Online formative assessments with social network awareness

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Abstract

Social network awareness (SNA) has been used extensively as one of the strategies to increase knowledge sharing and collaboration opportunities. However, most SNA studies either focus on being aware of peer’s knowledge context or on social context. This work proposes online formative assessments with SNA, trying to address the problems of online formative assessment (i.e. lack of individual assistances and low participant rate) and enhance learning effectiveness. This study focuses on being aware both peer’s social context and knowledge context for student to promote the opportunity of peer interaction and to select the appropriate helpers to ask for help when facing problems in online assessments. Social-context information particularly includes centrality (i.e. social network position) of a candidate, and social distance (i.e. the shortest distance between the candidate and a seeker) in a sociogram, and nimbus (i.e. willingness to help others) of a candidate. A corresponding system, called Social Network Awareness for Formative Assessments (SNAFA), is further developed. The education experiments particularly focused on the effects of social-context awareness on learning activity and social activity. The results showed that the SNAFA not only increase the participant rate of students on formative assessment and opportunities of knowledge sharing, but also promote learning achievement, compared to the Traditional Formative Assessment (TFA). Meanwhile, centrality, which is represented by two indices: degree and closeness, also plays an important role in the SNAFA environment. More specifically, students with higher centrality (regardless of degree and closeness) 1) are more likely to take advantage of the social network position to ask for help, 2) easily become target helpers that peers seek to, 3) utilize the SNAFA more frequently, and 4) have better learning achievement, compared with those with lower centrality.

1. Introduction

Formative assessments, continuously embedded in the teaching and learning process of a curriculum, attempt to improve learning achievements by offering feedbacks on performance (Sadler, 1998). In addition to providing teachers with opportunities to adjust teaching strategies, formative assessment also provides students with feedbacks to revise their misconceptions (Bransford, Brown, & Cocking, 2000; Wang, 2007). Feedbacks received during the process of formative assessment facilitate student learning, assist students in reflecting on their learning, and improve their motivation (Marriott, 2009; Wang, 2007).

In general, providing feedback on formative assessments is difficult for teachers because they face a large number of students, lengthy pieces of work, or practical constraints such as time and workload (Buchanan, 2000; Wang, 2007). Additionally, the amount of questions that students generate in an assessment can overwhelm a teacher (Pear & Crone-Todd, 2002). Online formative assessment systems may solve the above difficulty, but most of them only provide fixed and predetermined answers and references as learning feedback. These predetermined answers and references can not offer adaptive assistances and satisfy individual student’s needs. Another problem of online formative assessment systems is a low participation rate among students in such systems (Buchanan, 2000; Costal, Mullan, Kothe, & Butow, 2010; Henly, 2003). This significantly influences learning effects and in turn downgrades learning achievements. Thus, designing an appropriate auxiliary mechanism to address the above issues of online formative assessments is important (Costal et al., 2010).

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Nicol and Macfarlane-Dick (2006) pointed out peer interaction is one of prominent principles of good feedback practice in assessments. The peer interaction and collaboration can motivate student learning, provide individual assistances, and reduce student frustration (Shute, 2008). Student can receive substantive feedback through a socially interactive process (Pear et al., 2002). However, students need to know the social activities, knowledge degree, and contexts of others to increase knowledge sharing opportunities and to communicate and collaborate effectively (Hu, Kuhlenkamp, & Reinema, 2002). Social network awareness (SNA) has been used extensively as one of the strategies to address this issue (Cadima, Ferreira, Monguet, Ojeda, & Fernandez, 2010; Cho, Gay, Davidson, & Ingrafea, 2007; Cross, Parker, & Borgatti, 2002; El-Bishouty, Ogata, & Yano, 2007). SNA is used to be aware of the knowledge context and social context of the others (Zheng & Yano, 2007). Knowledge context, which reveals the peer candidate’s knowledge expertise and experience, is used to match ‘who knows what’ in the knowledge dimension. Social context, which reveals the nimbus (i.e. willingness to help other) of the peer candidates, their social network tie, and social network position (i.e. central/peripheral positions in a network), is used to harmonize ‘who is willing to collaborate. Being aware of both context information and the interactions among peers are deemed as scaffolds at stimulating students to reflect on learning, to imitate peers’ actions, and to motivate coherent discussions.

