



# Supporting the development of synchronous text-based computer-mediated communication with an intelligent diagnosis tool



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## ABSTRACT

To date, a look at the scientific literature on the construction and use of synchronous computer-mediated communication (CMC) support environments reveals that most researchers have focused either on exchanging information or on constructing and presenting posts. In this work, an intelligent collaborative synchronous CMC platform that detects whether the learners address the expected discussion issues is proposed. The concept maps related to the learning topics are first outlined by the instructor. After each learner issues a post on the synchronous CMC platform, a feature selection approach is adopted to derive the input parameters of a one-class Support Vector Machines (SVMs) classifier. The classifier then determines if the learners' posts are related to the concept maps previously outlined by the instructor. Meanwhile, learner peers from the same group are asked to provide comments on the synchronous CMCs, and a group grading module is established in this work to evaluate the quality of the synchronous CMCs. If the evaluation results from the classifier and the group grading module are inconsistent, the instructor or the teaching assistant is consulted to verify the evaluation results. Notably, a feedback rule construction mechanism is used to issue feedback messages to learners in cases where the synchronous CMC support system detects that the learners have strayed astray from the expected learning topics in their posts. The classification rates for the one-class SVM classifier can reach up to 97.06%, and the average pre-test and post-test grades were 51.94 and 66.77, respectively, which revealed that the junior high school students participating in synchronous CMC activities related to natural science were benefited by the proposed intelligent synchronous CMC platform.

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## 1. Introduction

The distinguishing factor in the development of a computer-mediated communication (CMC) system is its use of the Internet as the transmission media. It is believed that using CMC system and the Internet offers advantages; for example, students with lower learning achievement and more passive learning styles can overcome their fears by participating and discussing in the course of learning activities using the synchronous CMC system. The instructor first assigns online discussion topics, and then learners issue their posts via the CMC platform. To build up students' knowledge via the CMC, teachers examine the content of the learners' posts to determine the degree to which is related to the learning topics. Clearly, this type of online learning platform cannot evaluate

the CMC automatically, and the teaching load of the teachers is therefore not alleviated. Moreover, the feedback for students' posts cannot be given in a timely manner, and must wait until the experts have completed their deliberations.

Synchronous CMC is similar to a telephone conversation except that much of the communication mode in the former is text-based while in the latter it is voice-based [1]. Synchronous CMC has a great potential to increase individual participation and group collaboration. The results of the study in [2] showed that the students were satisfied with their experiences in synchronous critique discussion. The students indicated that synchronous CMC was beneficial for them to exchange prompt feedback and suggestions without delay. The students also indicated that regular meaningful interactions scheduled across the semester enhanced social presence and a sense of connectivity among the participants which played an important role in their willingness and satisfaction. Findings in [3] suggest that improving student satisfaction with synchronous interactions will effectively raise their overall satisfaction with

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online courses. The study in [4] reported that various features, such as text chat and the webcam, facilitated interaction among the students and with the instructor in the virtual classroom. An evaluative case study of a university course that made extensive use of teacher and student synchronous chat was presented in [5]. It was claimed that the online instructor successfully presented new concepts for discussion, fostered interaction and explanations, and received confirmation of understanding through the chat tool. Meanwhile, student chat sessions reflected more substantive messages, which are directly related to the prescribed topic, than did the asynchronous discussions.

It was observed that synchronous CMC has the advantages of providing a greater sense of presence and generating spontaneity than asynchronous CMC [6]. Analysis of transcribed messages supports the contention that students develop skills via synchronous CMC and that tutor online behavior affects the quality of synchronous interaction [7]. It was reported that feedback was most effective when it was understood by the student, tailored to the mistakes that they had made and when it prompted students rather than giving the answer [8]. The importance of students' ability to receive immediate feedback and their experience as presenters was highlighted across the various kinds of interaction [4]. Thus, an effective online assessment tool for synchronous CMC can foster a learner and assessment centered focus through formative feedback and enhanced learner engagement with valuable learning experiences [9]. Accordingly, the development of an automatic assessment tool for synchronous CMC is required although it is more difficult to implement than asynchronous CMC, and strategies for the analysis of synchronous CMC will have to be carefully selected or developed in alignment with the purposes that the conversation is designed to engender [10].

