challenging to English language learners to master (Ellis, Sheen, Murakami, & Takashima, 2008). In this study, students were offered a total of 20 article related items in *Grammar Clinic*. It is not surprising that no obvious progress was found in our analysis (see Table 5), given the nature of article acquisition and limited items on article use.

In this classroom-based study, we are not able to attribute directly any improvements to the use of *Grammar Clinic*, due to a lack of comparative reference (i.e., a control sample that did not use *Grammar Clinic*). There are a number of compounding factors that may have contributed to the students' improvement in their efficacy of self-editing or the development of their grammatical precision, such as collaborative learning during peer review and corrective feedback from the instructor. Future studies on the effect of *Grammar Clinic* may consider experimental design to have a better control of these confounding variables. Nevertheless, the analysis results of the students' self-editing data and error rates in the final drafts suggest an existence of both the immediate and long-term effects of *Grammar Clinic* assignments on the students' writing performance.

ESL Learners' Perceptions of *Grammar Clinic*

To better understand the effect of *Grammar Clinic* assignments on the development of students' English grammatical precision, the responses to the end-of-semester questionnaire items were analyzed. 17 out of 19 students responded to the questionnaire, representing a response rate of 89.5%, which represents the majority of the class. The first part of the questionnaire was about how students used their mobile devices and how they perceived mobile assisted language learning (MALL) in general. The responses to the question "What are the main uses of your mobile devices" indicate that 94% of the questionnaire respondents used dictionary apps on the mobile devices. Other major uses of mobile devices include texting friends or using chatting tools (82%), making phone calls (71%), using social networks (65%), listening to music (65%), and sending or receiving emails (53%). Only 41% reported using course management system such as Blackboard/WebCT/Moodle and 24% reported learning foreign languages (including English) on their mobile devices. These responses show many learners in this study did not use mobile devices as a learning platform at this point in time.

When asked whether they were willing to use their mobile devices for learning purposes such as completing *Grammar Clinic* assignments, 71% of the questionnaire respondents gave a positive answer. 82% reported that they completed *Grammar Clinic* exercises on their mobile devices mainly because it was convenient to do so. For example, a student supported his use of mobile device by saying that "we can complete *Grammar Clinic* assignment anywhere." Only three students reported that they usually used computers or laptop to finish *Grammar Clinic* assignments and one of them thought that the computer was more convenient. This reflects a different view of using mobile devices for learning, as some students may be reluctant to use mobile technology. Overall, this background information supports the potential of mobile devices as a learning platform.

In terms of other questions, in response to "Did you use *Grammar Clinic* on your own when it was not required?" only 35% of the students gave positive answers. This means that most students only treated this exercise as a regular class assignment, instead of a platform for active learning of grammar. Regarding the time spent on a single assignment in *Grammar Clinic*, 35% reported that they spent less than 20 minutes and 64% reported that they spent more than 20 minutes. This duration may include item review or grammar handbook consultancy. Originally, *Grammar Clinic* was designed to keep each assignment short so that students can complete an exercise in 10 minutes, such as on the bus. Admittedly, this is a dilemma for MALL. On the one hand, instructors and researchers alike want to keep assignments as bite-sized activities, so the application is more manageable in a relative short time period; on the other hand, they hope learners will invest more time on learning. Time management should be balanced in the future design of mobile learning applications. The way mobile applications are integrated into course syllabi can help make mobile learning a routine for language learners. Also, information about user behavior can help teachers adjust the *Grammar Clinic* assignment configuration for learners, to make assignments more focused by reducing or increasing item numbers.

The second part of the questionnaire consists of eight statements about the learners' use and perception of *Grammar Clinic*. This section used a six-point Likert scale with 1 meaning "completely disagree" and 6 meaning "completely agree." The responses to this section are summarized in Table 6. 82% of the respondents agreed that *Grammar Clinic* was easy to use on mobile devices or computers ($M = 4.8$; $SD = 1.13$). 88% of the respondents agreed that the explanations in *Grammar Clinic* item review were clear ($M = 4.9$; $SD = 0.98$). 76% of the respondents agreed that the error types in *Grammar Clinic* were very typical in their own writing ($M = 4.4$; $SD = 1.01$). In regard to the item difficulty, 41% of the respondents thought the assignments were difficult whereas 59% thought they were not difficult. This information brings the issue of item writing to our attention. When items are too easy for some learners, the learning outcome may be compromised due to the limited challenge imposed. Some detailed diagnostic analysis of the existing essays in the learner corpus may be needed to inform future item writing. Certainly, adding an adaptive item selection mechanism would be one good way to address the

potential mismatch of learner proficiency and item difficulty. This system would present an item of a certain error type and difficulty level based on learners' performance on previous item(s).

