Collaborative Learning in Engineering Students under Social Distancing: An Action Research

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Abstract—In this work-in-progress, an action research was performed in a taught postgraduate engineering course during the global pandemic of COVID-19 in Spring 2020. Due to the social distancing policy, all courses offered by the authors’ university must be delivered online. In addition to the synchronous online lectures delivered through ZOOM, the course instructor (first author) established a class blogging community as an innovative practice to promote students’ social epistemic cognition (SEC) under physical isolation. The current action research focuses on course design, with a disposition that students’ SEC can be enhanced by collaborative learning in form of a class blogging community. The action research consisted of three implementation loops. The first author reflected her teaching in the end of each loop, and modified her practice in the next loop. A summative evaluation was conducted in the end of the semester. Our results suggest that the class blogging community, together with teacher’s action research and students’ social network analysis, are effective strategies in enhancing engineering students’ collaborative learning under nearly completed physical isolation.

Keywords—Collaborative learning; social epistemic cognition; action research; social distancing; engineering education

I. INTRODUCTION

Engineering students worldwide have undergone an atypical academic school year in 2019-2020 due to the global epidemic of the Coronavirus disease 2019 (COVID-19). Traditional lecture-based, face-to-face teaching had to be switched to synchronous online education for courses in Spring 2020. However, human learning is a continuous cognitive process that involves the social interactions between the learner and the environment in which learning activities take place [1]; where other individual learners are also present. Social distancing may impede students’ classroom learning because of the absence of the peers. New pedagogical strategies need to be formulated so as to transform the challenging societal conditions into opportunity for effective practices in online teaching and learning. The research goal of this work-in-progress is to synthesize an effective course design on online collaborative learning in engineering education during social distancing through the promotion of social epistemic cognition (SEC) [2]. Social epistemic cognition refers cognition and cognitive activities in social contexts [2], which can be manifested in activities such as collaborative learning [3] and knowledge building [4].

A. Related Studies

SEC is a theoretical framework established only very recently with limited available related works except e.g. [5], in which empirical evidence suggest that SEC predict students’ learning. SEC is pragmatically associated to computer supported collaborative learning (CSCL) [3] and knowledge building (KB) [4]. A few related works on pedagogies related to CSCL and KB in engineering education contexts exist. These include the work of Gillet et al. where a collaborative web-based environment for online virtual laboratories in automatic control and fluid mechanics were implemented to facilitate engineering students’ knowledge building [6]. Besides, Parker and Chao discussed the adoption of Wiki as a pedagogical tool for software engineering learning [7], where the interactions involved collaborative learning and knowledge building. In another work, Mats and Asa presented a case in online collaborative learning across engineering students from US and Sweden [8].

B. Our Contributions

In this action research, we study how engineering students’ collaborative learning can be promoted through a class blogging community. Our contributions include:

1. We have collected research data on students’ SEC and collaborative learning in an online teaching and learning environment under physical isolation.
2. We have suggested strategies on effective online collaborative learning for engineering students to cope with or overcome challenges arises from unexpected societal conditions such as social distancing.

II. SOCIAL EPISTEMIC COGNITION

SEC is a tripartite theoretical framework with roots in social epistemology [9] (in Philosophy), social cognition [10] (in Psychology), and epistemic cognition [11] (in Educational Psychology). SEC is driven by both individual and social epistemic aims. Furthermore, it has been proven by user studies in human-computer interaction that SEC can be mediated by online interactions [4]. As inherited from Chinn et al.’s epistemic cognition framework, SEC embraces the following 5 components:
1. **Social epistemic aims** – refers to the intended purposes when a learner engages in the social epistemic cognitive processes (such as establishing a common knowledge together, and explaining ideas to other individuals) in a common social environment.

2. **Structure of shared knowledge** – refers to a learner’s view about the representational format and structure of knowledge that is shared within an interacting group. It involves the learner’s own ontological views about a specific knowledge domain.

3. **Source and justification of shared knowledge** – refers to the attitudes that a learner has towards informational objects inside the shared social environment, e.g. his or her views about the authority of the shared knowledge and the corresponding reasoning of such views.

4. **Social epistemic virtues and vices** – refers to the intellectual virtues or vices that a learner adopts or shows in a social environment, such as seeking knowledge and understanding via a conscientious attitude (a virtue), or avoid to point out misinformation (a vice) in the shared environment.

5. **Processes of achieving social epistemic aims** – refers to the interactive processes that a learner performs in achieving the social epistemic aims, such as having discussions and collaborative works with the peers. It also involves the reliability of these processes.

