Essay Writing in Online Education:

introducing an iterative peer collaboration

system

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MIMS Final Project 2014

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Abstract

This study suggests a new peer learning and feedback system for essay writing assignment in online education to increase a chance of collaborative learning and feeling of engagement among large number of students in online education. In this system, each student will write an essay on an assigned topic, then review peer student's essay. Students will be encouraged to employ ideas from peer's essay and comments from feedback to revise and develop the essay. We propose that the system enables propagation of ideas resulting in essays become more similar to one another. The system enables the instructors and researchers to observe the iterative process of feedback and idea development. Using the system, we had a pilot implementation with a small set of students. We evaluated changes of an essay at each iteration, and we found the student's essay converged as a result, which means that ideas are spread out through peer collaboration on our system.

1. Introduction

Online education has developed fast for last couple of years. Students are flowing in to the classes seeking opportunity to learn from anywhere at anytime. The number of students is a lot larger than the traditional class size as well as the volume of student interactions. However, the peer interaction is partial as most of the interactions are generated by a number of active students.

Currently, for example, Massive Open Online Courses (MOOC) do not have solution to help less active students be engaged in peer interaction due to the size of class as well as asynchronous class schedule. Accordingly, collaborative learning opportunities among students are pretty limited. There are open discussion boards on the MOOCs so that students could exchange their ideas, but it is burdensome for the students to go through sequentially to track diverse ranges of opinions, questions, and topics from massively extended series of discussion. Instructors and TAs cannot respond to every single comment and question. On MOOC classes, the students cannot take advantage of collaborative learning as they could have done in smaller sized offline classes.

Through collaborative learning process like discussions, students actively exchange, debate and negotiate their ideas within their groups, and this results in increase of students' interest in learning. Moreover, by engaging in discussion and taking responsibility

for their learning, students are encouraged to become critical thinkers [1]. Many researches showed that students working in small groups tend to learn more of what is being taught. Moreover, they retain the information longer and also appear more satisfied with their classes [2, 3, 4]. Learning on MOOCs can be more successful if the students on MOOCs can discuss and argue their opinion on the course topic with other students as proven in previous studies. They could have naturally learned from feedbacks from peers and develop their own argument. The needs for collaborative learning from students on MOOCs are actually arising; for instance, people try blended learning, which combines MOOCs with on-campus course to take advantages of MOOCs and local study groups [5]. We believe lack of teacher- to-student interaction is one of the major factors that hinder students to be fully engaged in a class.

We would like to enhance the students' experience by focusing on scalable student-to-student interaction in large size classes in online education instead of teacher-to- student interaction, which is not immediately scalable. Current peer collaboration systems such as bulletin board system are not optimal for discussion among the large number of students with diverse cultural background and personality. In previous study, it was found that Asian students took initiative in class discussions significantly fewer times than did non-Asian students [6]. Public discussion system such as bulletin board system can be insufficient to encourage students of diverse cultural background and personality to participate discussions [7].

2. Iterative Peer Collaboration System (IPCS)

a. How IPCS works

In this study, we propose an iterative peer review and development process for essay writing in online education that helps students learn from peers and be engaged in the class through ongoing peer interactions without being overwhelmed by discussion boards. The system, IPCS, gives each student an opportunity to discuss with peer students in a format of essay writing and review process. This system will benefit students by providing the quantified measure of how their arguments are developed and learning through iterative idea developments through feedback iterations.

An instructor of MOOC can create essay-writing assignment through this system. The student will go through the phases below.

1. Write: An essay assignment is given, and students write an essay individually.

2. Feedback: All students submit the assignment by preassigned due date, and students receive a paired article of peer to read and give feedback on it. All students submit their feedback, and then students receive the feedback from their peer.

3. Development: Students get chance to revise their essay. They are encouraged to adopt ideas from the peer's essay they reviewed, and the feedback they received.

- Feedback phase and Development phase can be repeated 2-3 times depending on the number of iterations the instructor assigned.

b. Insights on collaborative learning from IPCS

We believe that data from IPCS will let us gain insights on how peer review among students affects their learning process. IPCS gives us dataset of students' essays for each iterations and the feedback given to the students. In addition, the students also give ratings for their own essays as well as the essay they review.