As for aspects related to user behavior, only 65% of the respondents claimed that they reviewed the explanations after finishing an assignment. The review of explanations was designed to be a metalinguistic awareness-raising activity and a grammar learning opportunity for learners. This result may have impact on the way in which *Grammar Clinic* assignments affect the outcome of the learners' self-editing. The reason why 35% of the respondents did not review the explanation was not clear. It is possible that some students found the items easy and did not need further explanation. It also could be due to some design issues. The current setting for *Grammar Clinic* item review is by assignment, instead being an on-demand review for a particular item. Some learners may have found it inconvenient to review items on the current version of *Grammar Clinic*.

Table 6. Selected Responses to Mobile Application Use Questionnaire

Statements	1 Completely Disagree – 6 Completely Agree						Disagree	Agree
	1	2	3	4	5	6	1-3	4-6
1. GC is easy to use on my mobile device or computer.	0%	0%	18%	18%	29%	35%	18%	82%
2. The feedback or explanation on GC is clear to me.	0%	0%	12%	12%	53%	24%	12%	88%
3. The error types in GC are very typical in my writing.	0%	0%	24%	29%	35%	12%	24%	76%
4. The items in GC are difficult for me.	6%	18%	35%	35%	6%	0%	59%	41%
5. I usually read the review pages after finishing an assignment.	0%	6%	29%	12%	29%	24%	35%	65%
6. The practice on GC can help me notice errors in my own writing.	6%	12%	6%	29%	35%	12%	24%	76%
7. The practice on GC can help me notice errors in the essays written by my classmates (peer review).	6%	12%	6%	29%	29%	18%	24%	76%
8. I need more instructions on grammar points in 101C class.	6%	6%	29%	18%	35%	6%	41%	59%

Other questionnaire results showed that 76% of the respondents believed that *Grammar Clinic* helped them notice errors in their own writing and in reviewing others' papers. This number is very encouraging because it shows a perceived positive effect of *Grammar Clinic* on students' writing development.

However, it is noteworthy that 59% of the students agreed that they needed more instruction on grammar points in this English academic writing class. This need may be related the lack of a stand-alone grammar teaching component in the English academic writing class. The short grammar handbook and *Grammar Clinic* assignment review may not give students a sense of formal grammar learning.

The questionnaire also considered the students' perceptions about how they were able to interact with the

different error types on *Grammar Clinic*. Students were given the list of error types used in *Grammar Clinic* and were required to check the error types that they could identify and correct in others' writing. Interestingly, the top five error types that they were confident in identifying were verb tense (82%), run-on sentence (65%), fragment (59%), word order (53%), and conjunction use (53%). However, the top five error types that they felt comfortable correcting were verb tense (53%), noun use (53%), adverb use (53%), article use (53%), and conjunction use (53%). This difference in their perceived ability of identifying and correcting certain types of error prompts us to reconsider the configuration of future assignments. The learners' perceptions of item difficulty and their actual performance should be taken into consideration when assembling future assignments.

The last section of the questionnaire included two open-ended questions eliciting students' feedback about the features of *Grammar Clinic*. Of the 18 total comments on the two questions, 10 were positive about the convenience and benefits of the *Grammar Clinic* assignments. For example, one student commented that

Mobile device is very useful and portable, but sometimes it is too small to use (for website browsing). Thus, a website like this is much better so that we can see every questions in one page and easy to write the answers. (SJ, all abbreviations are pseudonyms)

Another student WK shared his positive view on the representativeness of the items in *Grammar Clinic* assignments. He commented that "I like the sentences which are commonly used by every student. I can detect my common errors in my essay."

