# Collaborative Problem Solving Using Social Network Media: How to Effectively Evaluate Student Performance in Online Study Group?

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## ABSTRACT

The tremendous educational benefits of online collaborative problem solving have been confirmed in numerous research studies. Many researches cited advantages that include the development of skills of critical thinking and problem solving as well as skills of self-reflection and co-construction of knowledge. Mostly, they used dedicated collaborative environment to control the group dynamics and few have used and exploited the use of public social network media due to the concern how to treat and control learning process and prevent classroom disruptions. Moreover, the establishment and maintenance of active collaboration in online study group in collaborative environment is a challenging task, primarily due to students' inability or reluctance to participate actively in the group work. Aiming to understand and contribute to the resolution of the problems of effective online group, a motivational approach has been incorporated by means of social network analysis. The general contribution of the paper is to show students' collaborative effort/work on-time, allowing themselves to re-adjust their individual performance on-time in the social network and to strive and contribute solutions during collaboration. Applying the social network analysis, a reward is given to learners' effort and contribution in the success of solving collaborative assignments.

## KEYWORDS

Collaborative problem solving, social network analysis, e-learning, social network media.

## 1 INTRODUCTION

Collaborative problem solving receives a significant attention for its potential to increase problem solving skills [1] improve critical thinking [2] and knowledge acquisition [3] among learners. Collaboration describes social interaction within a group or a team, when students actively talk, share their cognitive resources and produce a single outcome. Students work in teams and act as one and confront problems as they occur. Although they get insufficient information, students must settle on the best possible way to solve the problem presented to them since a number of alternative solutions must be examined and analyzed to meet the goal. Brindley, Walti and Blaschke [4] observed that groups have been found to outperform individual members of a learning community in a higher order thinking such as problem solving and critical thinking.

Collaboration in a small group has been particularly recognized as both advantageous to and are appreciated by students. It has been shown that small groups enable students to identify and correct misconceptions more easily and quickly and improve understanding of the topics being studied [5]. Springer, Stanne and Donovan [6] found that small group provides students with a better learning experiences, understanding and ultimately greater academic achievements, whereas the work of Brindley et al. [4] reported that students often prefer working in a small teams over large study groups.

Despite all the above mentioned advantages of collaborative learning, when collaboration is taking place in online learning settings, students are often reluctant to participate actively. The main reasons for this reluctance include the following: sense of not having full control over the quality of the group work and the subsequently assigned grade [4], concerns that there might be a group member with less than satisfactory performance to whom other members will have to compensate [7], and time required for effective collaboration – group work requires students to stick to a particular schedule, thus reducing the flexibility and convenience of online learning [8]. For these reasons, the researcher proposed a mechanism that motivates the learner to actively participate in the learning process by showing the individual performance

of all learners during collaborative assignments on-time.

### 1.1 Social Media for Collaboration

In the field of e-learning, collaboration usually takes place using pre-programmed agent or animated character agent by virtually deceiving the learner that someone is helping him in the learning process, but in reality it was pre-programmed based on the learner's prior knowledge and personal profile. Many researchers have been trying to develop collaborative software and integrate it to e-learning module but none of which have surpassed the power of human socialization. For example, early e-learning system with animated agent cannot joke, greet and show facial expressions because of its limited domain, complexities, several issues and constraints [9]. These simple gestures can build rapport and develop personal and affective relationships among members and somehow affect the overall performance of the learning group. Thus, instead of pre-defined and pre-programmed socialization; social networking has been adopted as collaborative tool and incorporated inside e-learning system.

The growth of social networking has created new opportunities for collaboration in problem solving [10]. University of Cambridge posted a problem in mathematics using blogs and solved it within six weeks known as Polymath I [11]. Social networking media lets people rendezvous, connect or collaborate, support network of people, share content and services that are more adaptable and responsive to changing needs and goals [12]. Social media have already led to widespread adoption of portfolios for learners bringing together learning from different contexts and providing an on-going record of lifelong learning, capable of conveying expressions in different forms.

The rapid diffusion and public acceptability of social network media such as Facebook, Yahoo Messenger, Windows Media Live and Skype have enabled users to connect with people more than ever before. Students use social media at school for various purposes such as socialization, sharing experiences, exchanging informations and vice versa [13]. Whereas, many instructional strategist or educators are concerned with how they should treat social media in order to prevent classroom disruptions. Social media provide affordable resources and collaborative problem solving that can build social learning environment in a way that was not possible before. Recent researches show that the educational use of social media have significant potential in collaborative problem solving [5] and blended learning in e-learning systems.

