

# On Corpus Preparation and Deployment of a Web-based Critiquing System for English Essay Writing Enhancement

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**Abstract.** This paper describes the use of a web-based Essay Critiquing System and its integration into a series of composition workshops for a group of secondary school students in Hong Kong. It begins with a review and application of the hybrid learning approach, followed by a description of a methodology for corpus preparation and the distributed computing architecture for the system. Then, it explicates the way in which the system is integrated into a writing pedagogy implemented in the workshop and the feasibility evaluation result. The positive result confirms the benefits of hybrid learning.

## 1 Introduction

English is taught as a second language for students in Hong Kong. Among the four language skills, writing seems to be difficult to many second language students and they feel stressful in composition lessons. They have either difficulty in generating ideas to have a good coverage of the composition topic or insufficient time to well organize their ideas and thoughts within the lessons. Although process writing has been practiced for some time and teachers are encouraged to give feedback to students' writing drafts, they also find it stressful to provide immediate individual formative feedback within a lesson, especially when the class size is large. To alleviate this learning and teaching barrier, we developed a web-based system called Essay Critiquing System (ECS). ECS makes use of an automatic text analysis technique known as Latent Semantic Analysis (LSA) to give students just-in-time feedback for reflecting on the essay content and organization of ideas. Based on the feedback, students can further revise their drafts independently and repeatedly until they find their essays good enough to be submitted to teachers for grading. We believe that it is an effective way to challenge and encourage students to revise their essays' contents and organization. This teaching mode is related to hybrid learning as we integrate both the online composition learning process using ECS and face-to-face meetings in which the teacher reviews the submitted drafts, provides written and/or verbal feedback to the students, and grades the final drafts.

In this paper, we first give a review of hybrid learning and LSA in learning. Following a brief overview of the essay critiquing system, we present in detail the methodology for preparing the corpus to be used by the critiquing system, and a three-tiered architecture we adopted that makes the system scale well to meet the analysis need. Finally, we describe the integration of ECS into a process approach to teaching composition and the preliminary results of the feasibility evaluation.

## 2 A Brief Review of Hybrid Learning

Learning in contemporary education relies on various media and channels for achieving a rewarding result. More and more courses are designed with a hybrid learning environment that facilitates interactive learning. Hybrid learning refers to the learning that blends online and face-to-face delivery in which substantial proportion of the content or activity is delivered or carried out online [18].

Hybrid learning generates mixed results. An interesting study conducted on a hybrid college course at Appalachian State University showed that a class taught via both face-to-face and online channels (using WebCT) had almost the same pass and drop-out rates as those of a class taught solely face to face [8]. Apart from it, a hybrid learning net was adopted to optimize the learning experience of students who received executive management education that combined both in-class learning and online learning [6]. The network makes use of the Internet for content delivery and includes functions to support faculty-to-student and student-to-student interactions. The adoption of hybrid learning was regarded as a cost-effective measure to operate the programme.

Hybrid learning has been applied to lower level education and its results are encouraging. A study focusing on exploring the nature of online learning in K-12 schools was conducted by Picciano and Searman [18], where online learning was found growing in K-12 schools together with the trend of using electronic technologies to support that group of students. As reported in the study, potential challenges could be shortage of teachers with sufficient experience in adopting online tools in K-12 schools, especially those located in rural regions.

According to [20], the main objective of hybrid learning is to provide an opportunity to allow students to be more engaging in the learning process. It can also facilitate students to drive the learning process directly and make learning become more autonomous. The Internet is used to deliver and mediate the learning process. It is expected that the combination of this online experience and face-to-face contact between students and with instructors can lead to a meaningful and valuable outcome to all involving parties. Sife et al. [21] also suggested other benefits of adopting information communication technologies in education. They include more convenient information access, synchronous and asynchronous learning, more effective communication, improved collaboration and cooperation, etc. In addition, many research projects have demonstrated that the adoption of online or virtual learning practice for facilitating face-to-face learning can result in an enriched education environment [16, 19].