However, most SNA studies either focus on being aware of peer’s knowledge context (El-Bishouty et al., 2007; Yang, Chen, Kinshuk, & Chen, 2007) or on social context (Cadima et al., 2010; Chen, Hong, & Chang, 2008). Knowing who has expertise is a precursor to seek a specific helper out when we are faced with a problem. But, knowing what someone else knows is only useful if you can get access his/her thinking in a sufficiently timely fashion. This accessibility is heavily influenced by the one’s social context within a community (Cross, Parker, Prusak, & Borgatti, 2001).

This work proposes online formative assessments with social network awareness to raise the opportunities of collaborative learning and participant rate within a community, and further investigates its effects on learning the course “Electronic Business.” Students are able to be aware both peer’s social context and knowledge context, facilitating students to select the appropriate helpers to ask for help when facing problems in online assessments. In addition to knowledge–context information which includes knowledge degree of candidates, this work particularly emphasizes social-context information which includes nimbus, centrality, and social distance, of a candidate. Using the proposed approach, this work realistically develops a Social Network Awareness for Formative Assessments (SNAFA) system, which allows students to effortlessly maintain both context awareness of peers and further presents them in text form and ego-centered sociogram. This work describes how to construct social network and reveal both context information, and also introduces the overall operation processes. The first investigation is to assess the effectiveness of the proposed SNAFA. The second issue focuses on investigating the impacts of social network position (i.e. centrality) of a help seeker within the SNAFA environment. This study tries to investigate these issues in a more extensive way, whose scope includes learning performance, message flow, and system utilization. Currently, the related studies investigating the impacts of centrality of a help seeker are relatively scant.

2. Background

2.1. The problems of online formative assessment

The objective of formative assessments is to provide feedback to students rather than to evaluate them for course grades. However, the workload of teachers in higher education increases year by year as the number of students becomes larger (Nicol & Macfarlane-Dick, 2006). It is difficult for teachers to provide feedback for every formative assessment, because they face many students, lengthy work, and strict schedule constraints (Buchanan, 2000; Wang, 2007). To solve the difficulties, some works have adopted online formative assessment system (Buchanan, 2000; Henly, 2003; Wang, 2008). The system can actually solve the above difficulties, but they usually provided only fixed/predetermined answers and references as learning feedback. For example, Henly (2003) used a commercial web-based formative assessment system, WebCT (http://www.webct.com), for dental education, in which students can access correct answers immediately after finishing their assessments. Buchanan (2000) developed a web-based formative assessment system, PsCAL, for a psychology course. An important feature is that for each multiple-choice question answered incorrectly, the system provides a reference (appropriate explanation sections of textbooks) for students to further understand the reasons, instead of directly providing the correct answer. However, these predetermined feedbacks neither uncover individual needs nor provide adaptive assistances.

In addition, even given an online formative assessment system, the low participation rate among students is invariably low in tertiary education, which significantly influences learning effects and in turn downgrades learning achievements (Buchanan, 2000; Costal et al., 2010; Henly, 2003). Costal et al. (2010) indicated that a low participation rate is a critical concern to an online formative assessment in tertiary education. Henly (2003) reported that low ranking students, who are most likely to benefit from using an e-Learning system, were less likely to fully use online resources. Similarly, in the research of Buchanan (2000), only one tenth of undergraduate students had ever used an online formative assessment tool during a semester.

All in all, designing an appropriate auxiliary mechanism to address the above issues of online formative assessment (i.e. unable to provide individual assistance and a low participant rate) is an important direction for future research in this area (Costal et al., 2010).