Using the data from IPCS, we expect that we can answers for the main research questions below;

- Does the IPCS help students to learn from each other?
- Does the IPCS help students fulfill higher achievement?

Additionally, we expect that running an experiment on IPCS will give us a better idea about how to improve IPCS to determine the optimal number of iterations for Feedback and Development and the most effective peer pairing algorithm.

We expect that students could enhance their understanding by collaboratively writing an essay, and hence, be proactively engaged in the course. In addition, instructors can

increase student participation and help students achieve their learning goal on the course material. Furthermore, the achievement and improvement of participation can be quantitatively measured to provide solid understanding of how the students advance to meet their goals.

3.   A Pilot study of IPCS

Before putting IPCS in real world, we had a good chance to apply it to a smaller scale. From case study we expected to be able to show how IPCS benefit to the collaborative learning process, and also test the natural language process(NLP) algorithms in analyzing these essays.

With a consent of the instructor, we recruited participants from a graduate level class 'Information Law and Policy' at School of Information in University of California Berkeley. The assignment in this class gives a hypothetical legal case related to the course material, and the students write an about 2,000 words long argumentative essay in response using related court cases or course materials. We built an online system for this case study to let the participating students to go through IPCS phases.

a.   Participants

17 students volunteered to take advantage of IPCS; however, only seven students submitted their work following the schedule of IPCS. All of them signed informed consent and agreed to accept our incentives as they complete the participation. As we go through the three different phase of write, feedback, and develop, six of them completed using IPCS.

b.   Study design and setting

For this case study, we set the number of iteration as one, the students will go through Review and Develop phase only once. This is because current case study only had a short period of time before the assignment due in the class. Also, we chose a random peer assignment for the review since we do not have other information about the participant to use for the pairing.

The IPCS was created as a web platform by django running on a server at School of Information in UC Berkeley. The web platform enable the participants can write the initial essay, review the peer's, develop and rewrite their essay online. The system was designed to let the participants can easily see requirements of an assignment and write their own essay.

As the participants sign up to our study, we distributed each participant's login accounts and temporary password. The participants were notified about the schedule using IPCS.

We allocated two days for each of the phases. Therefore, the participants had to submit their first essay 4 days in advance to the due date. The participants then receive their peer's essay to review. They had 2 days to submit their review for the peer. For the next 2 days, the participants received a review from their peer and rewrite their own. This schedule was shown on our IPCS system, and we sent reminder emails to the participants.

Once the participants logged in to the system, they could see the assignments with deadline for each phase. The screen also listed four tasks to be completed sequentially.

1) Write the first draft of your essay :   The first task is write an essay. A student submit their initial essay on the assignment and give a rating on their own essay.

2) Give feedback on your peer's essay : Anonymously a peer was assigned to each student, and a student review the peer's essay and give feedback. The student also give a rating on the peer's essay.

3) Look at the feedback on your essay : A student receives a feedback from their peer.

4) Write final draft of your essay :   Based on the feedback from a peer and the peer's essay that a student reviewed, the student rewrite their essay. The student give a rating on their essay again.

The participants acknowledged that they are encouraged to borrow ideas from peers and write it in their style of writing, yet "copy and paste" is strictly restricted in the system. The system checks plagiarism by comparing every pair of writings.

For the ratings on each of these essays, we used a modified scoring matrix used by Lindblom-Ylanne et al. [8]. Our scoring matrix are shown in Table 1. Each criterion was scored in a four-point scale.

Table 1. Scoring matrix for case study

Criterion	4	3	2	1
Does this essay include key issues and themes?	Relevant issues included	Most of relevant issues included	Some relevant issues included	Relevant issues rarely included
Does this essay have coherent general picture?	Thorough understanding of how events are linked	Understanding of how events are linked	Some understanding of how events are linked	No understanding of how events are linked
Does this essay show independent thinking?	Independent thinking and analytic approach	Some independent thinking	Little independent thinking	No independent thinking
Does this essay show critical thinking?	Critical evaluation and thinking	Attempts at critical evaluation	Very little effort in critical evaluation	No effort in critical evaluation
Does this essay use the literature?	Several references, active search of references	Includes references other than 'the main reference'	Only 'the main reference'	No references, except discussions

Lastly, we acquired the grades of the participants on this assignment from the instructor with a consent of the participants.

c.   *Results and Analysis*

First of all, we needed a way to compare these essays quantitatively. After reviewing a few different natural language processing algorithms, we chose to use two different measures to compare these essays.

