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COLLABORATIVE PROBLEM SOLVING USING PUBLIC SOCIAL NETWORK MEDIA: ANALYZING STUDENT INTERACTION AND ITS IMPACT TO LEARNING PROCESS

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ABSTRACT

This paper examines the use of social network media at three aspects in African and Libyan perspective. Firstly, to use social network media as an open network learning environment that provide service for interaction necessary for learners to support socialization and collaboration during problem solving. Secondly, to use social media as a tool to support blended learning in e-learning system and encourage non-native English students to express their ideas and fill the gap of communication problems. Thirdly, to analyze the interaction of the learner in social media threaded messages and its relation to group and individual performance using different social schema and social network analyses. Quasi-experimental results indicate that there is an increase on the cognitive level of students at different level while qualitative results reveal that it helps deepen learning, memorable, have freedom to express opinions and lessen pressure and increase communication and socialization.

KEYWORDS

blended learning, collaboration, e-learning, network learning, socialization, social network media

1 INTRODUCTION

Learning English is not mandatory in Libya, few years back the language has never been integrated in the curriculum and English was static and never been practice outside the school. Thus, foreign lecturers who were tasked to deliver computer science and information technology education suffered communication gap among learners and used different method to lessen the problem. One method is to employ e-learning systems that allows students to learn freely at their home and at school whenever possible. Given the emerging technology, from static e-learning (absence of multimedia and purely textual) becomes dynamic as evidence by several researches in e-learning development. The use of multiple agents [1],[2] and social media in e-learning system have been used [3][4], genetic algorithm and personalization [5][6] interactive and socially capable agent [7] [8]and socially deceiving agent [9] have been studied. With those papers, it's been very obvious that socialization becomes a major component of e-learning systems to cater the needs of the students. Through this paper, the students are encourage to use social network media and collaborate, solve problem using FaceBook, Yahoo Messenger, Window Live Messenger, Skype or other network technologies capable to support networked learning. Further, we have investigated the use of social network media as part of the blended e-learning system by analyzing the threaded messages of the students by studying its impact on the performance both in group and individual level during collaborative problem solving.

Collaborative problem solving receives a significant attention for its potential to increase problem solving skills [10],[11],[12],[13], improve critical thinking [14],[15],[16] and knowledge acquisition [17],[18] and academic achievements [19]]among learners. Collaboration describe social interaction within a group or a team, when students actively talk, share their cognitive resources and to produce a single outcome [20]. Students work in teams and act as one and confronting problems as they occur [21]. Although they get insufficient information, students must settle on the best possible way the problem presented to them [22]. In problem solving, a number of alternative solutions must be examined and analyzed to meet the goal. However, meeting

the goal is not that easy, since it will entail proper communication and conversation among members in the group. One should not feel superior or inferior among others; otherwise a catastrophic effect in the learning process will occur.

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 learner's prior knowledge and personal profile. Many researchers have been trying to develop collaborative software and integrate 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, issues and constraints [23]. 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 for collaboration.

The growth of social networking has created new opportunities for collaboration in problem solving [13],[24]. In 2009, University of Cambridge posted a problem in mathematics using blogs and solved within six weeks known as Polymath I [25]. Social networking media let people rendezvous, connect or collaborate, support network of people, share content and services that are more adaptable and responsive to changing needs and goals [26]. Social media have already led to widespread adoption of portfolios for learners bringing together learning from different context and providing an on-going record of lifelong learning, capable of expression in different forms.

The rapid diffusion and public acceptability of social network media such as Facebook, Yahoo Messenger, Windows Media Live and Skype have enable users to connect with people more than ever before. Student used social media at school for various purposes such as socialization, sharing experiences and exchange information and vice versa [27]. While 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 that can build social learning environment in a way was not possible before and collaborative problem solving. Recent research shows that the educational use of social media have significant potential in collaborative problem solving [1],[24],[28] and blended learning in e-learning systems.

In this paper, our main objective is to experiment whether public social media can help students in collaborative problem solving, improve learning delivery by employing such technology and one way to encourage non-native English student to express their idea. The researcher believed that students suppressed their sharing ability and team-based attitude due to communication difficulty. In the experiment we will try to prove and encourage e-learning stakeholder to consider implementing e-learning with blended environment using social media. The researcher believed that we can establish the benefits of employing social media in the learning process such as knowledge transfer, skill acquisitions, teambuilding, collaboration, socialization and their perceptions towards the used of this technology.

The paper is organized according to the following; discussion of study and methodologies, findings and discussions, and conclusions

2 THE STUDY

2.1 Participants and Materials

Participants were enrolled in Design and Analysis of Algorithms, one of the core computer courses that requires mathematical analysis and algorithmic program. The study has been conducted for two semesters at university with 48 students, the first semester composed of 20 students with 12 females and 8 males and divided into 4 groups consisting of 5 members while the second semester composed of 28 students, which is composed of 21 females and 7 males and

divided into 5 groups consisting of 5 or 6 members; overall, there were 9 groups in the study. Group members were randomly selected as suggested by [29],[30].

The topics included in the course Algorithm in e-learning module have been selected/driven by 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, combinatorial problems. These topics are all suitable for collaborative problem solving.

2.2 Program Overview

The study was created as a blended learning approach 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. Each group freely chooses social media on their own with 5 Facebook, 3 Yahoo Messenger and 1 Windows Live Messenger.

During on-site study, the students get familiarize with the topics e.g sorting problems. The e-learning module discussed how time complexities will be computed and expressed in mathematical notations. There are many possible solutions of the sorting problem and 2 of which will be presented using simulations, with program code, and time complexities computation. Others will be left for collaborative problem solving using social media. The students are required to discuss their problem and share their idea in the social networking site until they agree and arrive with the final solution of their given problem. The final output of the students will include computation of the time complexity and its algorithmic program implementation.

During collaboration, facilitator who is in-charge with 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 is 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 are setup for use by small study groups.

During face-to-face session, students are required to submit their progress report including the printout of their sessions, program code or pseudo-code and computation of time complexity. They are also required to present and share to other groups their solution to problems.