2.2. Social network awareness (SNA)

Social network awareness (SNA) has been extensively used as one of the strategies to promote the opportunities of peer interaction and collaboration, and to support the co-construction of knowledge and the sharing of information (Cadima et al., 2010; Chen et al., 2008; Chen, Chen & Kinshuk, 2009; Dawson, 2008; El-Bishouty et al., 2007; Hu et al., 2002; Yang, Chen, & Kinshuk, 2007). Deeper mutual awareness of peer social context enables more fluid and expressive communication between individuals, resulting in a more effective coordination of ideas, opinions, and actions (DiMicco, Hollenbach, Pandolfo, & Bender, 2007; Erickson & Kellogg, 2000). However, most SNA related works focus on the awareness of either peer’s knowledge context (El-Bishouty et al., 2007) or peer’s social context (Cadima et al., 2010; Chen et al., 2008). The social-context studies mainly focus on being aware of peer’s social status, including social network tie, social network position, and social interaction. For example, Cadima et al. (2010) developed an SNA system which only based on social network tie and social interaction.
interaction aimed at promoting the opportunity of knowledge sharing. The system provided two types of information in a visual way. One type is social network ties among the members within the community. Each node in the network represents a person and each arrow represents the direction of knowledge transfer. The other type is social interaction patterns, including the number of contacts, the number of receiving transfers, and the number of sending transfers. Chen et al. (2008) presented a method of mining social interactive networks, which used a prediction model based on peer's past social interaction (i.e. request and response messages), to recommend appropriate peer helpers for a requester. On the other hand, the knowledge-context studies mainly focus on being aware of peer's proficiency level of a specific domain, including knowledge level and experience. For example, El-Bishouty et al. (2007) proposed a ubiquitous learning system, which used a prediction model mainly based on candidates' proficiency level to recommend the qualified candidate for a help seeker. The provided awareness information mainly included a helper's academic level, interests, physical location, and the detected objects. However, the social context of a candidate is not considered.

Knowing that someone else knows something of relevance does little good if people can not gain access to their knowledge and helps (Cadam et al., 2010; Cross et al., 2001). This accessibility is heavily influenced by the one's social context within a community (Cross et al., 2001). In a virtual environment users should be able to perceive and compare the social and knowledge patterns of activity with their own models of work and interaction (Soller, Martinez, Jermann, & Muehlenbrock, 2005). This could enhance users' motivation to communicate and collaborate, allowing them to structure their social networks to maximize their benefits by getting closer to the existing resources and opportunities. Therefore, Yang et al. (2007) has proposed a prediction model to recommend candidates based on a peer's trust association and knowledge association. The knowledge association is the level of proficiency of a candidate pertaining to a specific knowledge domain. The trust association is the trustworthy level of a seeker to a candidate, which is determined by past social interaction (i.e. request and response messages) experience. Although their work has considered both contexts, the social-context information merely contains past interaction experience. In addition, to calculate trustworthy level of a candidate, the model needs sufficient (or large enough) samples of past interaction experiences.

2.3. Investigation in social networks

Currently, the impacts of social context (e.g. social network tie, social network position) on students' learning activity and social activity within an online community have drawn attention. Studies investigating the impacts of social network tie are more extensive and thorough (Chen et al. 2009; Dawson, 2008; Hanneman & Mark, 2005; Haythornthwaite, 2002). For example, social network tie has a positive correlation with the intention of knowledge sharing (Chen et al. 2009) and has an impact on learning outcomes on student sense of belonging to a community (Haythornthwaite, 2002). Members connected via weak social ties are less likely to utilize and share resources and information in contrast to members connected via strong ties (Dawson, 2008). In contrast, studies examining the impacts of social network position are relatively fewer and scant (Cho et al., 2007; Nurmela, Lehtinen, & Palonen, 1999). Cho et al. (2007) studies focused on the impact of social network position on learning performance in an online collaborative system. Nurmela et al. (1999) investigated only the relationship between social network position and message flows (received and sent messages) in an online collaborative system. There is no analysis between social network positions and learning performance due to the small number of student samples. There is no analysis between social network position and time usage (e.g. system utilization) either.

In a real-world collaborative learning environment, students often recruit existing colleagues, resulting in that some take central/peripheral positions from the beginning. That is, existing friendships affects social network position of a student. Social network position may significantly enable or constrain how knowledge distributes and how students benefit from emerging social network (Cho et al., 2007). Having a favored position means that a student may extract better bargains in exchanges, have greater influence, and that the student will be a focus for deference and attention from those in less favored positions (Hanneman et al., 2005). Thus, social network position may substantially influence students' learning activity and social activity.