Other comments pertained to the functionality of *Grammar Clinic*. For example, regarding the item difficulty, SJ wrote:

Since everybody has different level of grammar skills even if we are taking the same class, the program is somehow not suitable to everybody because sometimes some grammatical errors are very easy. Thus, by making different steps or categories, it could be easy for students to recognize which part of errors are weak or need to make a progress.

Another student XS complained about the usability of *Grammar Clinic*, saying that "Once you accidentally close it you have to login in again." Overall, these suggestions and comments can help us make *Grammar Clinic* more user-friendly and hopefully more effective in promoting ESL learners' self-editing efficacy and grammar ability development.

CONCLUSIONS AND IMPLICATIONS

As with any study, some limitations emerged that we feel need to be addressed in future research. Firstly, only one group of students participated in this research. Ferris (2010) has recommended the use of a control group to investigate the effect of treatment in corrective feedback research. Secondly in this study the performances of all students were analyzed as one group. There were some important individual differences in both pre-test/post-test results and error reductions, which our procedure obscured. More qualitative methods will help investigate individual differences in user behavior and learning gains. Observation, user diary, and user behavior tracking can be implemented in future studies.

There are some areas that can be strengthened in future versions of *Grammar Clinic*. The feedback information in the current version of *Grammar Clinic* is manually prepared by the instructor. An automatic feedback system based on natural language processing techniques and the use of an academic English corpus will greatly facilitate the application's usability and maintenance. The incorporation of a grammar parser and other natural language processing-based feedback generators would help transform *Grammar Clinic* into an intelligent system that would provide customized assignments and feedback to

ESL learners (Heift 2010). Other important features of effective mobile learning should be taken into consideration, such as those suggested by Herrington et al. (2009) (e.g., multimedia environment and cooperative learning platform). The feature of a user action log could be added in the future to track students' browsing and interactive behavior. In this way, it would be possible to monitor the students' investment of time and their progress on *Grammar Clinic*. Building on this information, the assignment content and schedule adjustments could be made for learners to optimize learning. The functionality of sharing comments was not well developed and utilized in this particular ESL class, a feature which could help build a learning community and promote collaborative learning.

Despite some limitations, the analyses in this study show that the learners' performance on *Grammar Clinic* was positively correlated with their score gains between pre- and post-tests of grammar. In the learners' second drafts of two major papers (Papers 1 and 4), increased correction rates in verb use, preposition use, and word choice were found. Along with the decrease in occurrences of self-editing in Paper 1 and Paper 4, the increased correction rates indicate learners' improvement in their English grammatical precision. This finding was further supported by the decreased error rates of the final drafts of each major paper. However, the results from multiple paired-sample *t*-tests reveal that only the error rate of run-on sentences was reduced significantly from the final draft of Paper 1 to that of Paper 4.

Overall, *Grammar Clinic* is a positive example of mobile-assisted language learning as it was perceived by students as a useful learning application in an ESL writing class. *Grammar Clinic* was regarded as beneficial in helping learners raise their metalinguistic awareness and improve their self-editing ability in English writing. Continued research and development in the realm of MALL is necessary as it will help illuminate helpful factors for the development of a language learning specific application.

APPENDIX A. Error Types in Grammar Exercise Application

Error Type	Example
Adjective use	There is an interest story about the development of this video game.
Ambiguous expression	I can't understand these papers completely because my vocabulary foundation was unstable.
Adverb use	People on this island have an extraordinary different way of living.
Article use	She was having hard time because she didn't have many friends at school.
Conjunction use	The reason that those inventions are so famous is because they are so successful in serving their purposes.
Fragment	In my opinion, usually is best to take the puppy outside and play with him for a while everyday.
Noun use	Visitors can gain information about aerospace science here.
Preposition use	John chose engineering major when he attended into college.
Pronoun use	Before I came to the United States, many people told you that America was a developed country.
Punctuation use	However at last we succeeded in making a good film for all the students of the school.
Relative Pronoun use	Last summer, I travelled with my parents to Dallas where was 400 km from my home.
Run-on sentence	It was my first day in America, Ames was beautiful but too cold.
Word Choice	I could image the suffering he had gone through.
Word Order	Many people see him as a hero, no matter what ages or genders are they.
Verb use	The hi-tech education which is provided in these halls are good.