III. **STUDY DESIGN AND METHOD**

A. **Action Research Study Design**

Action research (AR) is an educational research approach which engages both the researchers and participants to undergo cycles of action and reflection so as to improve actions in the future [12]. Given our disposition that SEC predict students’ learning [5] and can be mediated by online interactions [2], the current study aims to promote SEC in engineering students during social distancing where face-to-face physical interactions are nearly completely eliminated. The research is guided by two questions:

1. **(RQ1)** How to facilitate engineering students’ collaborative learning when they are physically isolated with each others?

2. **(RQ2)** How to effectively promote engineering students’ social epistemic cognition and online collaborative learning?

B. **Course Design and Learning Activities**

The current study is carried out in a taught postgraduate course, “Social Networking,” in a master level Information Engineering curriculum at a university in Hong Kong. The course aims at providing an interdisciplinary view on both technology and humanity aspects of social networks. It covers topics such as social network analysis (e.g. discourse analysis, semantics, social network pattern) and applications of social networks in global and societal contexts. The learning activities in addition to the online lecturing are given below.

<table>
<thead>
<tr>
<th>Learning Activities</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Python Programming</td>
<td>Two Python programming assignments for (1) sentiment analysis, and (2) social network analysis.</td>
</tr>
<tr>
<td>Class Blog Posting*</td>
<td>Students establish and maintain their individual blogs and publish at least four posts to reflect on their course learning. The target readers of the posts are their fellow classmates.</td>
</tr>
<tr>
<td>Class Blog Commenting*</td>
<td>Students visit their classmates’ blogs and provide comments to one another’s posts.</td>
</tr>
<tr>
<td>Group Presentation</td>
<td>Students form into groups with 3 to 5 members to give an online presentation of a social media analytic case study.</td>
</tr>
</tbody>
</table>

*Collaborative learning activities.

C. **Participants and Procedures**

The course (N = 73) is taught by the first author during the spring semester of 2020, in which the outbreak of the COVID-19 occurred in the 4th week of the semester. The author’s university announced a university-wide switch from traditional lecture-based, face-to-face teaching to synchronous online education for all courses in the remaining of the semester. No students were allowed to physically enter the classrooms because of the social distancing policy. All participants attended ZOOM online class meetings according to the original teaching schedule. To this, the first author set up a teaching environment to facilitate her teaching (figure 1).

Since the students were no longer able to have face-to-face social interactions with their classmates physically, two activities, namely ePortfolio and participation (in form of blog postings and commenting), had become important means of interactions and collaboration of the class. The students were required to visit one another’s blog posts and provide comments and responses. 1 score was given to every non-trivial comment (up to 15 comments). The students also worked on two Python programming assignments individually to perform social media analyses using the data collected from the online learning community created by the whole class. Assignment one was about sentiment analysis. Assignment
two was about social network analysis. Both assignments were individual projects. The analysis results were also used to reflect students’ own experience in the online learning community participation, and they were encouraged to share their self-reflection in the last blog post.

**D. Implementation**

The overall implementation of the action research is described with the help of figure 2. Every implementation loop consists of four steps, namely planning, acting, observing, and reflecting. With the help of the second author (who was the teaching assistant of the course), three action research loops had been conducted. A university-wide announcement of online teaching and learning policy was made near the end of the first implementation loop.

**IV. FORMATIVE REFLECTION AND FINDINGS**

In this section, we report the findings from each of the implementation loops. We also report the observations, actions, and reflection in each loop.

**A. First Implementation Loop (4 Jan to 2 Feb, 2020)**

In the first implementation loop, the author introduced the conceptual knowledge of social networking and online interactions to the students. The classes were conducted in a traditional face-to-face lecture mode while every student maintained their personal ePortfolio (in form of a blog). Students’ learning behavior could be observed (1) directly from their participation in class, and (2) from the blog contents provided by individual students. The author reflected on her own implementation with the following findings:

- Students were new to the concepts of online collaboration and social interactions; and
- Students interacted with each other more actively in the online environment than in the physical classroom environment.

**B. Second Implementation Loop (3 Feb to 11 March, 2020)**

The University announced the social distancing policy on 31 January and the extension of the Lunar New Year holiday by 2 weeks (from 3 February to 17 February). Furthermore, all courses were required to conduct in synchronous online mode using ZOOM (www.zoom.us). Based on the reflection in the first implementation loop, the author decided to:

- Release the course materials to students via the course website one week earlier than the resuming of the semester.
- Revise the blog commenting deadlines so as to allow more time for students’ online interactions.

The author delivered the classes via ZOOM since 20 February, 2020 (figure 3).