2.4. Contributions in this work

This work uses social network awareness within online formative assessment to promote the opportunities of peer interaction and collaboration. This is because peer interaction and collaboration can motivate student learning, provide individual assistances, and reduce student frustration (Shute, 2008), which are promising to address the problem of online formative assessments. This study allows students to be aware both peer's social context and knowledge contexts to select the appropriate helpers to ask for help. In addition to knowledge-context information which includes knowledge degree of candidates, this work particularly emphasizes social-context information which includes nimbus, centrality, and social distance, of a candidate.

A corresponding system, called Social Network Awareness for Formative Assessments (SNAFA), is further developed. Utilizing the developed SNAFA in the evaluation, two important issues are further investigated in this work. The first issue is to evaluate the effectiveness of the proposed SNAFA by comparing with the Traditional Formative Assessment (TFA) because there are few studies discussing the effects when harnessing SNA in the process of online formative assessments. The second issue is to investigate the impacts of social network position on learning activity and social activity within the SNAFA environment. This study tries to investigate these impacts in a more extensive way, whose scope includes learning performance, message flow, and system utilization. To differentiate social network position, a concept originated from mathematic graph theory, called centrality, is used to measure individual position in a social network. A student with high centrality means he/she approximately locates at the center of a network. Moreover, this paper uses social network analysis to quantify the interaction and to assess the degree of cohesion within the community because social network analysis has been developed and practiced to investigate social group dynamics in the domain of social studies for decades (Reffay & Chanier, 2003; Wang & Chiu, 2008).

In summary, this work has three main contributions: (1) We propose the SNAFA, an online formative assessment system with social network awareness, which particular emphasizes on social-context awareness. (2) We compare the SNAFA and the Traditional Formative Assessment (TFA) and verify the superiority of SNAFA. (3) Many factors in social networks, such as message flow and system utilization, are further investigated via the SNAFA system to more perceive their effects on learning performance.
3. The proposed SNAFA system

This section is divided into three subsections. The first subsection introduces the overall process of the SNAFA. The second subsection describes how to construct the social network and both context information in the SNAFA. The third subsection demonstrates some important graphic user interfaces (GUIs).

3.1. The overall process

The overall process consists of three phases: Initialization, Test, and Review phases. At the beginning, the Initialization phase is used to let each student preset his/her existing friendship network. Afterward, students enter the Test phase to take their online formative assessments. After the Test phase, students will know what questions they incorrectly answered. Then in the Review phase, students can know both social and knowledge contexts of peers and ask the desired candidates for help by referring the above information when encountering problems. Students have to undergo several rounds of Test and Review phases if several assessments are taken place.

The detailed procedures of these three phases are illustrated in Fig. 1. In the Initialization phase, each student in a community registers his/her personal information (e.g. account, name, and photo) in the SNAFA and then sets his/her existing friendship by selecting his/her close friends. After this phase, the SNAFA will record the relationship between students into the Social Network Database for generating social network position in the Review phase.

Students in the Test phase take an online formative assessment, which pertains to one chapter of a curriculum. The assessment quizzes are based on textbook material and handouts. To build the Question Bank Database for all assessments, teachers have to build representative questions and their answers for each chapter in advance. This study uses multiple-choice format for most questions. Following the test phase, student learning records are stored in the User Learning Portfolio Database. After finishing the Test phase, students obtain their test results, including the question restatements and result (e.g. correct or not). Correct answers are not provided because “correct answers should not be given” and “reference should be given when answering incorrectly” are two important strategies for formative assessment design (Buchanan, 2000; Wang, 2007). To get needed reference, the process enters the Review phase which supports SNA.

The procedure of the Review phase consists of the following steps:

- Step 1: If all incorrectly answered questions (IAQs) are addressed, the Review process in this assessment terminates. Otherwise, the student enter step 2.
- Step 2: A student can ask for help by sending message to a helper. A student can select an appropriate helper though the provided information about social and knowledge contexts.