In the recent literature, most of the short free-text assessment tools that can be used to detect if a student's post in CMC is related to the prescribed topic only handle English-written text and require large volumes of text for learning [11]. The study in [32] proposed a method for short text assessment from scientific documents based on titles, and three types of universal datasets, DBLP, LNCS and Wikipedia were applied to enhance the features of short text documents with topic models. Yang et al. [33] used Wikipedia as background knowledge, combined lexical and semantic features by mapping words to topics with different weights, and employed a Support Vector Machine (SVM) as a classifier for assessing short texts. Besides, WordNet database have been extensively employed to alleviate the need for a large corpus in order to fairly assess short textual synchronous CMC. Meanwhile, word co-occurrence may be rare or even null in short free-text synchronous CMC, and yet have similar meanings. However, the use of a large corpus is impractical because of the unrestricted possible different free-text synchronous CMC's to a prescribed topic in online discussion [12]. An automatic assessment in recent study [11] was performed to both types of exams, training and evaluation for short free-text synchronous CMC. However, the evaluation exams were checked by teachers, because the purpose of their assessment system was not substituting the teacher, but to support him the best way in the laborious task during the assessment. Most important of all, the above-mentioned works [11,12,32,33] cannot solve the problem that arises when the extracted keywords are not stored in the sample database; therefore, as a result, the posts could be adjudged as unrelated concepts by the system.

In recent years, the concept of learning from crowds [13] has attracted increasing research attention, and crowd-labeling emerged in response to the need to label large-scale and complex data. Since it is often a tedious, expensive and time-consuming task, cheap-and-fast labeling is becoming widely used by researchers and practitioners. The quality and integration of different labels

remains an ongoing problem, however, because the labelers taking part in the task are unfamiliar with it or are unreliable in terms of a lack of expertise. A common approach called simple majority voting (SMV) [14] has been proposed to estimate consensus labels from individual worker labels. A limitation of SMV, however, is that the consensus label for any given example considered only the labels assigned to that example, without regard to the accuracy of the workers involved in other examples. An alternative is to take the full set of global labels into consideration to estimate worker accuracies. A variety of work has investigated means for assessing the quality of worker judgments and difficulty of annotation tasks [15]. Experts first annotated the true labels for some examples. Other workers re-annotated these same examples and useful information can be obtained by comparing their labels with those of the experts. However, with the method in [15] it was necessary to increase the number of parameters to be learned to improve the reliability of the system.

Recently, social network sites have become popular, with one of them, Facebook, founded by Mark Zuckerberg with his college roommates in 2004 [15], becoming the world's largest social networking site and boasting a rapidly increasing number of registered users. It has been observed that almost every fourth user of the Internet also uses Facebook [17], and Facebook has attracted significant research attention because of its booming popularity. For example, Fovet [18] designed an online platform that examined the impacts of Facebook on students' peer relations and their adaptation to school. The experimental results pointed out Facebook gives a great support for students with social, emotional and behavioral difficulties (SEBD) in terms of their adaptation to school and management of peer relations. Nemeč et al. [19] found that a combination of Facebook and applications whose features are like Facebook Groups or Chat could serve as an effective supplemental tool in academic courses. In addition, Manca et al. [20] analyzed how Facebook works in promoting the establishment of new friendships.

The motivation of this work is that we found the contents in an online discussion board were too disordered and in a mess. If teachers want to check the content of these posts one after another, the loads of teaching may be increased. Therefore, we applied the advantages of synchronous CMC for providing a greater sense of presence and generating spontaneity. However, there are some problems to be solved while synchronous CMC system is applied in actual teaching activities. For example, recent literature pointed out that the CMC system can only handle English-written text, not for Chinese-written text. Moreover, the feedback for students' post cannot be given immediately. Besides, if the extracted keywords are not stored in the sample database, some posts will be adjudged as unrelated concepts by the system, and this problem still cannot be solved in other related works.

To tackle the above-mentioned challenges, we proposed a tool which can effectively assist teachers by automatically examining students' posts in synchronous CMC to determine the degree to which these posts address the various learning topics. The students could receive some suggestions in the form of feedback messages if the evaluation of the learners' posts indicated they were irrelevant to the expected learning topics. As for the problem arising when keywords are not stored in the sample database, a so-called group grading module was proposed in this work to overcome this shortcoming of other algorithms in the literature. As mentioned in the work of Jang et al. [34], soft computing can incorporate human knowledge effectively, deal with imprecision and uncertainty, and learn to adapt to unknown or changing environments for better performance, and the proposed group grading module demonstrates the application of a soft computing algorithm to simulate the human mind.

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