2.3 Data Collection

The data used in this study are both quantitative and qualitative. The quantitative data used survey to collect the demographic profile of the learner such as gender, age, year level and grade point average. After reading the on-line materials of Design and Analysis of Algorithm, the students were asked to answer set of questionnaires about the course. The same set of questionnaires were administered after collaboration and compared their performance both for group and individual using Bloom's Cognitive Test [31]. In analyzing the threaded messages of the group, four approaches were used; counting in and out-messages, coding the learning process using Veldhuis-Diermanse Schema Technique, tutoring and communication process analysis using Anderson Schema and social network connectivity (SNA) using NodeXL software to analyze density of collaboration and social centralities [32],[33],[34].

The qualitative data on the other hand were collected via students description and opinions and then combined to note emerging pattern to gain understanding of the learner experience in the study. Data were re-analyzed until saturation had been reached.

3 FINDINGS AND DISCUSSIONS

For the purpose of epitomizing the results and analysis, some groups were selected for interpretation. We are also assuming that the learning process are actually represented by the expression we are coding drawn from the schema. The limitation of the coding process is that linguistic expression varies accordingly based upon the intentions and motivation of the learner. Nevertheless, the codings suggest some clear pattern in the study.

3.1 Quantitative Analysis

The quantitative data regarding the demographic profile of the learner shows that there are 15 males and 33 females with age mean of 22 and standard deviation of 2.0. Year level of all the learners belong to 4th year with a grade point average 63.5 and a standard deviation of 10.1

3.1.1 In and Out Messages

Table 1 shows the in and out-messages of all the group with 573 total messages encoded during the collaboration. Out of 573 messages, 344 or 60% of the total encoded is an in-messages while 229 or 40% is out-messages. In-messages are the number of messages contributed by all groups related to the problem at hand while the out-messages are interjected social interaction. Though out-messages are threaded communication that are not related to problem, it becomes integral in the overall collaboration by providing informal communication. Informal communication entice the collaboration by making jokes, creating relationship, encourage to talk and share opinions, thus, allowing learner to increase their level of collaboration. Among the 9 groups studied, Group 9 emerge with 101 messages (66 in-messages and 30 out-messages), Group 1 contributed 82 messages (62 in-messages and 20 out-messages) while Group 6 contributed 82 total messages (34 in-messages and 48 out-messages). It appears from the table that Group 9 is the most serious group during collaboration as indicated by 66 in-messages. Group 6, 4 and 2 are the most least sociable group with 5,10,15 out-messages reported respectively. This is perhaps attributed to random selection of participants. Group 8 has a 51 out-messages making it the most sociable group as indicated by many times used of social interjection like greetings to one another, asking how is family life, asking about weather, news and others, evident to Arab learners' everyday life.

Table 1. In and Out-Messages of Different Groups During Collaboration

Type of Massages (No. of Members)	Group 1 (5)	Group 2 (5)	Group 3 (5)	Group 4 (5)	Group 5 (6)	Group 6 (6)	Group 7 (5)	Group 8 (5)	Group 9 (6)
In-Messages (344)	62	24	26	60	34	28	26	18	66
Out-Massages (229)	20	15	25	10	48	5	20	51	35
Total Messages (573)	82	39	51	70	82	33	46	69	101

3.1.2 Coding Schema

Analyzing the threaded messages, two coding schema have been adapted for analysis. The first coding schema is developed by Veldhuis-Diermanse Schema [34], was used to code units of meaning focusing on learning processes that includes the three main categories: cognitive activities - used to process learning content and to attain the learning goals; metacognitive knowledge and metacognitive skills - used to regulate the cognitive activities; and affective activities - used to cope with feeling occurring during learning. The second schema is the Anderson [35], was used to attempt to reveal the ways in which the participants were facilitating and regulating each other's learning, while undertaking the collaborative problem solving. This schema involves three activities: design and organization, facilitation of discourse and direct instruction activities. Capturing these activities using strict syntactic rules analysis is difficult and not possible

due to elaborative nature of discussion nevertheless it was coded using the guided example provided by the two coding schema.

Veldhuis-Diermanse Schema

Table 2 summarized the coded learning processes using Veldhuis-Diermanse Schema where type of learning has been divided into four subgroups; Cognitive, Affective, Meta-cognitive and Others. Other category is the number of out-messages. Among the 344 in-messages from Table 1, it was further breakdown to Cognitive category with 155 or 45% of the total in-messages , Affective with 91 or 26%, and Meta-cognitive with 98 or 29%. For cognitive category, Group 1 has 30 messages, Group 9 with 27 messages and Group 4 with 25 messages, they were ranked 1, 2 and 3 respectively. In this category, member of the groups debated and discussed, used external information and experiences and linked internal information or concepts found. It involves knowledge and the development of intellectual skills by recall or recognition of specific facts, procedural patterns, and concepts that serve in the development of intellectual abilities and skills.

In the affective category, the same set of group emerge, Group 9 produce 18 messages, Group 1 with 17 and Group 4 with 15 messages. These means that these groups value the feelings of other learner by carefully criticizing their opinions and their suggestions. It includes manner to deal with emotions, feelings, values, appreciation, enthusiasms, motivations, and attitudes. Group 2, 5 and 6 are the least affective group. This could be attributed to feeling of strangeness within the group. Looking at the meta-cognitive learning category, Group 9 has 21 messages, Group 4 has 20 messages and Group 1 has 15 messages. Usually, this category viewed learners as more on planning, clarifying matters, asking for more suggestions and monitoring other learners. This means that students collaborated and discussed solutions, the learner with the most convincing possible solutions will be adapted and become basis in the threading. The learners are trying to contribute and help to achieve the goal.

Table 2. Units of Meaning Coded for Learning Process(Veldhuis-Diermanse Schema)

Type of Learning Process	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9
Cognitive (155)	30	12	10	25	18	13	14	6	27
Affective (91)	17	4	10	15	6	7	8	6	18
Metacognitive (98)	15	8	6	20	10	8	4	6	21
Total (344)	62	24	26	60	34	28	26	18	66

Anderson Schema

Table 3 summarized the Anderson schema of how communication and tutoring takes place in the social network media. This schema is divided into three subgroups; direct instruction, facilitation and instructional design. Direct instruction receives the lowest messages in the schema throughout the entire activity of all group with a total of 70 coded messages or 20% out of 344 in-messages. Group 9 has 16 messages, contributing 24% , Group 1 has 15, contributing 24% and Group 4 has 13 messages, contributing 22% in their group respectively. This is not surprising given that the group was engaged in collaborative activity that drew own members' individual resources and other materials to which they were directed before the activity commenced. Members were hesitant at first how to present their ideas and questions to the group. Due to communication gap and estrangement, students are not reluctant to share knowledge unless being asked to do so, not to mention their personality issues and poor understanding of the problem at hand.