Now the procedure of Step 2 is further explained because it is a very important role in SNAFA. For each incorrect question, the student can click the corresponding button called “looking for peer assistance” to generates the candidate list. These candidates are all answering the question correctly. Most importantly, the information about knowledge context and social context of each candidate, which is elaborated in next subsection, are also displayed. Then, the student can select desired helpers from the list and send help messages. When a request has responded, the student (i.e. help seeker) receives a notification e-mail sent from the system, which contains a hyperlink linking to the newly

Fig. 1. The overall process of the SNAFA.
response. The student can also login the system to verify whether new responses arrive. When entering the system, a student can get the list of the asking helps sent from peers. Also, a student can get the list of whether his/her requesting questions have been responded. Every assessment follows the same procedure above. Even after a period, students can still login to review their previous (or historical) assessments. In addition, to boost members’ desires to respond, an Enthusiastic Bulletin Board displays the ranking of students who are the most enthusiastic. Yang et al. (2007) stated that posting and responding to messages can help to create social-interaction ties among the members of a community and these ties are helpful for encouraging online knowledge sharing.

3.2. Constructing social network and generating social and knowledge contexts

3.2.1. Constructing social network

In the Initialization phase, a student sets existing friendship by selecting his/her close peers. According to Cross et al. (2002), obtaining social relationship data is a straightforward process and simply asking all members of the community to characterize their social relationship with each other. Thus, we used binary decisions about whether a member has friendship with each member on the roster (Marsden, 2005). These results can be represented in a matrix, namely a sociomatrix \( R = [r_{ij}], 1 \leq ij \leq M \) in which \( M \) is the number of members in a community. An element \( r_{ij} \) (i.e. value of the tie) is binary, indicating the presence (1) or absence (0) of a relationship. The element in the diagonal is always not defined (students do not indicate ties with themselves).

In practice, when member \( i \) selects \( j \) as a familiar peer, \( r_{ij} \) is set as 1 and a message will be sent from \( i \) to \( j \) for confirmation. If \( j \) acknowledges the relationship, \( r_{ji} \) is set as 1; otherwise, \( r_{ji} \) is set as 0. In other words, a friendship link between two members is established only when these two admit the relation. Fig. 2(a) illustrates the snapshot of each member in a community selecting his/her existing friendships. The sociomatrix of the whole network for the community can be thus generated. Fig. 2(b) shows an example of a sociomatrix. In the graph of a social network (i.e. a sociogram), a node represents a member, and a link represents a tie that exists between the pair of members (Wasserman & Faust, 1994). In the real world, when member \( i \) recognizes member \( j \) as a close friend \( (r_{ij} = 1) \) and vice versa \( (r_{ji} = 1) \), they have a close friendship (i.e. node \( i \) and node \( j \) are connected). That is why we use an undirected graph to represent a friendship network within a community instead of a directed graph. Thus, the final sociogram of the whole network can be defined as follows.

\[
\begin{align*}
\text{if } r_{ij} = 1 \text{ and } r_{ji} = 1 & \quad \text{node } i \text{ and node } j \text{ are connected,} \\
\text{otherwise} & \quad \text{node } i \text{ and node } j \text{ are disconnected.}
\end{align*}
\]

Fig. 2(c) shows an example in which node 2 and node 3 are disconnected because of \( r_{3,2} = 0 \) although \( r_{2,3} = 1 \). Similarly node 8 and node 9 are also disconnected because of \( r_{8,9} = 0 \) although \( r_{9,8} = 1 \). Notably, the data of the final sociomatrix of whole network are stored in Social Network Database (Fig. 1) for further use on generating social context in the Review phase.

3.2.2. Generating social context

The information about social context and knowledge contexts of each candidate are provided for a seeker to select a desired helper. A candidate is one of the members who correctly answered the question of an assessment. Here some parameters are defined in advance as follows: \( C_i \) denotes the \( i \)-th candidate, \( M \) denotes the number of members in a community, and \( N \) denotes the number of formative assessments which has been conducted until now.

![Fig. 2. The process of constructing social network.](image-url)
Social context mainly shows the social distance, centrality, nimbus of candidates.