### 3 Applications of Latent Semantic Analysis in Learning

Latent Semantic Analysis (LSA) is a mathematical technique for computing the semantic similarity between pieces of textual information (for example, sentences, paragraphs or essays) with the help of a large corpus [11, 12], and is commonly used to support learning. It works out a matrix showing the co-occurrence of terms and texts. In LSA, a 'term' means any word that appears in more than one text. The matrix takes into consideration of the occurrence frequency for a term in a single text and the occurrence frequency across texts.

LSA is commonly used to support the tutoring aspect in education [13, 23]. It is adopted by Summary Street, an educational software system for assisting writing and revision activities [5]. A main function of this system is to provide feedback on a student summary to see whether the summary covers important source content. Trials were conducted with the system and the results showed that the system is useful especially when students work with a summary for a harder text.

LSA has also been adopted in the development of an automated essay grader [5] and critic, and was found to be able to score as accurately as human in the study. They implemented the tool for an undergraduate course and found that there was improvement in writing as students could write and revise the essays online. Apex is yet another system that adopts LSA to help assess a student essay based on its content. Their experiments showed that there was a significant correlation between the human grades and the Apex grades. That is, using Apex for essay evaluation could generate similar outcomes as graded by human [14].

LSA is also found applicable in contexts other than education. An experiment was conducted to filter SPAM e-mails by adopting LSA [15]. In another study, LSA was used as one of the methods to infer the semantic orientation of a word [22]. 3596 words that have been labeled as positive and negative manually were used in the study to test how LSA could identify the semantic orientation. It is expected the method can support analysis on online discussion, survey, chat system in text filtering, text classification, and opinion tracking. In bioinformatics, LSA was adopted for protein remote homology detection [3]. "Words" of "protein sequence language" was created to represent several basic building blocks of protein sequences and a matrix was developed accordingly. LSA was then performed on the matrix to find out the latent semantic representation vectors of protein sequences. Results of the study showed that the adoption of LSA can significantly improve the performance of remote homology detection when compared with basic formalisms.

### 4. A Critiquing System for Essay Writing

In view of integrating online means into English writing courses for obtaining more fruitful results, a web-based essay critiquing system that uses a text analysis technique known as latent semantic analysis has been proposed in [2,24] with some promising results reported. For the reason of completeness, we briefly present the ECS in this section. More details can be referred back to [2].

ECS contains teacher input, student input, database that stores student answers and reference materials from external sources, text segmentation and preprocessing engine, LSA engine, semantic matcher and critic feedback to students. Generally speaking, the teacher decides on an essay topic for students, and collects some relevant background materials of the topic such as articles from the Internet resources or textbooks to build a corpus. Then, a list of possible sub-themes which may be included in the essay is extracted from a set of sample essays, which can be some good student essays of past years or model essays from some books. Before feeding the training data into the LSA engine, all articles are first broken down into sentences and preprocessed, e.g. stop-word removal and stemming. Then the LSA engine computes the word-segment association matrix and the semantic similarity between all possible pairs, one from the student essay and the other from the sub-theme list extracted from good samples. When it is completed, the sub-themes on the list that are found missing in the students' essays can be identified. The final step is to determine the missing sub-themes to be reported to students for their consideration when revising their essays. Also, the texts in the student essays that match against one of the sub-themes of the sample essays are highlighted in color along with a sentence describing the sub-theme. This can help students take a new look at the organization of their essays.

## 5 Corpus Preparation Methodology

Since LSA is a statistical method, its performance depends very much on the size and the quality of the corpus prepared for the analysis. According to our experience, the corpus preparation step is one of the most crucial ones for the critiquing system to provide accurate feedback.

As described in [2], our web-based critiquing system needs (1) a set of sub-themes which are related to the essay topic, (2) good essay samples with sentences matched with those sub-themes marked, and (3) relevant but unmarked articles. Both (1) and (2) can be completed with teacher's assistance whereas (3) is obtained from the Web.

The detailed steps for preparing the corpus of the critiquing system are shown in the following.

1. Prepare a stop list which includes a number of common or meaningless words like articles, pronouns, numbers, etc.
2. Prepare a set of good essay samples written by some old students, where careful spell-check is normally needed.
3. Create a list of sub-themes by carefully scanning the essay samples.