### 1.2 Social Network Analysis

Social network analysis (SNA) is the mapping and measuring of relationships and information flows between and among members in the groups. By conducting SNA, several factors and essential benefits can be revealed, and study of the process of collaboration somehow affects the performance of individuals. Some students become leader then gradually fade while others become active and later inactive and many others. Through this, we will be able to unmask properties of socialization and collaboration and reveal the centralities. To understand social network and their participants, educators evaluate the location of actors (students) in the network. These measures give us insights into the various roles and groupings in a network – who are the connectors, leaders, bridges, isolates, where are the clusters and who is in them, who is the core of the network, and who is the periphery. There are many important properties within a social network that relate to the identification of the power of relationships in the network structure. It was revealed that certain participants in collaborative online learning communities have a greater power within the community than others. This was evident in the study when comparing the fact that some participants attracted a number of responses to their queries while others attracted no responses and quickly become isolated [14]. To perform social analysis, three centralities have been incorporated during collaborative assignments: degree of centrality, betweenness centrality and closeness centrality.

The degree of centrality refers to the number of connections that a node contains and indicates the level of activity of a node within a study group. The general idea is that, the greater a node's degree is the more potential influence it

has on the network and the more potential influence the network has on it. On the other hand, betweenness centrality refers to the fraction of the number of shortest paths that flow through a node. It is an indicators on how information flows through a social network graph. Nodes that occur on many shortest path will have a higher value of betweenness than those that do not, while closeness refer to the geodesic distance of a given node to all other nodes in the graph. The closeness of a node indicates how easily a node can be reached. In general, a node with a relatively high level of closeness can be more easily reached and received information more quickly.

If these centralities will be shown and a numerical value is extracted from the collaboration network, student will be able to see their individual performance and strive to actively participate in problem solving. The numerical value generated from the network analysis will also serve as justification on how students' mark is proportionately given and distributed according to the learners' effort in collaboration environment.

## 2 METHODS

Participants were enrolled in Design and Analysis of Algorithms, one of the core computer courses that requires mathematical analysis and algorithmic program. The study was conducted for two semesters at the university. Group members were randomly selected. The topics included in the course Algorithm in e-learning module have been selected/driven either by the problem's practical importance or by some specific characteristic making the problem an interesting research subject. The following topics have been included in the module such as sorting techniques, searching algorithms, string processing, graph problems, and combinatorial problems. These topics are all suitable for collaborative problem solving.

The study supported blended learning approach in e-learning by combining on-site studies, face-to-face guidance and collaborative problem solving using social media such as Facebook, Windows Live Messenger and Yahoo Messenger. Student can activate by clicking the social media icon for Facebook, Yahoo Messenger, Windows Live Messenger that were incorporated in the e-learning module. Each group freely chooses social media on their own. During on-site study, the students get familiarized with the topics (e.g. sorting problems). The e-learning module/materials discussed how time complexities will be computed and expressed in mathematical notations and presented in different media format. These media formats could be in the forms of animations, simulations that allows "learning by doing", executable programs with program code analysis, numerous examples and illustrative materials. Other related problems will be left for collaborative problem solving using social media.

The students are required to discuss their problems and share their ideas in the social network environment until they agree and arrive with the final solution of their given problem. The final output of the students include discussions and computation of time complexity of an algorithmic problem. Also, each group is required to submit their program code implemented in C++ or Java with the attachment of their communication threading during the collaboration process.

During collaboration, a facilitator who is in-charge of the course is a member of all the groups and usually view and see the communication threading. The facilitator will never comment and just read the threaded messages but can press the "like" button signifying that sessions are relevant to the problem. The participants are also permitted and welcomed to use the open forum for both casual conversation and information sharing (Facebook), invite to conference (Yahoo Messenger) and request for remote assistance (Windows live Messenger). All activities are conducted on group page, which is setup for use by small study groups. Students will be able to view their performance in the network while collaborating to other members of the group by copying the communication threads and pasting them to Dedicated Social Network Analysis software (DSNA). The DNSA is a chat software that can socially analyze the communication thread by converting it into social network graph

and dynamically computing centralities (performance matrix indicator). Students will be able to view their numerical performance value such as degree of centralities, betweeness and closeness centralities, thereby adjusting themselves in the collaboration process and motivating them to continue making contributions in solving problems via social media.

Through social analysis, Instructors will be able to view the numerical performance of the students and become the basis of their individual grades. Social analysis will show who becomes the leader, how much weight the learners contributed in learning process, who did not contribute, who suggest solutions, who do the follow-ups, who do the research and many other relationships can be unmasked.

## 3 RESULTS AND DISCUSSION

Social network analysis (SNA) is the mapping of and measuring relationships and collaborative effort between people, groups and organizations and other knowledge entities. Applying the SNA in collaborative problem solving, justify how an instructor will be able to give marks according to individual contributions in problem solving process. Preliminary part of the study shows the communications threading of the student in Figure 1.