1) The social distance, the shortest distance \( (SD) \) between a seeker and a candidate in a sociogram, will rule the establishment of relations, in such a way that two individuals with a short distance will have a large probability of being related, while two individuals with a large distances will be connected with a low probability (Boguna, Pastor-Satorras, Díaz-Guilera, & Arenas, 2004). The \( SD \) is computed by the Dijkstra’s Algorithm (Dijkstra, 1959) for a constructed sociogram as shown in Fig. 2(c). The algorithm produces all short paths from the seeker to all candidates. \( SD_i \) represents the shortest distance between the seeker and the candidate \( C_i \). If \( SD_i = 1 \), it means they have a link. If \( SD_i = 2 \), it means a mediator exists between them. If \( SD_i = \infty \), it means the seeker is isolated from the candidate \( C_i \).

2) The centrality, which represents individual’s social network position, can be measured in terms of three indices: degree centrality, closeness centrality, or betweenness centrality (Freeman, 1979; Wasserman et al., 1994). Each index has its own specific definition for centrality. In general, a node with high centrality is in a more central position in a network. This study adopted two popular indices: degree and closeness, to identify an individual’s network position. This is because according to Dawson (2008), closeness and degree centrality are substantial predictors of an individual’s perceived sense of community, and they profoundly influence the way in which information flow in a learning network (Haythornthwaite, 2002).

Degree centrality measures the prominence of members in the network, and helps to identify those who are the most active or most inactive (Wasserman et al., 1994). The degree centrality of candidate \( C_i \) is simply the number of other adjacent members. To normalize this index into the range between 0 and 1, the degree centrality of candidate \( C_i \), denoted as \( DC_i \), is defined as:

\[
DC_i = \frac{d_i}{M-1},
\]

where \( d_i \) is the degree of node \( i \) and \( M \) is the number of nodes in the graph. In other words, \( d_i \) is the degree of candidate \( C_i \) and \( M \) is the number of members in the sociogram.

Closeness centrality is the measurement of global centrality in term of the “closeness” of all the nodes in the network by measuring the path distance (Freeman, 1979; Wasserman et al., 1994). The measure focuses on how close a member is to all the other members (Hanneman et al., 2005). To normalize this index into the range between 0 and 1, the closeness centrality of candidate \( C_i \), denoted as \( CC_i \), is defined as:

\[
CC_i = \frac{M-1}{\sum_{j=1}^{M} l(i,j)},
\]

where \( l(i,j) \) is the shortest distance from candidate \( C_i \) and member \( j \). However, such definition has a problem when there are some isolated nodes. The distance from a node \( i \) to an isolated node \( k \) is infinite, i.e. \( l(i,k) = \infty \), since the node is not reachable. This causes that the sum of distances is \( \infty \) and the closeness centrality of all nodes are all 0 (Wasserman et al., 1994). Since the longest distance in a group is \( M-1 \), we set \( l(i,j) = M \) if \( l(i,j) = \infty \) to avoid this problem. Such settlement is still able to differentiate closeness among nodes in a graph, regardless of connected nodes or isolated nodes.

3) The nimbus represents the willingness degree to help the others. The nimbus of candidate \( C_i \), denoted as \( WD_i \), is defined as follows:

\[
WD_i = \frac{\text{Number of asking helps that } C_i \text{ has responded}}{\text{Number of asking helps that } C_i \text{ has received}}.
\]

A candidate with a higher \( WD \) is more willing to help others than that with a lower one.

3.2.3. Generating knowledge context

Knowledge context mainly shows a candidate’s knowledge degree. The knowledge degree of candidate \( C_i \), denoted as \( KD_i \), is defined as follows:

\[
KD_i = \frac{\text{Number of questions that } C_i \text{ has correctly answered}}{\text{Number of questions that } C_i \text{ has answered}}.
\]

A candidate with a higher \( KD \) has better performance than that with a lower one. Also, for a candidate with a high \( KD \), the probability of correctly answering a question based on his/her knowledge instead of guessing is relatively high.