For example, for a topic "*More and more married couples in Hong Kong choose not to have their own children nowadays. Do you support their choice? Use specific reasons and examples to support your opinion.*", the titles of the sub-themes could be

- a. Women's independence
- b. Career consideration
- c. Economic consideration
- d. Change of lifestyle

4. Go through each sentence of each essay sample and marked the phases which are related to different sub-themes manually.

For instance, based on the aforementioned example, the matched phases to each of the sub-themes are as follows: (the indices shown at the end of each phrase indicate from which documents the phrases come.)

- a. Women's independence
  - women's independence. [c1.doc]
  - can find a job. [c1.doc]
  - better education. [c1.doc]
  - women don't want to marry. [c1.doc]
  - women don't want to marry just for a baby. [c1.doc]
- b. Career consideration
  - forgo the job. [c1.doc]
  - love working instead of taking care of a baby. [c1.doc]
  - discourage mothers from returning to work. [c1.doc]
  - career opportunities. [c11.doc]
  - do not want their staff to be pregnant. [c11.doc]
  - a problem for the one who is working. [c11.doc]
- c. Economic consideration
  - child care is expensive. [c1.doc]
  - expense. [c10.doc]
  - economy. [c11.doc]
  - price level is very high. [c11.doc]
  - spend a lot of money. [c11.doc]
  - economic development. [c12.doc]
  - economic difficulties. [c13.doc]
- d. Change of lifestyle
  - have a peaceful life. [c1.doc]
  - peaceful life style. [c1.doc]
  - childlessness becomes a new lifestyle. [c1.doc]
  - enjoy current lifestyle. [c10.doc]
  - wouldn't enjoy life. [c10.doc]
  - prefer leisure time. [c10.doc]
  - prefer to enjoy their own lives. [c10.doc]
5. Collect relevant texts from the Web and marking is not needed. According to our experiments, the total number of words of a corpus to be good enough for our application usually falls between 20,000 to 40,000.
6. Treat each sub-theme and each sentence of the texts collected from the Web to a 'document'. Apply the stop list for stop word removal. Use WordNet as a dictionary for stemming, compute the term-document matrix as described in [2] and then apply the LSA<sup>1</sup>. Then, for each sub-theme, remove the terms with the

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<sup>1</sup> In our implementation, the singular value decomposition (SVD) step needed by LSA is performed using the Matrix Toolkits for Java (MTJ) which support structured sparse matrix computation.

highest scores because these words are less discriminative in general. Also, remove the words which appear in more than 80% of the sub-themes. After that, store the results in binary format. Regarding the size of the corpus we have collected, this step takes around 30 minutes. In many cases, we find that some parameter tuning for those thresholds and the reduced dimension of LSA can help further improve the system accuracy.

In principle, one can follow the six steps to have a corpus prepared for an essay topic to be released to the students. We have tested the methodology for more than five different topics. We found that Steps 3 and 4 are not mechanical and one may need to iterate the two steps before a satisfactory performance of the critiquing system can be obtained. The main causes include (1) insufficient sub-theme coverage of the essay samples, and (2) indistinguishable sub-themes initially created by the teacher. For the former, we need to create some additional phrases and associated them to the sub-themes which lack a sufficient number of related phrases. For the latter, we need to review the phrases matched to them and see if some needed to be merged or split. Given our observations, we are currently studying if some automatic phrase clustering scheme can be derived so as to further reduce the time and effort required to create the sub-themes and mark the related phrases.

## **6 A Three-tiered Architecture for Just-in-time Feedback Support**

With the corpus carefully prepared and tested, the teacher can release the topic to the students to work on in class. Students write essays using Microsoft Word and submit their drafts to ECS to get feedback. In ECS, the Apache POI (API to access Microsoft format files) module is used to extract the terms from the student submitted essay in Word file. After the stop word removal and stemming steps, a cosine value between each sentence of the essay and a sub-theme is computed. If the result is higher than a threshold value, the corresponding sentence will be highlighted as relevant to that sub-theme.