Table 3. Units of Meaning Coded for Tutoring and Communication Process (Anderson Schema)

Type of Tutoring Process	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9
Direct Instruction (70)	15	7	2	13	8	8	7	3	16
Facilitation (120)	20	7	14	18	12	9	9	5	20
Instructional Design (157)	27	10	10	29	14	11	10	10	30
Total (344)	62	24	26	60	34	28	26	18	66

Facilitation has 120 total messages out of 344 in-messages or 35% have been coded into this category. Group 1 and Group 9 coded with 20 messages respectively followed by Group 4 with 18 messages. In this category, indicators show that student making agreement/disagreement, seeking understanding/consensus, reinforcing student contributions and assessing the efficacy of the collaboration process.

Instructional Design composed of 157 messages or 45% of the total 344 in-messages. Examining the performance of each group in this category shows that instructional design category receives the highest number of messages in the schema. From the table, Group 9 has a total of 30 messages followed by Group 4 with 29 messages and Group 1 with 27 messages. This is not surprising because this is where the students are starting to set their goals and how to deal with the problem. Learners are currently negotiating how to deal with the problem, establishing parameters and deadlines, and assigning task to members. An indication that collaboration will take place effectively.

The learning and tutoring pattern that have emerged from this coding analysis provide some insights into the dynamics of individuals and group behavior in social network environment. Collaborative learning is dependent on individual contributions. But the benefits of doing collaboration have a big impact on individual learning process; transforming learners to become independent.

3.1.4 Blooms Cognitive Level and T-test

To determine the benefits and impact of collaborative problem solving, an exam was conducted. Table 4.1 and 4.2 shows the comparative cognitive level based on pre and post-exam results by the groups. In the exam, a total of 18 items have been asked with 3 items in each category. The two tables show the six classification based on Bloom Taxonomy of Cognitive learning; Evaluation, Synthesis, Analysis, Application, Understanding and Knowledge. Table 4.1 show the results/performance of each group upon reading the e-learning module while Table 4.2 was taken after the collaborative problem solving.

Table 4.1 Blooms Cognitive Level Coding of Different Groups (after reading e-learning module)

Cognitive Level	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9
Evaluation	1	0	0	1	0	0	0	0	1
Synthesis	0	0	0	1	0	0	0	0	1
Analysis	1	0	1	0	0	0	0	0	1
Application	1	0	0	1	0	1	0	0	1
Understanding	1	1	0	2	1	1	0	1	2
Knowledge	2	1	1	1	1	1	1	0	3

Table 4.2 Blooms Cognitive Level Coding of Different Groups (after collaborative problem solving)

Cognitive Level	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9
Evaluation	2	0	0	3	1	1	0	1	1
Synthesis	2	1	1	1	1	1	0	0	2
Analysis	3	1	1	2	1	1	1	1	3
Application	3	1	2	2	2	1	1	1	2
Understanding	3	2	3	3	3	2	2	2	3
Knowledge	3	2	3	3	3	3	2	1	3

Based on group performance, Group 1 and Group 4 were taken for analyses. For group 1 there is a significant increased in all the categories; Evaluation increased by .33, Synthesis, Analysis, Application, and Understanding are all increased by .66, while Knowledge increased by .33. For Group 4, it shows a dramatic increase for Evaluation by .66, Synthesis remain at .33, Analysis increase by .66, Application increase by .33, Understanding increased by .33 and

Knowledge remain at 1; a perfect score for pre and post-exam. For knowledge category, students exhibit memory of previously learned materials by recalling the content of the e-learning module, so it is not surprising that in the pretest, these categories have high result.

Understanding category also increased due to prior knowledge taken by the students from the e-learning module, students were able to organize, compare and interpret data given a change of the input of the algorithmic problems of the course presented to them during collaboration. Initially, Synthesis and Evaluation have the lowest value but it is where the cognitive level significantly increased. The highest cognitive level in Blooms taxonomy is Evaluation where student are expected to demonstrate the ability to validate data based on predefined criteria. Student for example, were able to prove that the time complexity of sorting technique varies accordingly as input changes. Another criteria in analyzing the algorithm is generality, where certain inputs can be changed into different format and re-evaluate their coded program to fit the new input. In the Synthesis, students can change the program from one data types to another, e.g. from integer, to character, or string or another data types in their coded program. These changes were not specifically mentioned in the e-learning module but it was observed and illustrated during collaborative problem solving.

In the study, we want to show that working by group collaboratively in the area of problem solving can increase critical thinking, understanding, and other cognitive domain, that when applied individually it will lead to an increase of individual performance credited from collaboration. Table 4.3 shows the average individual cognitive difficulty level of Group 9. The result of the pretest (after the e-learning module) and the posttest (after the collaboration) show that there is a significant increase of individual learners in different cognitive level; Knowledge from .60 to .98, an increase of .38, Understanding from .28 to .93, an increase of .64, Application from .55 to .77, an increase of .22, Analysis from .06 to .60, shows a dramatic increase of .54, Synthesis from .38 to .55, an increase of .17 and Evaluation from .11 to .50. an increase of .39. Further, the table reveals that from Analysis up to Evaluation level, majority of the learner failed to answer correctly during the pretest but increase significantly after collaboration. This is quite considerable since students are still relying on their individual knowledge and effort.

