Organization and Development of Computer-Assisted Writing: A Case of Part-Time English Majors in Taiwan

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***Abstract*—Much research on automated writing evaluation (AWE) has been centered on psychometric issues, especially its validity, mostly by program developers. Most studies regarding AWE conducted in Taiwan have been concerned with college students' perceived effects of using AWE programs for improving English writing. However, little research has been carried out on real gains in various aspects of student writing, especially in the aspect of organization. Therefore, the purpose of the study was to find out changes in discourse elements of learner essays before and after AWE use. The research was designed as a case study, wherein a class of part-time English majors from a university of science and technology in northern Taiwan participated in this yearlong investigation. Findings showed students' significant improvement in revising main points, supporting ideas, and conclusion elements. Besides, background and thesis elements in the student essays might need writing teachers' more attention.**

***Index Terms*—automated writing evaluation, computer-assisted writing, second language writing, self-regulated learning**

I. Introduction

The rapid development of computer technology within the last two decades has made writing as a way to communicate with people more important than ever before. The ability to write well in English as a lingua franca for communication across diverse cultures has become an imperative in second/foreign language education. However, the heavy workload of grading vast numbers of repeated drafts of student writing is a hindrance to the teaching of second/foreign language writing. In order to reduce writing teachers' workload and provide instant scores along with feedback, a demand for computer-assisted language learning is increasing around the world, and in Taiwan as well. Although the validity of automated writing scoring systems still remains contentious (e.g., [1]-[6]), the efficacy of diagnostic feedback seems pedagogically appealing for formative learning [7].

So far, much research on Automated Writing Evaluation (AWE) has been centered on psychometric issues, especially its validity, mostly by program developers (e.g., [8]-[11]). Most studies regarding AWE conducted in Taiwan have been concerned with college students' perceived effects of using AWE programs for improving writing (e.g., [7], [12]-[15]). However, little research has been carried out on real gains in various aspects of student writing, especially in the aspect of organization (For an overview, see [16]). Therefore, the purpose of the present study is to find out the changes in organizational structure before and after AWE use. Accordingly, the objectives of the research are as follows:

1) To find out changes in discourse elements from first to last submission of an essay in relation to automated feedback
2) To understand the difference between the actual and optimal development of student writing

In addition, suggestions regarding writing pedagogy will also be provided.

The next section will offer a sketch of *Criterion*, an AWE program used in this study, which will be followed first by a brief review of relevant literature and then by a description of the method used. This will then be followed by a discussion of results and finally concluded with the implications of findings.

II. A Sketch of Criterion

Criterion is a web-based AWE program with the essay scoring engine *E-rater* developed by Educational Testing Service (ETS). *E-rater* was developed in the 1990s with a primary function of scoring online student essays and has been used to score the essay portion of the Graduate Management Admissions Test (GMAT) along with a human rater since 1999 [17]. It provides holistic scoring on a 6-point scale, with 6 being the highest score and 1 the lowest. A score of 6 indicates an excellent essay, which develops ideas well with specific, relevant details, is well organized with transitions, exhibits varied sentence structure and many specific word choices, and contains little or no errors in grammar and conventions, whereas a score of 1 means an unsatisfactory essay, which exhibits no control over organization and sentence structure, contains inaccurate word choices and errors in grammars and conventions throughout the essay, and is extremely brief.

Along with holistic scoring, *Criterion* offers diagnostic feedback in five main writing aspects. The Natural

Manuscript received May 25, 2015; revised October 8, 2015.

doi: 10.18178/ijlt.1.2.110-115

Language Processing (NLP) techniques in *E-rater* accompanied by *Critique* writing analysis tools allow *Criterion* to make a broad range of linguistic diagnoses and offer individualized feedback not only on grammar, usage, mechanics, and undesirable style, but also on discourse elements [18]. Table I describes the five feedback aspects.