**C. Third Implementation Loop (12 March to 16 April, 2020)**

Upon the reflections and findings in the first two implementation loops, the author realized the importance of the class blogging community in maintaining the social interactions and collaboration amongst the students. Therefore, she decided to further promote the students’ SEC in addition to the class blogging interactions. Related teaching activities carried out in the third implementation loop include:

- Discussion of case studies on online collaboration and social networking during online lectures;
- Showing and discussing the social network analysis results of the underlying online social network of the class blogging community to the students (figure 4);
- Inviting the students to reflect on their own collaborative learning experience in accordance to the social network analysis results obtained from their Python programming assignments.
Below are the first author’s reflections in the end of the third implementation loop:

- Students continued to show active interactions in the class blogging community.
- Students actively introduce external resources (e.g. research and case studies related to the course but not discussed by the author) into the community.
- Students could visualize their individual participations in the class-wide community from the sociograph, and relate their experience to the analysis results.

V. SUMMATIVE EVALUATION

In order to answer RQ1, a shortened version of the Epistemic Cognition Instrument (ECI) [2] was used to measure students’ beliefs associated to SEC by asking them to compare their views between the presence and the absence of the class blogging experience. The shortened-ECI consists of 10 four-point Likert scale response items (in five scales each consists of the “with” vs. “without” class blogging condition):

1. (Social epistemic aims) I have a strong social epistemic aim (such as establishing a common knowledge together, and explaining ideas to other individuals).
2. (Structure of shared knowledge) I have a clear picture about my classmates’ knowledge of this course.
3. (Source and justification of shared knowledge) I justify the information shared by my classmates before accepting it as my own knowledge.
4. (Social epistemic virtue and vices) I seek for the knowledge shared amongst our classmates using a careful attitude.
5. (Processes of achieving social epistemic aims) I adopt a collaborative attitude in achieving the shared knowledge with my classmates.

62 students had completed their questionnaires. The response rate was 84.90%. Cronbach’s alpha value of the 10 items was 0.768. The statistical analysis result is summarized in Table II. ANOVAs were performed to determine if SEC differs with and without the class blogging community experience. Statistically significant main effects for the “with vs. without blogging” factor are obtained in all scales, all favoring the “with” condition. In addition to the quantitative survey, students’ were invited to share their collaborative learning experience in their last blog posts. Most of the students expressed that they enjoyed the online interactions with classmates over the blogging community. Below are a few quotes from their reflections:

“It’s really a tough experience considering the influences caused by COVID-19 that we had only attended the class in the lecture room for 3 times. However, with the effort that everybody has been made to get the online class done well, I think this course is very valuable for me and will be having positive impacts on my way of thinking.”

“By browsing and commenting with my classmates, I can absorb everyone’s different and interesting opinions and find resonance. It has always been a pleasure to see that my opinions and thoughts can be accepted by others.”

“The result (0.0265) show that my betweenness centrality for each node is not very high, thus I think this course is very valuable for me and will be having positive impacts on my way of thinking.”

Table II: Students’ Beliefs Associated to Social Epistemic Cognition With and Without Class Blogging (N = 62)

<table>
<thead>
<tr>
<th></th>
<th>With Class Blogging</th>
<th>Without Class Blogging</th>
<th>F(1, 124)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social epistemic aims</td>
<td>3.25 (0.54)</td>
<td>2.75 (0.69)</td>
<td>21.05***</td>
<td>&lt; .00001</td>
</tr>
<tr>
<td>Structure of shared knowledge</td>
<td>3.24 (0.56)</td>
<td>2.21 (0.83)</td>
<td>67.34***</td>
<td>&lt; .00001</td>
</tr>
<tr>
<td>Justification of shared knowledge</td>
<td>3.24 (0.67)</td>
<td>2.87 (0.68)</td>
<td>9.23**</td>
<td>.002</td>
</tr>
<tr>
<td>Social epistemic virtue and vices</td>
<td>3.43 (0.56)</td>
<td>2.98 (0.75)</td>
<td>14.18***</td>
<td>.000255</td>
</tr>
<tr>
<td>Processes of achieving aims</td>
<td>3.46 (0.53)</td>
<td>2.94 (0.76)</td>
<td>20.07***</td>
<td>.00017</td>
</tr>
</tbody>
</table>

Note: **p < .01, ***p < .001

VI. CONCLUSION

We have reported an action research conducted in the spring semester of 2020, when most engineering students worldwide were not able to physically interact with their peers due to the global pandemic of COVID-19. Our goal of promoting SEC in engineering students during physical isolation has been achieved. Our conclusion is supported by evidence including quantitative survey results and qualitative feedbacks from students. The class blogging community, which was established in addition to the synchronous online class meetings, was effective in facilitating students’ online collaborations. Our experience shows that on top of the class blogging community, (1) teacher’s action research and (2) students’ social network analysis on their own community are two effective strategies in promoting SEC and online collaborative learning in engineering students.
REFERENCES