Table 4.3 Blooms Cognitive Level
(Individual Indicators - Before and After Collaboration)

Group 9	Knowledge		Understanding		Application		Analysis		Synthesis		Evaluation	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Member 1	0.33	0.98	0.33	0.66	0.33	0.66	0.00	0.33	0.33	0.33	0.00	0.33
Member 2	0.33	0.98	0.33	0.98	0.00	0.66	0.00	0.33	0.33	0.66	0.00	0.66
Member 3	0.66	0.98	0.33	0.98	0.33	0.66	0.00	0.66	0.33	0.66	0.00	0.66
Member 4	0.98	0.98	0.33	0.98	0.66	0.99	0.00	0.98	0.33	0.66	0.33	0.33
Member 5	0.66	0.98	0.00	0.98	0.98	0.99	0.33	0.98	0.00	0.66	0.33	0.66
Member 6	0.66	0.98	0.33	0.98	0.98	0.66	0.00	0.33	0.33	0.33	0.00	0.33
Average	**0.60**	**0.98**	**0.28**	**0.93**	**0.55**	**0.77**	**0.06**	**0.60**	**0.28**	**0.55**	**0.11**	**0.50**

Table 4.4 Comparative Group Performance of All the Group in 2nd Semester
(T-test Before and After Collaboration)

Group	Exams	Mean	Stand. Deviation	Maximum	Minimum	Range	T-test
Group 5	Pretest	3.16	1.17	5	2	3	.000118 < .05
	Postest	10.1	2.56	14	7	7	
Group 6	Pretest	4	1	5	3	2	.000742 < .05
	Postest	10.6	2.61	14	8	6	
Group 7	Pretest	3.8	2.16	5	0	5	.000215 < .05
	Postest	10.8	2.77	14	8	6	
Group 8	Pretest	4.8	1.48	7	3	4	.000254 < .05
	Postest	12	2.12	14	9	5	
Group 9	Pretest	4.83	1.72	8	3	5	.000235 < . 05
	Postest	12.83	3.06	14	9	8	

Table 4.4 shows students' pretest and posttest result analyses which include the mean, standard deviation, maximum score, minimum score, range and t-test. Among the 5 groups, Group 9 emerged with a highest posttest 12.83 mean with an increase of 8, followed by Group 8 with 12 with an increase of 7.2, Group 7 with10.8 with an increase of 7, Group 6 with an increase of 6.6 and Group 5 with an increase of 6.94. The standard deviation before and after increased at all groups while minimum and maximum before and after collaboration shows a dramatic increased at all levels, signifying a knowledge transfer has occurred during collaboration. To test the difference between the mean of the two exams if statistically significant, t-test evaluation was conducted. Group 6 received the highest t-value with .000742, followed by Group 8 with .000254, Group 9 with .000235, Group 7 with .000215 and Group 5 with .000118 respectively. All the T-value is accepted with .05 cut-off criterion. This mean that the difference is not likely to happen by chance, and therefore, statistically significant. Overall, there is a general indication that there is a positive effect of using public social media as a collaboration tool. Further concluded that a knowledge transfer occurred and skill acquisition acquired.

3.1.5 Social Network Analysis

Social network analysis (SNA) is the mapping and measuring of relationships and information flows between members in the groups. By conducting SNA several factors and essential benefits can be revealed and study how the process of collaboration somehow affect the performance of individuals. Some students become leader then gradually faded while other 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 networks and their participants, we evaluate the location of actors 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.

Starting with SNA analysis of Figure 1 and 2, it is clear that participation over time is dynamically changing as all groups becoming more interconnected and communicated to solve problem. Initially, the overall tendency is to act as a group and getting familiar to each other. There are central and peripheral participants, but the interaction are not centralized around a few "dominant" participants. Based on the preliminary collaboration phase, Eman dominates Group 5,

Sadiya for Group 6, Mona for Group 7, Fathiya and Saber for Group 8 and 9 respectively. Participants tend to communicate to the person whom they perceived intelligent or have exceptional characters among the groups.

As deadline approaches, collaboration tend to change and communication effort become more dense. Figure 2 shows how interaction seems to change more drastically throughout the ending part. The central participant in the preliminary collaboration phase have established their position except for Group 9 where initially it was Saber but was taken gradually by Mosbah. It is very interesting to note that other central players of other groups seem to collaborate with Mosbah, making him the most active and the most influential node in the network. He become the connector or a hub in the network making the connections to other groups vulnerable. If Mosbah node is damaged or removed, the network quickly fragments into unconnected sub-networks. A highly central node can become a single point of failure. Also noted that during preliminary collaboration, many nodes have been isolated such as Hadi, Aisha, Mariam, Amira and Naja2 but gradually become active and communicate among members in the group. Central node or the most connected node in each group network seems given an authority by all member to communicate outside, a common practice of an organized team learning.