APPENDIX B. Item Type Distribution in Grammar Clinic Assignments

Assignments	Adj	Adv	Art	Conj	Frg ^a	Noun	Prep	Prn	RIPrn	Run	Vb	WC	WO	Total
1-3	3	0	4	1	2	2	2	1	2	3	8	1	1	30
4-6	3	3	2	1	0	1	4	1	1	1	12	0	1	30
7-9	2	1	9	0	5	2	2	0	1	2	5	0	1	30
11-13 ^b	0	0	5	1	3	0	2	0	2	7	5	3	2	30
Total	8	4	20	3	10	5	10	2	6	13	30	4	5	120

Notes. a) Frg = Fragment, Run = Run-on sentence, Verb = Verb form (including Subject-verb agreement, verb tense), Art = Article use, Prep = Preposition use, Adj = Adjective use, Adv = Adverb use, Noun = Noun use, Conj = Conjunction use, RelPro = Relative pronoun use, WO = Word order, Pron = Pronoun use, WC = Word choice. b) Assignment 10 is a bonus assignment focusing on ambiguous expressions in students' writing. Assignment 12 is a special assignment focusing on run-on sentence and fragment only.

APPENDIX C. Mobile Application Use Questionnaire

Mobile device using experience

1. How long have you been at Iowa State University? (including IEOP program.)
- | | |
|---|--------------------------------------|
| <input type="checkbox"/> less than 1 semester | <input type="checkbox"/> 3 semesters |
| <input type="checkbox"/> 2 semesters | <input type="checkbox"/> Other: |
-
2. Are you using any mobile devices? (a mobile device can be cell phone, personal digital assistant (PDA), tablet, electronic dictionary and etc.)
- | | |
|------------------------------|---------------------------------|
| <input type="checkbox"/> Yes | <input type="checkbox"/> Other: |
| <input type="checkbox"/> No | |
-
- 2.1. What kind of mobile devices are you using now? (including tablets, such as kindle fire, iPad. Please check all that applies.)
- | | |
|--|---|
| <input type="checkbox"/> iPhone/iTouch | <input type="checkbox"/> No mobile device |
| <input type="checkbox"/> Blackberry | <input type="checkbox"/> Tablets (iPad, Kindle Fire and etc.) |
| <input type="checkbox"/> Android mobile phones | <input type="checkbox"/> Other: |
-
- 2.2. What are the main usages of your mobile device(s)? Please check all that applies.
- | | |
|---|---|
| <input type="checkbox"/> playing games | <input type="checkbox"/> using social networks (such as Facebook) |
| <input type="checkbox"/> using dictionary | <input type="checkbox"/> shopping online |
| <input type="checkbox"/> reading stories (books, magazine and etc.) | <input type="checkbox"/> managing my schedule |
| <input type="checkbox"/> listening to music (mp3, radio) | <input type="checkbox"/> using Blackboard/Moodle/WebCT |
| <input type="checkbox"/> watching videos (e.g. Youtube) | <input type="checkbox"/> using GPS/maps |
| <input type="checkbox"/> learning foreign language | <input type="checkbox"/> viewing webpages |
| <input type="checkbox"/> making phone calls | <input type="checkbox"/> sending/receiving emails |
| <input type="checkbox"/> texting friends or using chatting tools | <input type="checkbox"/> Other: |
-
- 2.3. Would you like to use your mobile device(s) for learning purposes, for example finishing class assignments (*Grammar Clinic*)?
- | | |
|---|--|
| <input type="checkbox"/> No, I do not want to use it for assignments. | <input type="checkbox"/> I don't care. |
| <input type="checkbox"/> Yes, I am willing to use it for assignments. | <input type="checkbox"/> Other: |
-
3. Which device(s) did you usually use for *Grammar Clinic* assignments? Mobile devices or computers? Please explain your choice. If you do not have a mobile device, please put 'n/a' in the textbox.

APPENDIX C. Mobile Application Use Questionnaire, continued

4. How much time did you usually spend on ONE assignment, including reviewing feedback? (for example, assignment 3 with 10 items in it.)