A. Cosine Similarity

A cosine similarity score indicates how similar two text documents [9]. We treat each writing as a bag of words. And, each word is assigned Term Frequency-Inverse Document Frequency (TF-IDF) score. This score reflects the degree of importance of a word in a document, which increases as a word exclusively appears in the document among all submitted writings. Since an essay can be represented as a list of {word: tf-idf weight} dictionary, each document can be assumed as a vector of words with one component corresponding to a word. We can calculate cosine similarity of two essays using TF-IDF weights.

B. F score of grammatical similarity

We analyze grammatical structure of each sentence of a writing using Standford CoreNLP [10] tool. The tool provides a description of the grammatical

relationships in a sentence. For example, from a sentence "NSA violates restrictions.", it finds "direct object" relation and gives output like this *dobj(violates, restrictions)*. It generates a list of grammatical relationships for a writing. Grammatical distance of two documents is measured by counting common grammatical relationships of the two documents.

The essay assignment in this case study consists of two parts which are separable, so we regarded an essay from a student as two essays when we analyze. This is because separating the parts of the essay increase the precision of similarity measures we applied.

First of all, we found that the IPCS in this study helped students to learn from each other. We compared similarity measures of every pair of essays so that we can see whether the students' essays were converged. We observed that the similarity of the students' essays increased over the feedback and review process. Both of cosine similarity and F score showed statistically significant increase in the essay similarity on the second essays compared to the first essays. Cosine similarity increased 54% (t (58) = 6.23, p < 0.05), and F measure increased 36% (t (58) = 2.23, p < 0.05).
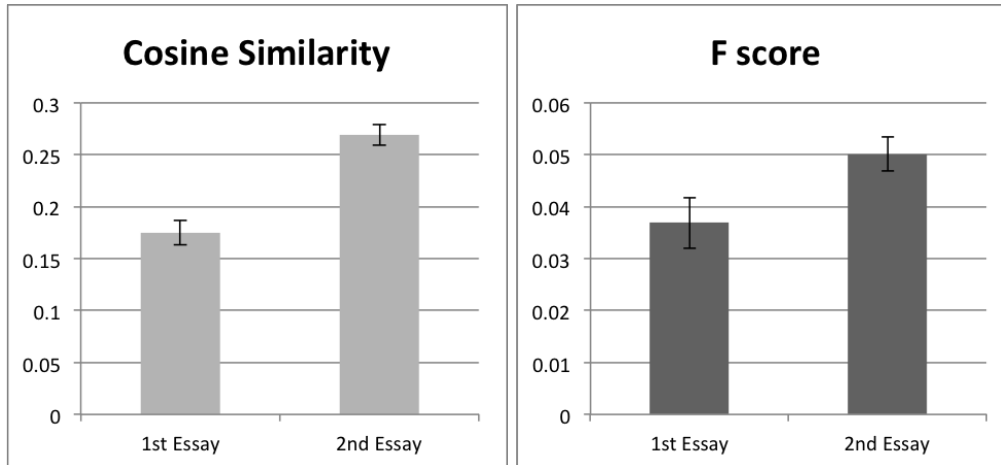
Figure 1. Cosine Similarity measure and F score increased after feedback and review phases

Secondly, we found that IPCS help students fulfill higher achievement in terms of self assessment. The self assessment score on essays significantly increased over the feedback and review process (t (10) = 2.78, p < 0.05). However, in terms of grade for the essay assignment, we weren't able to find the significant increase on the participants' grade compared to the median of whole class(t (5) = 0.45, p > 0.05) or the participants' grades from prior assignment in class (t (5) = 0.04, p > 0.05). Additionally we couldn't see a strong correlation between the grade with self assessment and peer assessment.
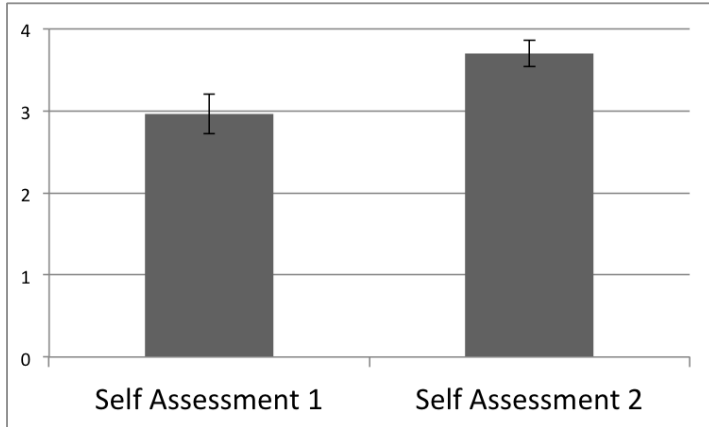
Figure 2. Self Assessment rating for the essays increased over the feedback and review process