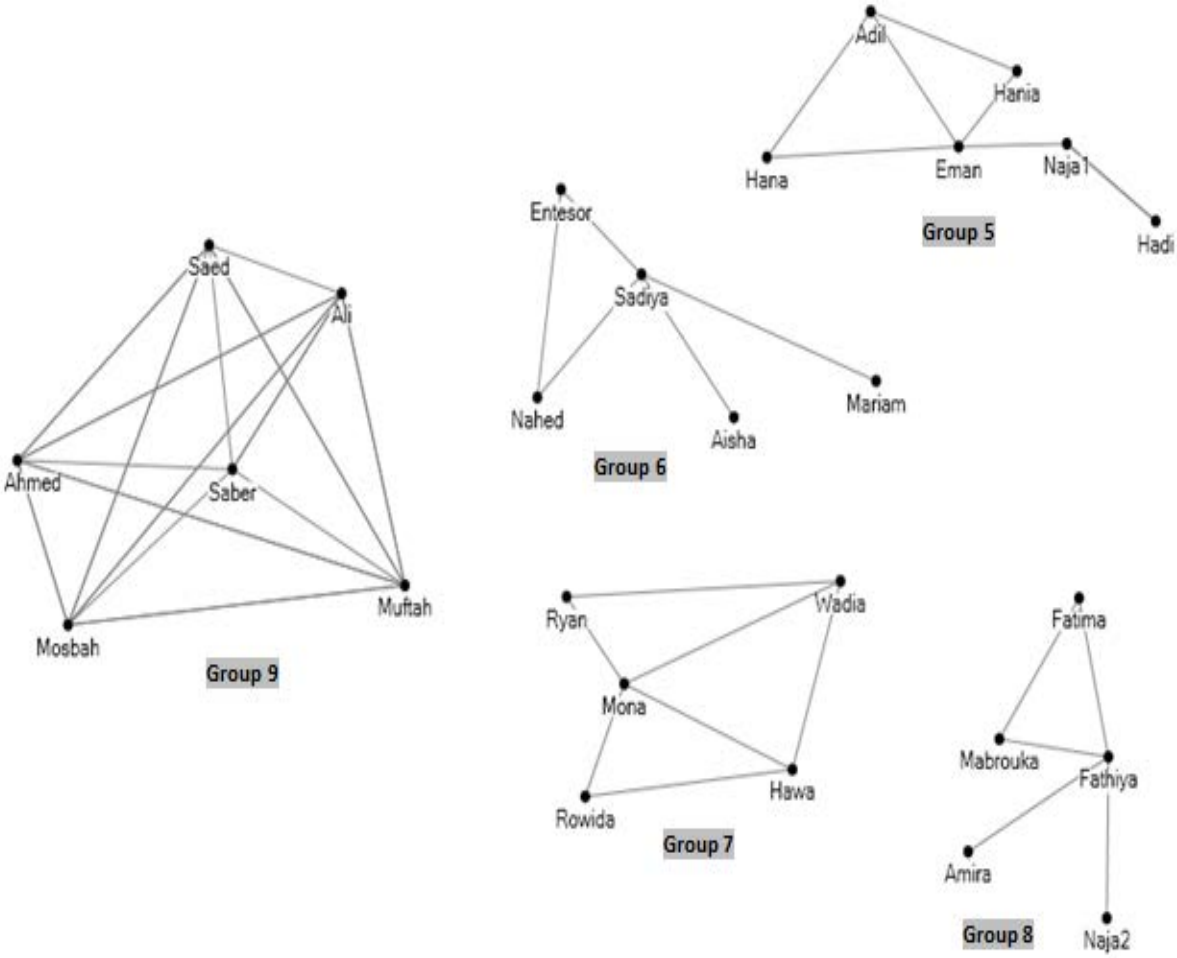

Figure 1. Preliminary Density Group Collaboration

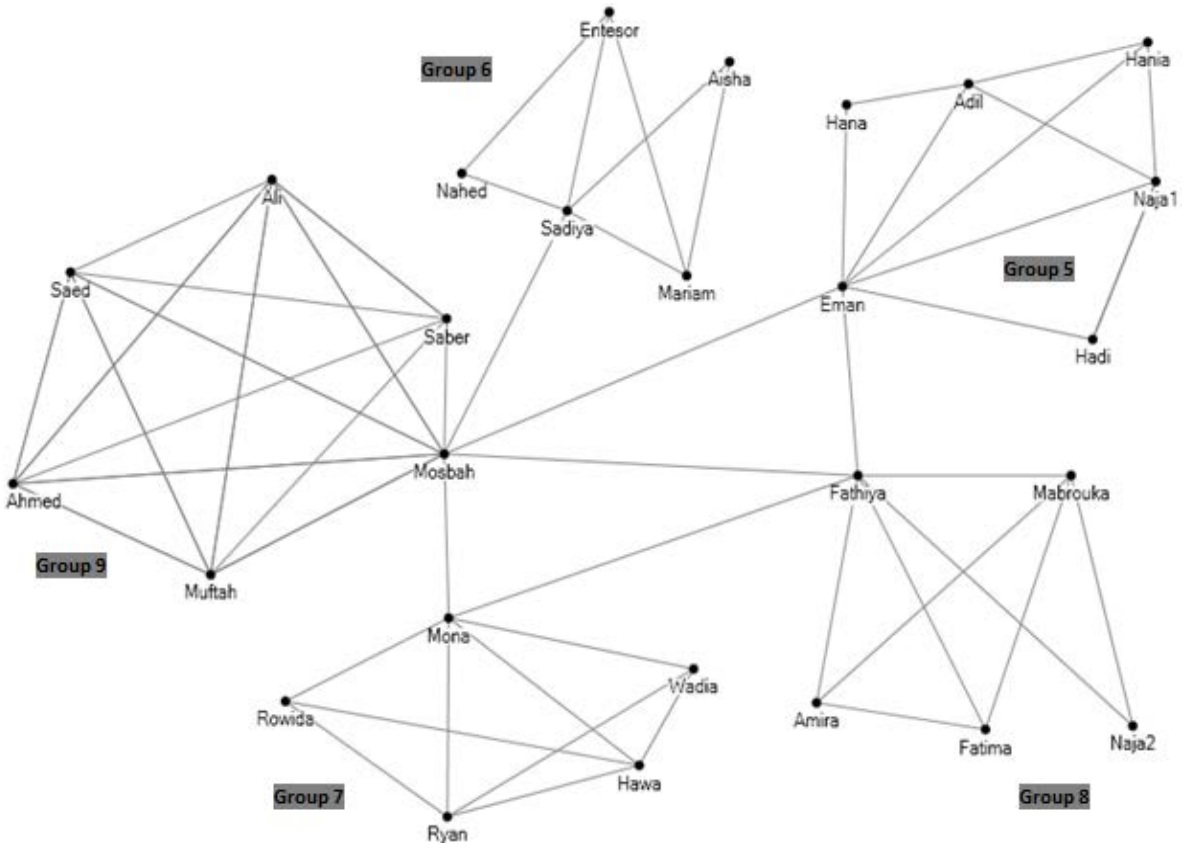

Figure 2. Post Group Collaboration

Taking deeply the SNA analysis of Group 9, Figure 3 and Figure 4 show the connections and its collaboration network. This network visualizes all the connections each participant has with other members in the group and how communication evolves over time as they work collaboratively on the learning task. Also, in these figures the number associated with the network represent the volume of communication between participants. Figure 3 was taken in the first week of collaboration with a total of 50 in and out messages while Figure 4 was taken on the third week of the collaboration with 101 in and out- messages. At the beginning, Saber has initiated the most of the discussion with 16 messages. He acts as a central member of the group as depicted in the graph while Mosbah the most intelligent as revealed in the individual cognitive performance level contributed only 7 messages. In the network analysis we cannot identify which one contributes the best in the problem solving since we are only showing the threaded messages to whom participants communicated with. At the end of the collaboration interaction pattern seem to change. Figure 4 revealed now that Mosbah increased his collaboration by overtaking Saber and become the new central player of the group with 25 messages while Saber contribute 18 messages. There was no evidence what triggered Mosbah to increase his collaborative effort but examining the pattern of this student, he is slow at the beginning and suddenly climbing at the end of the collaboration, other students follow the same pattern. Collaboration effort also increased with Ali and Saed both 8 to 15 messages, while Mufta from 5 to 16 and Ahmed from 9 to 14 messages.