The program can also allow for multiple revisions and editing. Furthermore, various online writing resources (e.g., *Make a Plan* and *Writer's Handbook*) and editing features (e.g., *Grammar Check* and *Error Report*) have made it not only an essay assessment device but also a writing assistance tool, and even a writing learning object. Learners can thus make use of the computer-generated assessment results and diagnostic advice to help them write and revise their essays as many times as they need autonomously for self-regulated learning [19], [20]. However, only first and last submissions are stored in the system.

III. Review of Relevant Literature

Studies on AWE might fall roughly into two categories: those by program developers and those on program users. On the part of program developers, much research has been centered on its validity as well as credibility (e.g., [5], [21]), as mentioned in the introductory section. On the other hand, most studies on program users have been concerned with learner' perceptions of AWE programs in improving their English writing, especially in Taiwan (e.g., [7], [12]-[15]). In this section, the review of literature will focus on the latter in the following two respects: learner' perceived effects of AWE programs as well as changes in various aspects of student writing before and after the use of AWE programs.

TABLE I. *Criterion's* Feedback Analysis

Aspect	Error/Comment
Grammar	Fragment or missing commas, run-on sentences, garbled sentences, subject-verb agreement, ill-formed verbs, pronoun errors, possessive errors, wrong or missing words, proofreading
Usage	Wrong articles, missing or extra articles, confused words, wrong form, faulty comparisons, preposition errors, nonstandard verbs or word form
Mechanics	Spelling, proper noun capitalization, missing initial capital letter in a sentence, missing question mark, missing final punctuation, missing apostrophe, missing comma, hyphen error, fused words, compound words, duplicates
Style	Repetition of words, inappropriate words or phrases, sentences beginning with coordinating conjunctions, too many short sentences, too many long sentences, passive voice
Organization and Development	Thesis statement, main ideas, supporting ideas, conclusion, transitional words and phrases

A. Learners' Perceived Effects of AWE Programs

Reference [7] showed advanced English learners' dissatisfaction with the computer-generated score as well as feedback. According to a questionnaire survey, none of the respondents showed agreement regarding the adequacy of automated scores, while about half of the respondents considered the AWE feedback to be of no help. The reasons that the students gave for such negative attitudes toward the automated assessment were due to four major problems with the scoring system: favoring lengthiness, overemphasizing the use of transition words, ignoring coherence and content development, and discouraging unconventional writing styles. On the other hand, one important reason for learners' dissatisfaction with the automated feedback lay in the fact that it failed to provide specific guidance to help them revise their essays, particularly concerning the content. Reference [7] also revealed that the autonomous use of the AWE program *My Access* as a surrogate writing teacher with minimal human facilitation caused frustration to students with advanced English proficiency and limited their learning of writing. Reference [7] finally concluded with a suggestion that with limitations inherent in the design of AWE software, instructors needed to be more cautious about the implementation of the technology in their writing pedagogy.

Reference [12] also revealed more advanced language learners' less favorable attitudes toward the scores and feedback of the AWE program *My Access*. It was found that only 13% of the student users thought the scores were appropriate, while over half of the students felt uncertain about the scores. Moreover, when asked about what they did not like about the program, 37 out of the 59 responses were related to the score and feedback. According to [12], the AWE program was helpful only when students, in particular with intermediate language proficiency, wrote in fixed formats or writing modes. On the other hand, it was also found that the more frequently the learners used the program, the more positive they tended to feel about it. Since only few students with strong motivation or good learner autonomy could keep writing till the end of the program trial period, reference [12] then concluded with a suggestion of incorporating the online essays into class assignments and counting them in the final grades.

In contrast, such technological use might produce different effects on students with different language proficiency levels such as intermediate learners or beginners. Reference [13] showed intermediate English learners' favorable attitudes toward the use of the AWE program *My Access* as an instrument for writing but less positive attitudes toward its use as an essay grader. The interview data in [13] also revealed that the automated feedback had a positive effect on writing skill development, especially in language form rather than content. Besides, 8 out of 9 interview participants suggested that the AWE program could be utilized in future writing classes.