**Mosbah**: Saber, the binary search problem is found in page 87 please take a look.
**Saber**: Mosbah, the binary search must be sorted first.
**Senusi:** Mosbah, does it mean we will sort the given elements first?
**Saber:** Senusi, yes we will, please review the best sorting algorithms first.
**Zakaria**: Saber, let us apply the merge sort, instead of quick sort – I remember our previous discussion the problem of quick sort.
**Senusi:** Zakaria, it's ok.
**Mosbah:** Jamal, sort the elements given to us and tell us the running time of merge sort, we will try to check it soon for binary search
**Jamal:** Saleh, let us join for this part
**Saleh:** Jamal, no problem I will see, I'll come in your house and have coffee.

**Figure 1.** Social Media Threading Snapshots of Different Members in Solving Collaborative Assignments using Binary Search Algorithm Problem Copied and Pasted to DNSA.

Figure 1, shows the snapshots of the conversation threading among the group members. During the exchange of messages sender (*S*) communicate with receiver, (*R*), creating a node between two learners. For example, Mosbah (*S*): Saber (*R*) of line 1 in Figure 1 established a connection between the node of Mosbah and Saber. Analyzing the communication threading provides a dynamic bases of social network graph shown in Figure 2. The graph is dynamically changing as the chat keeps going and changing. Student will be able to see their effort numerically on-time and compete among the members on how they contribute to the problem solving process by copying and pasting their current threads to DNSA.

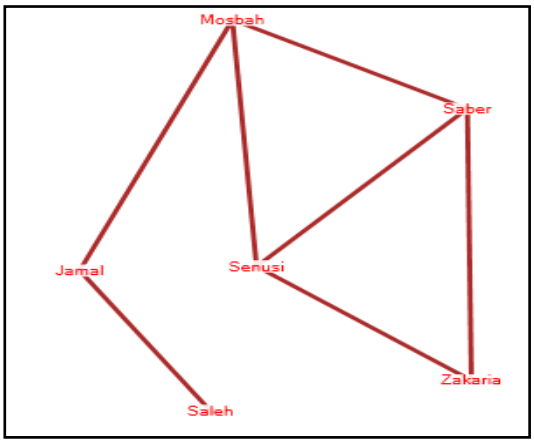


**Figure 2**. Graph Equivalent of the Social Media Threading Snapshots of Figure 1, illustrating the collaboration among Group Members converted by DNSA.

Figure 2, shows the converted graph of the communication threading where Mosbah directly communicated with different learners in the group such as Jamal, Senusi and Saber. Other connections is reflected in the graph. Through the dynamic graph, students will be able to see their efforts numerically on-time and compete among the members on how they contribute to the problem solving process. The higher their collaborative effort is, the higher their individual mark is.

The group social network graph re-computes students performance matrix every time the students refresh their collaborative efforts window indicating each numerical value and equivalent as seen in Table 1.

Table 1 shows that Mosbah emerged as the most powerful/leader in the group together with Saber and Senusi with their degree effort of .6. In terms of friendship and helping other and communication to other members, Mosbah emerged with .71. This is evident from the graph since all other members is trying to associate with Mosbah, hence the lower the closeness score is the more you hold control in the social graph. In terms of its relevance among all members, Mosbah has the highest betweeness value of .7 followed by Saber as shown in the table. Without Mosbah, other players become isolated and cannot communicate with other members.

**Table 1.** Numerical Equivalent of Graph given in Figure 2, indicating Individual Performances in DNSA

| Student | Degree | Normalized | Closeness | Normalized | Betweeness |
|---|---|---|---|---|---|
| Mosbah | 3 | 0.60 | 7 | 0.71 | 0.70 |
| Saber | 3 | 0.60 | 8 | 0.63 | 0.50 |
| Senusi | 3 | 0.60 | 8 | 0.63 | 0.30 |
| Zakaria | 2 | 0.40 | 11 | 0.45 | 0.00 |
| Jamal | 2 | 0.40 | 9 | 0.45 | 0.30 |
| Saleh | 1 | 0.40 | 13 | 0.38 | 0.00 |

## 4 CONCLUSION

This paper is implemented as an initial phase of the study and is still on-going, subject to deeper analysis and discussion. The authors were able to study/investigate that the use of social network analysis during the actual collaboration is possible by extracting numerical value from the threaded messages of learners in real time. The extracted numerical value is the individual effort contributed by the learners in problem solving, thereby, justifying how a marking system could be attributed to learners' performance. It is hypothetically concluded that by showing to learners their actual effort points, they will actively communicate and contribute to the learning process and increase their motivation to participate in the collaboration. Increasing motivation is tantamount to increasing problem solving skill, critical thinking and construction of knowledge. Full results will be available for publications with more in-depth analysis and hoping to discover more relationships among individuals, groups, social network media preferences and comparative performance among the group.

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