In this study, students were asked to participate in the social network media at their convenience to exercise freedom and flexibility, but were given a deadline to meet the requirements. This study want result to be real as possible. Interestingly, students increase their individual contributions as deadline comes. Another interesting feature we can read from this graph is how tightly knit the collaboration effort this learning group is. All participants get responses from almost all the members. Although they have different levels of

contribution, everybody is engaged. . For this, in the beginning student gets to know each other and slowly increases the collaboration and communication. As time goes by and each become relax to deal one another. Surely, there was an increased of learning since no one among the groups lose interest during their collaborative problem solving. The interaction pattern clearly showed transformation of membership as learners gradually move towards the center of the network. We have also seen that it is not necessarily the case that the most active members always regulate and dominate the discussion, in the case of Saber he communicated very well from the beginning to open the discussion then gradually taken by Mosbah. Saber is more socially engaged while Mosbah is more concentrated in getting the goal.

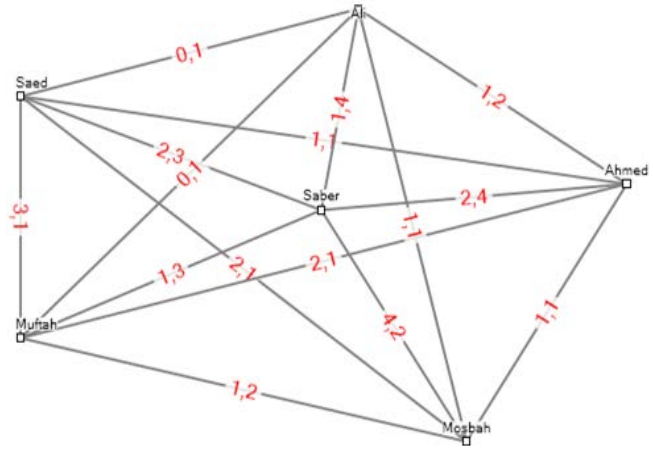

Figure 3. Social Network Analysis
(Density of Collaboration for the 1st Week of Group 9)

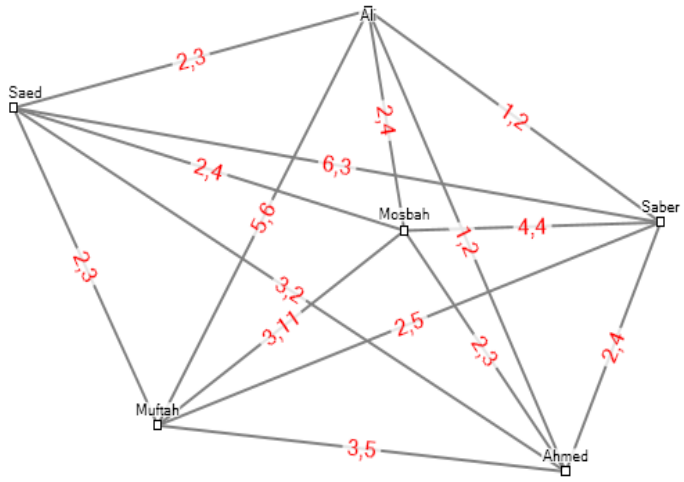

Figure 4. Social Network Analysis
(Density of Collaboration for the 3rd Week of Group 9)

Measures of Centrality

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. Taking into account the preliminary group collaboration of Figure 1 and the post group collaboration of Figure 2, the following centrality has been computed Table 5.1 and 5.2 for degree centrality, Table 5.3 and 5.4 for betweenness centrality and Table 5.5 and 5.6 for closeness centrality.

Degree Centrality refers to the number of connections that a node contains and indicates the level of activity of a node within a group. The general idea is that the greater a node's degree, the more potential influence it has on the network and the more potential influence the network has on it. Table 5.1 and 5.2 shows the degree centrality among the five groups. For Group 5, Eman is the most active in the network and manage to maintain till the end of the collaboration but what is so interesting to note is that, as the collaboration takes place, its original value of .32 becomes .28, a decrease of .04. This means that during the process of solving the problem, Eman decreased its degree centrality while other member increased. Other members actively participated in the social network threading. In Group 6, the reverse happened, Sadiya from .33 to .4 and increased of .07. It means that she was able to maintain her leadership and become the connector or hub of the group. Group 7 performance likewise shows a dramatic change where all member decreased their degree of centrality except for Wadian, whom she increased her participation in the threading. Almost all members of Group 8 decreased their

degree centrality an indication that all groups were actively involved and working very close while Group 9 shows a very good relationship to each other as their degree centrality becomes all equal at the end of the collaboration. It means that there is no competition among the members as they are all involved in solving problem and just focused to deliver the output as one group activity. Overall the minimum and maximum degree, average and median degree decreased, a general conclusion that the students work as team in solving the problem.

Table 5.1 Degrees of Centrality of Preliminary Group Collaboration

Degrees of Centrality									
Group 5	Value	Group 6	Value	Group 7	Value	Group 8	Value	Group 9	Value
Adil	0.18	Sadiya	0.33	Rowida	0.15	Mabrouka	0.21	Saed	0.145
Eman	0.32	Mariam	0.20	Mona	0.30	Fathiya	0.39	Ali	0.145
Hania	0.14	Aisha	0.13	Ryan	0.20	Fatima	0.16	Saber	0.145
Hana	0.11	Entesor	0.20	Hawa	0.20	Naja2	0.11	Muftah	0.145
Naja1	0.18	Nahed	0.13	Wadian	0.15	Amira	0.16	Mosbah	0.265
Hadi	0.11							Ahmed	0.145

Minimum Degree	2
Maximum Degree	9
Average Degree	4.079
Median Degree	4

Table 5.2 Degrees of Centrality of Post Group Collaboration

Degrees of Centrality									
Group 5	Value	Group 6	Value	Group 7	Value	Group 8	Value	Group 9	Value
Adil	0.21	Sadiya	0.40	Rowida	0.14	Mabrouka	0.20	Saed	0.17
Eman	0.28	Mariam	0.10	Mona	0.28	Fathiya	0.40	Ali	0.17
Hania	0.14	Aisha	0.10	Ryan	0.14	Fatima	0.20	Saber	0.17
Hana	0.14	Entesor	0.20	Hawa	0.21	Naja2	0.10	Muftah	0.17
Naja1	0.14	Nahed	0.20	Wadian	0.21	Amira	0.10	Mosbah	0.17
Hadi	0.07							Ahmed	0.17