- | | |
|---|---|
| <input type="checkbox"/> less than 10 minutes | <input type="checkbox"/> more than 30 minutes |
| <input type="checkbox"/> between 10 to 20 minutes | <input type="checkbox"/> Other: |
| <input type="checkbox"/> between 20 to 30 minutes | |

4.1. Did you use *Grammar Clinic* on your own when it was not required?

- | | |
|------------------------------|---------------------------------|
| <input type="checkbox"/> Yes | <input type="checkbox"/> Other: |
| <input type="checkbox"/> No | |

5. What is your impression of *Grammar Clinic* application used in this class?

Please rating the following statements based on your own experience. 1: 'completely disagree', 2: 'disagree', 3: 'somewhat disagree', 4: 'somewhat agree', 5: 'agree', 6: 'completely agree'.

- 5.1 *Grammar Clinic* is easy to use on my mobile device or computer.
- 5.2 The feedback or explanation on *Grammar Clinic* is clear to me. (The feedback or explanation is on the review pages.)
- 5.3 The error types in *Grammar Clinic* are very typical in my writing.
- 5.4 The items in *Grammar Clinic* are difficult for me.
- 5.5 I usually read the review pages after finishing an assignment.
- 5.6 The practice on *Grammar Clinic* can help me notice errors in my own writing.
- 5.7 The practice on *Grammar Clinic* can help me notice errors in the essays written by my classmates (Peer review).
- 5.8 I need more instructions on grammar points in 101C class.

6. Please check the following categories that you can IDENTIFY in editing your draft or reviewing drafts written by others.

- | | |
|---|---|
| <input type="checkbox"/> Verb use (tense, passive voice, linking verb and etc.) | <input type="checkbox"/> Run-on sentence |
| <input type="checkbox"/> Noun use (plural form) | <input type="checkbox"/> Fragment |
| <input type="checkbox"/> Word Choice (wrong word class, ambiguous expression) | <input type="checkbox"/> Adjective use (comparative form) |
| <input type="checkbox"/> Preposition use (wrong or missing preposition) | <input type="checkbox"/> Adverb use |
| <input type="checkbox"/> Pronoun use (unclear pronoun) | <input type="checkbox"/> Word Order |
| <input type="checkbox"/> Conjunction use (wrong conjunction) | <input type="checkbox"/> Article use (missing or wrong article) |
| <input type="checkbox"/> Relative pronoun use | <input type="checkbox"/> Punctuation use |
| | <input type="checkbox"/> Other: |

APPENDIX C. Mobile Application Use Questionnaire, continued.

6-1. Please check the following categories that you can CORRECT in editing your draft or reviewing drafts written by others.

- | | |
|--|---|
| <input type="checkbox"/> Verb use | <input type="checkbox"/> Fragment |
| <input type="checkbox"/> Noun use (plural form) | <input type="checkbox"/> Adjective use (comparative form) |
| <input type="checkbox"/> Word Choice | <input type="checkbox"/> Adverb use |
| <input type="checkbox"/> Preposition use | <input type="checkbox"/> Word Order |
| <input type="checkbox"/> Pronoun use (unclear pronoun) | <input type="checkbox"/> Article use (missing or wrong article) |
| <input type="checkbox"/> Conjunction use (wrong conjunction) | <input type="checkbox"/> Punctuation use |
| <input type="checkbox"/> Relative pronoun use | <input type="checkbox"/> Other: |
| <input type="checkbox"/> Run-on sentence | |
-

7. Can you talk about the features in *Grammar Clinic* that you like and dislike?

8. Do you have any other comments or suggestions on *Grammar Clinic* exercise and/or 101C class teaching in general?

NOTES

1. The term “Mobile devices” in this article refers to any internet-enabled handheld device that has a capability of using internet services. Typical mobile devices include personal digital assistant (PDA), smart phones, and tablets.

2. Though a detailed account of technicality issues is beyond the scope of this paper, interested readers can find more information about web-based mobile application development in Firtman (2010) and Stalk (2010).

3. In our analysis, students’ revision behavior was also included in [Table 2](#) to present a more comprehensive picture of students’ effort in writing process. However, only the term “self-editing” is used for terminology consistency.

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