Similar results were also found in reference [14] that intermediate English learners preferred the AWE program *Criterion* as a formative assessment tool to facilitate writing to that as a summative essay assessment device. 78% of the respondents felt it helpful to use the automated feedback analysis, whereas only 28% of the respondents had trust in the computer-rated score.

Reference [15] reported on a case study of lower-intermediate English learners' autonomous use of a web-based writing program, *Criterion*. It was found that learners with lower language proficiency tended to have positive attitudes toward the use of AWE programs as both a formative learning tool and a summative essay grader. Besides, the majority of the learners also agreed that the program could help them improve the organization of their writing. Furthermore, reference [15] also indicated that the instructor's positive attitude toward the AWE use might be a key factor to the results.

In brief, the perceived effects of AWE programs used to facilitate learning might vary according to learners' language proficiency. While advanced language learners tended to hold a negative attitude toward the use of AWE systems as a whole, learners with lower language proficiency tended to have positive attitudes. Besides, intermediate learners prefer AWE programs as a formative writing tool to those as a summative essay grader.

B. Aspects of Student Writing before and after AWE Use

Reference [22] investigated whether the feedback report of the AWE program *Criterion* was helpful for learners, 6th to 12th graders in the US during the 2002-2003 school year, in subsequent revisions of their essays. It was concluded that the learners were able to understand and attend to a variety of error types to some significant extent.

Reference [23], on the basis of [22], investigated changes in various aspects of essays written by lower-intermediate English learners before and after the use of the AWE program *Criterion*. The results showed a significant decrease in the error rates from first to last submissions, especially in the aspects of grammar and usage. Furthermore, the findings also revealed that the extent of the different error types varied considerably. In [23], repetition of words and missing articles were two most common errors for college students in Taiwan, which were found in 95% and 78% of the essays, respectively. However, negation errors, missing apostrophes, and inappropriate words or phrases were not found at all. Nevertheless, the aspect of organization was not examined in [23].

Part of reference [22] was devoted to the analysis of discourse elements. A micro-level analysis of particular organizational elements was conducted in [22] on the basis of the five-paragraph essay strategy adopted in *Criterion*. Table II presents the findings from [22], which shows learners' significant improvement in the background, main points, supporting ideas, and conclusion elements from first to last submissions, though with small effect sizes (for effect sizes, see [24]).

Additionally, an overall development score was also presented in [22], which was defined as the sum of the development elements, namely an introductory paragraph, a three-paragraph body (three paragraphs, each containing a single main point and supporting idea pair) and a concluding paragraph. It could be interpreted as the difference between the actual and optimal development. Thus, a score of -3.07 obtained from the computation, as shown in Table III, means that at least three required elements were absent. In other words, there was discrepancy between optimal and existent development.

As already mentioned in the introductory section, little research has been conducted on real gains in various aspects of student writing by comparing the results of computer-generated feedback before and after AWE use, especially in the aspect of organization, to which more attention needs to be paid. The analysis of the current research is based on [22].

TABLE II. DESCRIPTIVE STATISTICS FOR DISCOURSE ELEMENTS [22]

Element	Range of values	Mean in first submission	SD in first submission	Difference between last and first sub.	Effect size
Background	0-1	0.55	0.55	0.09	0.18
Thesis	0-1	0.79	0.40	-0.01*	-0.03
Main Point	0-3	1.78	1.13	0.34	0.30
Supporting Ideas	0-3	1.76	1.13	0.34	0.30
Conclusion	0-1	0.60	0.49	0.14	0.28
Other	0-	0.32	0.47	0.02	0.04

Note. Main point elements were restricted to three different elements per essay. Supporting ideas elements were counted only when they immediately followed a main point element. Effect size is defined as difference divided by the standard deviation of first submission. *The Wilcoxon signed-ranks test was not significant at the .01 level, two-tailed.