Minimum Degree	1
Maximum Degree	5
Average Degree	2.889
Median Degree	2

Betweenness centrality refers to the fraction of the number of shortest paths that flow through a node. It is an indicators how information flows through graph. Nodes that occur on many shortest path will have a higher value of betweenness than those that do not. Table 5.3 and Table 5.4 shows the value of preliminary and post collaboration betweenness centrality taken from Figure 1 and Figure 2 respectively. In the preliminary collaboration stage, Eman have 108 for Group 5, Sadiya have 90 for Group 6, Mona have 88.33 for Group 7, Fathiya have 104 for Group 8 and Mosbah have 200 for Group 9. They become the most influential and have the power to control the information flow in their respective network. However having said that, there is an interesting observation which happened in the post collaboration betweenness centrality value, there is general and conclusive

observation that collaboration takes place and students gradually contributing to problem solving as the maximum betweenness and average decreased drastically. It means that students actively participated in problem solving. Analyzing Group 9, preliminary shows that Mosbah dominates the discussion but gradually all members equally participated in the process. If one of the nodes will be damaged or destroyed, the information flow will not be affected since all information are readily available among the members as indicated by 0 betweenness value.

Table 5.3 Betweenness Centrality of Preliminary Group Collaboration

Betweenness Centrality

Group 5	Value	Group 6	Value	Group 7	Value	Group 8	Value	Group 9	Value
Adil	1.00	Sadiya	90.00	Rowida	0.00	Mabrouka	1.00	Saed	0.00
Eman	108.00	Mariam	0.50	Mona	88.33	Fathiya	104.00	Ali	0.00
Hania	0.00	Aisha	0.00	Ryan	0.33	Fatima	0.00	Saber	0.00
Hana	0.00	Entesor	0.50	Hawa	0.33	Naja2	0.00	Muftah	0.00
Naja1	1.00	Nahed	0.00	Wadian	0.00	Amira	0.00	Mosbah	200.00
Hadi	0.00							Ahmed	0.00

Minimum Betweenness	0
Maximum Betweenness	200
Average Betweenness	22.037
Median Betweenness	0

Table 5.4 Betweenness Centrality of Post Group Collaboration

Betweenness Centrality

Group 5	Value	Group 6	Value	Group 7	Value	Group 8	Value	Group 9	Value
Adil	0.50	Sadiya	5.00	Rowida	0.00	Mabrouka	0.00	Saed	0.00
Eman	6.50	Mariam	0.50	Mona	2.00	Fathiya	5.00	Ali	0.00
Hania	0.00	Aisha	0.00	Ryan	0.00	Fatima	0.00	Saber	0.00
Hana	0.00	Entesor	0.50	Hawa	0.50	Naja2	0.00	Muftah	0.00
Naja1	4.00	Nahed	0.00	Wadian	0.50	Amira	0.00	Mosbah	0.00
Hadi	0.00							Ahmed	0.00

Minimum Betweenn	0
Maximum Betweenn	6.5
Average Betweenne	0.889
Median Betweenne	0

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 receive information more quickly. Table 5.5 and Table 5.6 shows all the value of closeness centrality taken from the network of Figure 1 and Figure 2. According to the table for both preliminary and post collaboration stage, Eman have the highest in Group 5 with .019 to .167, Sadiya have the highest in Group 6 with .017 to .250, Mona have the highest in Group 7 with .018 to .018 and Fathiya have the highest in Group 8 with .02 to .250 and Mosbah has the highest in Group 9 with .023 to .2. They are the most nodes that can efficiently obtain information in the network and into other groups. They have the

shortest paths to all others – they are all closed to anyone else and they are in excellent position to monitor the information flow of the network. Group 9 has all equal value at post collaboration closeness centrality, thus allowing each member to have equal access to all nodes in the network more quickly.

Table 5.5 Closeness Centrality of Preliminary Group Collaboration

Closeness Centrality

Group 5	Value	Group 6	Value	Group 7	Value	Group 8	Value	Group 9	Value
Adil	0.130	Sadiya	0.017	Rowida	0.013	Mabrouka	0.014	Saed	0.016
Eman	0.019	Mariam	0.012	Mona	0.018	Fathiya	0.200	Ali	0.016
Hania	0.013	Aisha	0.012	Ryan	0.013	Fatima	0.014	Saber	0.016
Hana	0.013	Entesor	0.012	Hawa	0.013	Naja2	0.014	Muftah	0.016
Naja1	0.013	Nahed	0.012	Wadian	0.013	Amira	0.014	Mosbah	0.023
Hadi	0.013							Ahmed	0.016

Minimum Closeness	0.012
Maximum Closeness	0.023
Average Closeness	0.015
Median Closeness	0.014

Table 5.5 Closeness Centrality of Post Group Collaboration

Closeness Centrality

Group 5	Value	Group 6	Value	Group 7	Value	Group 8	Value	Group 9	Value
Adil	0.125	Sadiya	0.250	Rowida	0.167	Mabrouka	0.167	Saed	0.200
Eman	0.167	Mariam	0.143	Mona	0.250	Fathiya	0.250	Ali	0.200
Hania	0.111	Aisha	0.143	Ryan	0.167	Fatima	0.167	Saber	0.200
Hana	0.111	Entesor	0.167	Hawa	0.200	Naja2	0.143	Muftah	0.200
Naja1	0.125	Nahed	0.167	Wadian	0.200	Amira	0.143	Mosbah	0.200
Hadi	0.083							Ahmed	0.200

Minimum Closeness	0.083
Maximum Closeness	0.250
Average Closeness	0.172
Median Closeness	0.167

3.2 Qualitative Analysis

Another way to study the impact of collaborative problem solving using social media is taking event recall technique and interviewing the learner after collaboration. The qualitative data were collected via written students description, observation and opinions based on the learner experience in the study and upon showing them the table results from the previous discussion. Their responses have been re-analyzed until saturation has been reached. The four themes have been identified in Table 5.

Table 5. Qualitative Themes

Theme
-Learning is fun, better, better, better! Thinking more!
-Memorable! Because of video, I remember because it is interactive and can repeat the simulation.
-We are free, we can say what we want, and get helped, No pressure.
-Support socialization, allowed us to chat, practiced English

Learning is fun, better, better, better! Thinking more! – Participants agree that e-learning provides them an opportunity to study "anywhere, whenever scenario" is fun. During collaboration students can communicate with friends while working on their problem. This is demonstrated by out-messages where students greet one another several time as a daily customary way in the Arab world. The out-messages ware not taken as negative in the threaded communications since it builds rapport among learners and making their collaborative more effective and relaxing.