As the possible number of terms for a topic is typically large and pre-processing steps are rather costly, we found a typical PC server is not powerful and stable enough to manage a high volume of requests for the essay critiquing services coming all at a time. However, such peaked requesting period is not unusual, especially when it is near the end of the lessons where a number of students would like to have the final check.

To address the scalability requirement, we adopted a three-tier computing architecture. In particular, we put the web-based module for interaction with the students in the front end server (presentation layer) and the LSA computation module into another backend resource layer (see Figure 1). By such a separation and together with the use of AJAX and Message Queue<sup>2</sup> technologies, we managed to make the front end server very responsive regarding essay submission and very stable regarding submission status updating. The use of the message queue is to support asynchronous

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<sup>2</sup> Apache ActiveMQ 5.0.0 Release <http://activemq.apache.org/>

communication between the presentation layer and the backend layer. Technically speaking, if a student submits an essay, the front end server (presentation layer) will create a thread for the message queue to call back. After the LSA-based analysis of the submitted essay, the call back method will be invoked and the result will be stored into the database in the front end server. With this design, additional LSA backend servers can be easily added and the front end server can automatically make use of them for balancing the load without the need to modify any code. We have rigorously tested the system with four LSA backend servers in a real school setting and the performance was found to be very satisfactory.

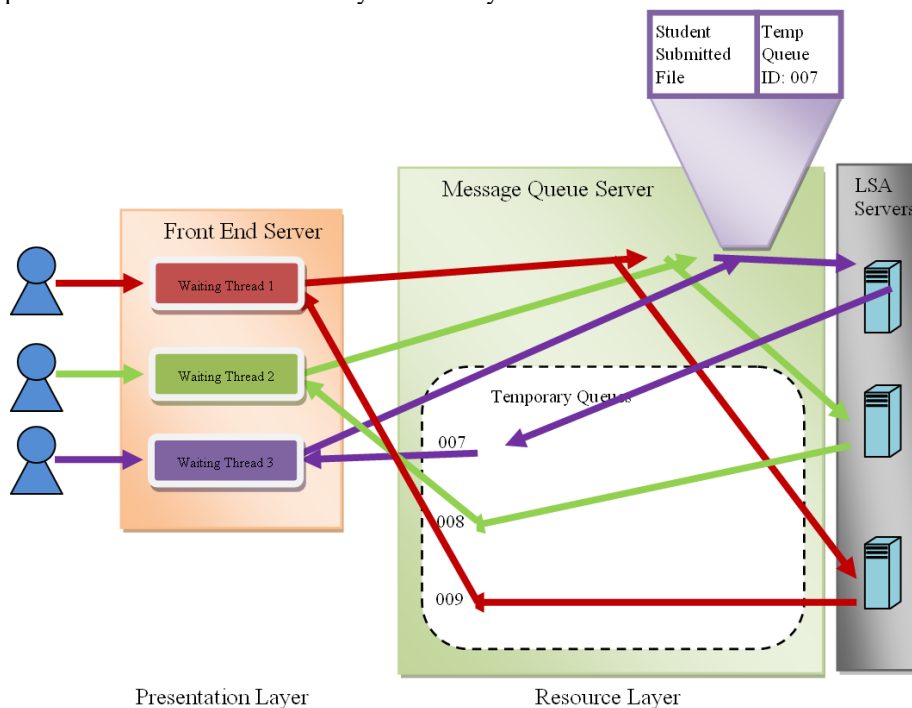


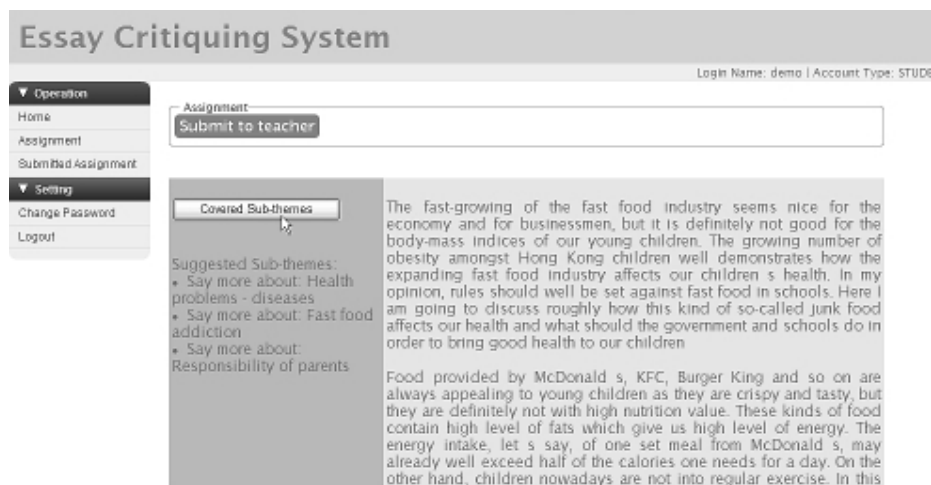
Fig. 1. A Three-tiered Computing Architecture for Essay Critiquing.