TABLE III. DESCRIPTIVE STATISTICS FOR OVERALL DEVELOPMENT SCORE [22]

	Mean in first submission	SD in first submission	Difference between last and first sub.	SD of difference	Effect size
Development	-3.07	2.56	0.79*	1.91	0.31

Note. Effect size is defined as difference divided by the standard deviation of first submission. *The Wilcoxon signed-ranks test was significant at the .01 level, two-tailed.

IV. METHODOLOGY

A. Participants

This research was designed as a case study, wherein a class of 44 college students enrolled in the evening session of the Applied Foreign Languages department in a university of science and technology in northern Taiwan was under investigation. They were fourth-year English majors. Their English language proficiency was mostly at the lower-intermediate level according to a pretest. They were taking the required senior year writing course and using the AWE program *Criterion* during the first and second semesters of academic year 2011-2012.

B. Procedure

The instructor implemented the use of *Criterion* as an integrated part of her writing pedagogy. She associated the essay genres of in-class writing drills first with those of take-home writing assignments and then with those of midterm and final examinations. The program was used for formative learning though it also served as a summative assessment tool for midterm and final examinations with a score of 4 set as a pass threshold, which indicates that the essay achieves a "sufficient" level of communicating the writer's ideas. Besides, the instructor counted the automated scores as part of the students' actual grades, which suggests that she might have confidence that the automated scores were able to reflect students' writing performance to a reliable extent. She also allowed the students to take advantage of the automated feedback to help them reduce errors and problems in grammar, language use, and organization during their revision process even in the midterm and final examinations, which implies that she seemed to trust such feedback to be able to provide sufficient and useful information in guiding students to improve their writing. Thus, the students should be highly motivated to write multiple drafts using the program for autonomous learning.

C. Data Collection and Analysis

Data used in this study were collected from the aspect of *Organization and Development* in the feedback report of *Criterion*, wherein organizational elements of student writing drafts were highlighted in different colors. Identified discourse elements fall into five categories: *Introductory Material*, *Thesis Statement*, *Main Ideas*, *Supporting Ideas*, and *Conclusion*. In addition, elements that cannot be identified and categorized into the five categories are classified as *Others* in the program such as fragments, missing punctuations, or run-on sentences.

The students worked on their writing assignments independently with the AWE program as formative learning. The instructor's involvement in the students' writing process was minimal, only with little consultation. The data collected included 410 student essays, which were composed of 201 essays in the first semester and 209 in the second semester. Of these, 308 (or 77%) were submitted more than once: 171 (or 85%) in the first semester and 137 (or 66%) in the second semester. This suggests that most students did make good use of the revision capabilities of *Criterion*. For the purpose of the study, only essays with more than one submission were included in the analysis.

An analysis of particular discourse elements was conducted on the basis of [22] according to the five-paragraph essay strategy adopted in *Criterion*. Effect sizes of the difference between first and final submissions were also computed.

V. Results and Discussion

Results will be discussed in terms of the two research objectives mentioned in the introductory section, namely 1) to find out changes in discourse elements from first to last submission of an essay in relation to automated feedback; and 2) to understand the difference between the actual and optimal development of student writing.

TABLE IV. Descriptive Statistics for Discourse Elements (First Semester)

Element	Range of values	Mean in first submission	SD in first submission	Difference between last and first sub.	Effect size
Background	0-1/0-1	0.50	0.50	0.15*	0.29
Thesis	0-1/0-1	0.66	0.47	0.02	0.05
Main Point	0-9/0-9	1.41	1.47	0.80*	0.54
Supporting Ideas	0-10/1-11	1.88	1.38	0.80*	0.58
Conclusion	0-2/0-1	0.41	0.50	0.31*	0.61
Other	0-1/0-1	0.09	0.28	-0.02	-0.08

Note. The range of values includes those in the first and last submissions. Effect size is defined as difference divided by the standard deviation of first submission. *The t-test was significant at the 0.05 level, two-tailed.