> Mabrouka said that "Asalamalaikum, How are you! The study is great. If my husband will forbid us to come, we can still study at home, in that case, we can continue studying while supporting our family","I am happy that I passed the exam", "I learn a lot from e-learning and love chatting with my friends".
>
> Rokiya agree that "we should have asked our classmates, especially the smart ones to help us more in our study to pass our courses, making our study better and better", "Oh I am happy that it shows I am learning, I hope it will continue."
>
> Mosbah on the other hand tell us that "We have more time to think, have more time to solve problems than in the presence of our instructor, through this, we will not ask again and again". "I am very hesitant from the beginning to collaborate because I don't know the other guy, but he became my good friends and then I collaborate and we solve the problem, I am very happy with the study"

These excerpts illustrate how the participants enjoy the learning process. It can also be noted that the exchange of messages increases from all the participants signifying their interest, finish their activity and submit on-time their output thus, collaboration increases as shown in the social network diagram. The Blooms taxonomy collaborates the outcome of the study. Having fun while learning increases significantly the cognitive skills of the learner.

Memorable! Because of video, I remember because it is interactive and can repeat the simulation. – Majority of the participants in each group agreed that using interactive simulation and videos make the lessons memorable. Transforming this memorability of the lesson makes the collaboration effective and continue since students have basis to attack the problem at hand. Without such understanding, group performance during collaboration suffer.Sample excerpts from the students;

> Muftah says that "The interactive simulation somehow fill the gap of communication problems., since it gives us more time to process data rather than human instructor". The video is very good, while I am in chatting I am thinking what I saw and I am sharing it with my groupmates".
>
> Entesor mentioned that "It gives us idea to solve the problem because of the video, it provides us guide to solve the problem step by step". "I am happy with the results, my group mates asked me to see the computation of time complexity but I don't have it so I asked in FB, I managed it".
>
> Hamed commented further that " I can play several times and then perform by myself without the instructor supervision because I remember the step." "During collaboration, I was able to respond to some of my groupmates because I remember the step from simulation".

Thus, simulations and visualizations tools make it possible for student to bridge experience and remember better the lessons presented to them. It has been observed that students remember the concepts make them actively participate in the

collaboration. The inclusion of interactive simulations in the e-learning improve the quality and outcomes of the study. By knowing the concepts, learners actively collaborate and negotiate among themselves as shown in the social network analysis.

We are free, we can say what we want, and get helped, No pressure.- The pouring of in and out-messages during collaboration relate this, they have freedom to express their opinions in the social media without limitations. Many students try to communicate with other learners in and out of their circle to seek help. Students can collaborate without the pressure and watchful eye of their instructor. This is illustrated through the following excerpts:

> Fatma claimed that " Libya is free so are we to express our opinion, I studied in my house and chat with my friends, it make sense since we can tell to our parents that we are studying instead of just searching and chatting non-sense", I learned a lot so it is not surprising that I have a good mark in the exam".
>
> Rowida also said that "We can say what we want, seek help to our friends, and collaborate with the groups. I get some inputs and explanation from the other group, and it helps me a lot. Sometimes we have a good output if no pressure is given to us, just ample time to solve the problem".

With this line of reasoning, students viewed the social media as environment to express their opinions and seek help with other learners. The increase of coded messages could be attributed with this thinking. Although it is good for the time being, this attitude could lead to spoon feeding type of learning, where learner could just request from others and instantly provides an answer to problems. An indications we need to watch and address in the next papers.

Support socialization, allowed us to chat and practice English – Adapting social media definitely increase socialization. Socialization is a learning perspective that needs to be address and include in any on-line education suitable and essential in the area of collaboration. Construction of knowledge takes place in a social context such as this study where students were asked to solve problem collaboratively, thereby increasing their cognitive and affective skills. In the case of Saber, the most sociable keeps the group communicate while Mosbah is constructing or organizing the solution .

> Mosbah said "Saber can communicate well because he knows how to express in English like me, but lack the ability to start solving the problem. Luckily, he helps me keeps the participants to continue the communication process. He communicates and socializes well. FB is very powerful, it help us a lot to communicate".
>
> Saber said "Mosbah is good and very serious, so I open topics to other while we are waiting for his comments and suggestion. But there is a serious problem in communication for others, They should take more time to chat and practice English".
>
> Aisha mentioned that " We have to practice more English to communicate with other learners, members who are fluent in English tends to dominates discussion and we need to deal with that. Perhaps I need to chat more with Nadia".

The more in and out messages the more communication takes place and this can be viewed as a way of practicing English. In the study, we have slightly relate the impact of threaded social media as a medium of practicing English language for computer science students, students are strictly instructed to use English as medium of communication. Many messages have been discarded because it was written in Arabic. The impact of social media allows students to socialize, a factor that can never be removed in ideal educational setting. The power of socialization in the collaboration allows student to negotiate, criticize their own and others students' contributions, ask for explanations and counter arguments if necessary and in doing so, learners modify and develop their own learning process.

4 CONCLUSIONS

This paper has presented the results of an approach to content analysis of messages exchanged during collaborative problem solving of approximately three weeks duration. This analysis has enable the tentative identification of patters of individual and group learning during the activity. The students interactions have been analyzed using the Veldhius-Diermanse schema and Anderson schema and relate the results to group and individual performance. The cognitive performance level of students increased dramatically after collaboration.

The social network analysis likewise shows the density of collaboration among learners. This provides little insights into a key aspect of the individual and group processes and argued that there is a need to perform more analysis to understand fully the richness of these learning interaction. It also concluded that the more threaded communication the better, but it doesn't guarantee that such quantity is transformed into effective collaboration. The out-messages for example are communication but not related to the problem at hand and yet, it was concluded that this provides informal communication and support socialization.

In the interview, four themes have been selected based on the written recall of events, experiences and observed during the study. This recall has the potential to access aspects of learning that are not directly available in discussion or transcripts. But, having many messages, performing saturation or filtering is difficult. In summary, the study successfully reported the used of event recall among participants, the used of several content coding analysis and the used social network analysis.

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