We were also able to observe that the increase in self assessment over the review and feedback process was negatively correlated to the similarity between the essays (Correlation coefficient was -0.88). The F score also showed the similar pattern.
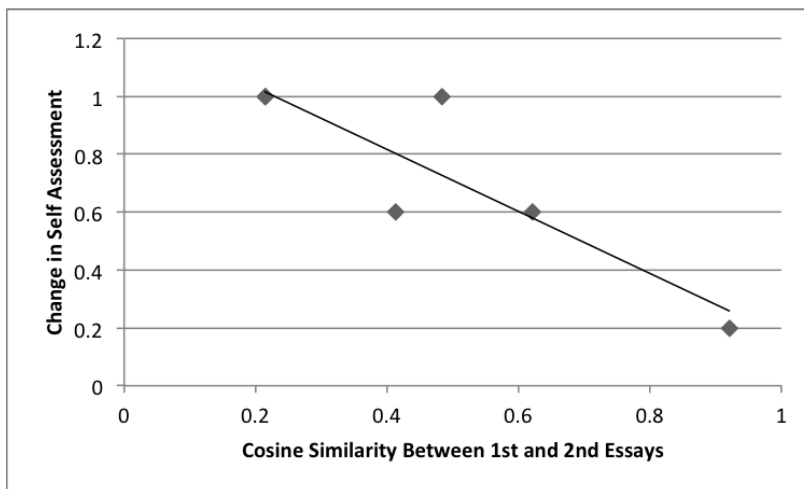

Figure 3. The more changes made in the essays, the participants rated their own essay higher.

4. Discussions and further studies

The rationale behind the IPCS is that by reviewing peer's essay, a student can establish his/her ability of critical thinking. After reviewing peer's essay, the student will have a chance to critically review his/her essay as well, which can improve the quality of the essay. Also, a student have an opportunity to learn peer's idea and approach to the problem by reading it. It can inspire a student to further develop his/her own essay. With peer feedback process, a student can review his/her own essay in a different view. The student can find strength and weakness of the essay. We believe iterating these process will really help the students to learn better and think critically.

From the pilot study we ran, using the IPCS, students had an opportunity to critically review their essay. With the learning, students have second chance to further develop and improve the essay. By analyzing the data from pilot study, we have found that the IPCS propagates ideas among students, resulting in essays in the second iteration become more similar compared to essays in the first iteration. We were not able to find a significant evidence that IPCS helps students earn better grades in the course. However, the participants rated their second iteration of essay significantly higher. Considering this is from only a smaller sized pilot study, we believe that we will be able to see a more improvement in larger scale.

One critical limitation of our experiment is the number of participants. Since this pilot study was not a part of curriculum the participant had to finish the first iteration of writing four days earlier than the due date. We had higher dropout rate for initial submission. Also, the course applied was smaller-sized graduate class, which has offline lecture and discussion sessions. Also, as the number is small, it was challenging to earn statistically significant measures. As IPCS wasn't tested in an experimental setting, it is difficult conclude anything from this pilot study.

We expect MOOC classes with writing assignments can be a good candidate. If IPCS is integrated into the original curriculum and used for students to submit an assignment, we can get large volume of dataset. However, when scaling up the size of experiment like MOOCs, it comes with quality assurance issue. In a large class, students are more likely to submit low quality essays, which cannot be productive their assigned peers. We suggest two options to control these issues. First, we can strengthen report function. If a student receives disqualified essay or review, s/he is able to easily report it to instructors so that teaching assistants take care of it. Second, plagiarism check function should be more elaborated. It should be capable of finding deceptive or meaningless writings in real time preventing cheating in advance.

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