## 7 System Integration with Writing Pedagogy

We believe that the critiquing system we have developed will not be able to reach its full potential unless a proper writing pedagogy is adopted. Referring to the literature, there was a major change in accepted approaches to teaching writing and composition in the 1970s and 1980s [1]. The pedagogies began to move away from a focus on the final written product. Instead, the teaching of composition began to emphasize the writing process, with a reduced emphasis on rhetorical structure, vocabulary, and grammar [9]. It emphasizes the importance and contribution of multi-drafts in the writing process. Teachers take the role of a facilitator providing formative feedback on content and organization to each student draft. This feedback is important for

students to revise their writing, especially on preliminary drafts [4, 7]. Myers [17] suggested that each student should have a portfolio in which all writing drafts are dated and stored. The important changes on each draft from the last draft should be indicated. This information allows the teacher to make a rough estimate about the frequency and influence of pre-writing. However, this teacher-student interactive process presents serious problems for secondary school teachers who have large-sized classes such as in the Hong Kong teaching environment. It is impossible for the teachers to read every student draft and provide feedback during the composition class. If the student drafts are collected and returned with teacher feedback on the next day, it will take at least a few days to complete a composition. Perhaps this is why Zamel [25] describes writing teacher as “a tired dog”. Responding to student drafts is indeed a very time-consuming job for teachers.

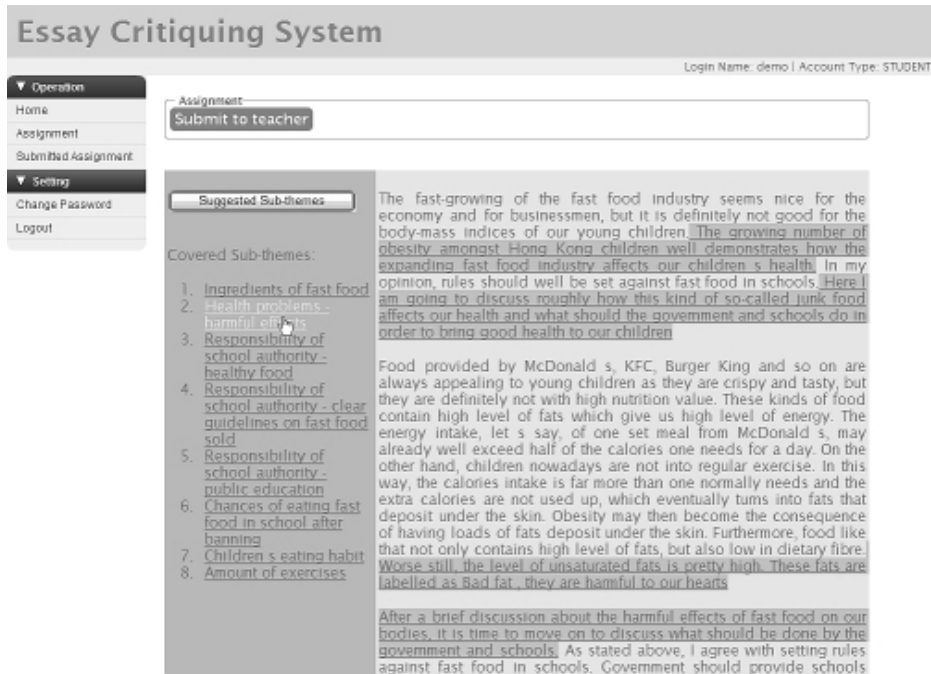
To alleviate teachers’ workload in providing feedback in the writing process, the ECS developed in this project can provide just-in-time formative feedback to students. The feedback takes two forms: (1) new sub-themes suggested to include, and (2) the visualization of the existing sub-themes’ organization (as shown in Figures 2 and 3). With the help of the feedback, students can further revise their compositions accordingly. Also, as the feedback is immediate, there is no need to wait for the teacher’s hints/comments before students can further revise their compositions. This can speed up the writing process. Besides, the system that is web-based allows learning to take place anywhere as long as there is Internet connection. This feature enables students to practice writing outside the classroom.