TABLE V. Descriptive Statistics for Discourse Elements (Second Semester)

Element	Range of values	Mean in first submission	SD in first submission	Difference between last and first sub.	Effect size
Background	0-1/0-1	0.51	0.50	0.04	0.07
Thesis	0-1/0-1	0.69	0.46	0.01	0.02
Main Point	0-8/0-9	2.20	1.77	0.47*	0.27
Supporting Ideas	0-10/0-9	2.60	1.78	0.47*	0.27
Conclusion	0-2/0-2	0.55	0.51	0.20*	0.40
Other	0-2/0-2	0.04	0.24	0.01	0.03

Note. The range of values includes those in the first and last submissions. Effect size is defined as difference divided by the standard deviation of first submission. *The t-test was significant at the 0.05 level, two-tailed.

TABLE VI. DESCRIPTIVE STATISTICS FOR OVERALL DEVELOPMENT SCORE (TWO SEMESTERS)

Semester	Mean in first submission	SD in first submission	Difference between last and first sub.	SD of difference	Effect size
First	-3.64	3.06	1.94*	3.73	0.63
Second	-1.96	3.64	1.16*	2.82	0.32

Note. Effect size is defined as difference divided by the standard deviation of first submission. *The t-test was significant at the 0.05 level, two-tailed.

A. Research Objective 1: To Find out Changes in Discourse Elements from First to Last Submission

Table IV and Table V present individual discourse elements of student essays for the two semesters respectively. As already mentioned, the *Organization and Development* module of *Criterion* identifies background (introductory material), thesis, main points, supporting ideas, and conclusion discourse elements, and it also labels word sequences as other if they cannot be recognized. Concerning effect sizes, an effect size of 0.2 to 0.3 is regarded as a "small" effect, around 0.5 as a "medium" effect, and 0.8 to infinity as a "large" effect [24]. Thus, the findings of this study indicate the students' significant improvement in main points, supporting ideas, and conclusion elements with medium effect sizes and in background with a small effect size, as shown in Table IV. Additionally, a negative difference is expected for other elements if the feedback has a positive impact. Table V reveals that although the effect sizes of the five main discourse elements are not as large as those in the first semester, higher means of especially main points, supporting ideas, and conclusion elements indicate better organized drafts in the second semester.

B. Research Objective 2: To Understand the Difference between the Actual and Optimal Development of Student Writing

Table VI presents development scores for the two semesters, which can be interpreted as the difference between the actual and optimal development. According to [22], a development score is defined as the sum of 8 development elements. Thus, a score of -3.64 indicates that at least three elements on average were absent from student essays in the first semester, and a score of -1.96 means that about two elements were absent in the second semester. This further suggests students' improvement from first to second semesters. Besides, the differences in element occurrence between the first and last submissions were significant with medium and small effect sizes for the two semesters (0.63 and 0.32, respectively). This also confirms the significant effects of computer-assisted revision on student essays and improvement in organization.

The results of this case study might be limited to these participants. However, generalization can be made to English writing learners who have similar backgrounds and can be suggested to writing instructors.

VI. CONCLUSION

This paper has reported on an investigation of the organizational structure of college students' English compositions through a web-based AWE program, *Criterion*, with which little research has been concerned. Two research objectives mentioned in the introductory section have been achieved. The findings from the investigation showed students' significant improvement in revising main points, supporting ideas, and conclusion elements. However, students' writing background and thesis elements in the introductory paragraph might need instructors' more attention. The present study has attended to part-time students, who are mostly academically low achievers in Taiwan. It is of the hope that the goal of lifelong learning can possibly be achieved through their successful experience in writing and revising their English essays autonomously through the AWE program.

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