**Fig. 2.** A screenshot of ECS with suggested sub-themes shown on the left hand side of the essay.

As suggested by Myers [17], students should have a portfolio to store all their writing drafts. ECS can record all the writing draft submissions with date and time automatically. Both the teachers and students can retrieve any submitted drafts for reference. This relieves students from handling the portfolios manually and allows them to concentrate on their writing.





**Fig. 3.** A screenshot of ECS with covered sub-themes and their detected locations shown with the corresponding sentences highlighted.

## 8 Feasibility Evaluation

In order to evaluate the feasibility of integrating ECS into the process approach, an experimental study was conducted. A series of five writing workshops was conducted in a secondary school. The subjects were the Secondary 4 and 5 (equivalent to GCSE level) students. In each workshop, they were asked to write a 300-word composition on an argumentative topic with ECS. They are encouraged to use ECS, but on a voluntary basis. There was no limit on the number of submissions and revisions for system feedback. After each workshop, the final essay was marked by the teacher who can access all the student drafts. He also gave face-to-face feedback to students at the beginning of the subsequent workshop, ranging from language problems, organization of ideas within and between paragraphs to their use of the system, based on his reading of students' multiple drafts. An anonymous questionnaire was administered at the end of the last workshop. Twenty-seven subjects returned the questionnaires.

The results of the questionnaire indicated that an average score of 4.04 on a 5-point scale (5 for very great, 3 for moderate and 1 for very least) was given by the subjects for the extent to which they thought ECS could improve their essay content in terms of number of ideas and arguments. The average score for the assistance in essay

organization improvement was 3.78. Twenty-five out of 27 respondents agreed that the teacher should continue to adopt this system for their essay writing in the future.

Although the ECS was well-received by the subjects, some difficulties were encountered if it is to be integrated into the normal composition writing class. A typical secondary school may require students to write a composition every two weeks. This will give teachers a great concern on the use of this system as corpus preparation is a very time-consuming task. In this regard, two ways are suggested. One way is to form a project team to prepare corpus for a list of commonly adopted composition titles and make them available to all the school teachers. Another way is to study the possibility of automating the corpus preparation process with some clustering techniques in order to reduce the time and efforts in this process. The availability of computer rooms is another difficulty. As each student requires a computer with the Internet connection for writing, it will be very difficult for a typical secondary school in Hong Kong to schedule a computer room for every composition class. Due to this difficulty, our workshops were scheduled during weekends. However, the penetration of WiFi technology will soon reach each and every classroom for the years to come. Students by then can easily get connected to computer tools/services like ECS in ordinary classrooms. We believe a variety of hybrid learning approaches would emerge and be adopted to help our next-generation to learn more effectively.

## **9 Conclusion**

To conclude, the paper has described our Web-based Essay Critiquing System (ESC) and reported the way in which it is integrated into a face-to-face teaching context. The positive feasibility evaluation result has given us confidence in pursuing the hybrid learning approach, and our mode is one of the feasible methods only. Given some teaching constraints (e.g. availability of a computer room for each lesson) described in the paper, we suggest installing WiFi network on the school campus. Finally, we believe a blend of Web-based and face-to-face classroom learning is a more interactive and dynamic approach than the traditional static pen-and-paper and face-to-face classroom learning.

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