3.3. Graphic user interfaces

To easily perceive the social network for students and teachers, graphic presentation of the social network is provided in SNAFA. For any student, his/her corresponding ego-centered network is established while for a teacher, the whole social network is established, as shown in Fig. 3(a) and 3(b), respectively. To draw the sociograms in web environment, dot language, which is a plain text graph description for placing nodes, links, and labels for drawing data structures (Gansner, Koutsofios, & North, 2009), is used. Then, an open source library called WinGraphviz (http://wingraphviz.sourceforge.net/wingraphviz/), is used to render the dot language to Scalable Vector Graphics (SVG) which can adjust a graphical quality and zoom in and out by clicking the right button of a mouse, as shown in Fig. 3(b). Studying at an individual level is analyzing ego-centered network while studying at a community level is analyzing whole network (Marsden, 2005; Marijtte, Van, & Vermunt, 2006). For a student, the SNAFA provides the sociogram of his/her corresponding ego-centered network, as shown in Fig. 3(a) in which the blue ellipse indicates the student while other ellipses indicate peers who have close friendships with the student.
For a teacher, the SNAFA provides the sociogram of the whole network, as shown in Fig. 3(b), which can use it to identify the positions of an individual within the network (i.e. a central or peripheral role) (Cadima et al., 2010; Haythornthwaite, 2002; Marijtje et al., 2006).

In the Review phase, a student can see his/her results of an assessment, as shown in Fig. 4(a). When a student selects an incorrectly answered question, the candidate list, which contains student ID, name, $SD$, $DC$, $CC$, $WD$, and $KD$, appears, as Fig. 4(b) shows. The student can sort the list according to these fields: $SD$, $DC$, $CC$, $WD$, and $KD$. For eye-catching purposes, the $WD$ and $KD$ above 50% displays in blue color while that below 50% displays in red color. The value of $SD$ displays in blue when $SD = 1$; otherwise, in red. Meanwhile, the above information about social and knowledge contexts of all candidates is also displayed in sociograms, as shown in Fig. 4(c). The light-grey double circle represents the seeker while a white circle represents a candidate. A bold arrow means the $SD$ between them is 1. A dotted arrow means the $SD$ between them is more than 1. The number labeled in a link reveals the $SD$. The text in a white circle shows the $DC$, $CC$, $WD$, and $KD$.

According to Fig. 4(b) and 4(c), a seeker can select the desired candidates and send messages for asking for help. Notably, $SD$ and social network position may significantly influence the behavior of knowledge sharing in the SNAFA. For example, if two candidates have similar $KDs$, it is very possible for some seekers to choose the candidate who has a lower $KD$ but a closer $SD$ with them. The default sorting criterion is $SD$ since one aim of this work is to investigate whether $SD$ plays an important role on selecting a helper. Furthermore, this paper investigates the in-depth effects of $SD$ and social network position in Section 5.

4. Method

4.1. Research procedure

This evaluation first compares the proposed system SNAFA with the Traditional Formative Assessment (TFA). Upon completion of a formative assessment, both systems give students no correct answers but only question restatement and their answers correct or not. The difference is that students with SNAFA are able to ask for peer online help though social network awareness (as shown in Fig. 3) but students with TFA have no such support. However, the content of peer feedback should be substantive. Thus, students with the SNAFA were suggested with the following instructions when providing feedback: (1) use of examples as possible, (2) all relevant key terms and concepts were...
The experimental course called “Electronic Business,” involving five lessons: “Basic Electronic Business Introduction,” “The Strategy and Plan of the Electronic Business System,” “The Design of the Electronic Business System,” “The Implementation of the Electronic Business System,” and “The Maintenance of the Electronic Business System.” To establish substantial question banks, two teachers cooperated to collect and edit the question banks, generating 34, 41, 40, 40, and 46 multiple-choice questions for lesson 1 to 5, respectively. The question content primarily originates from teaching materials. A typical question may address a specific term, for example, “Which one is a concrete example of Key Performance Indicators (KPI) for examining an electronic business system?” followed by four possible options, with only one correct option.

This research adopted a quasi-experimental design method. The study was administered to two 3rd-year classes of a university: the first class consisted of 53 students using SNAFA; the second class consisted of 52 students using TFA. The students in these classes are the first time to learn this subject. The experimental treatment lasted for six weeks for 2 h each week. Before the experiment, all classes were trained and practiced how to use their designated systems for one week. We set a one-week period for each lesson as an indication of learning one lesson. During the experiment, all classes adhered to the same teaching and assessment schedules as follows. Upon completion of face-to-face teaching for one lesson at the beginning of one week, all students of both classes can freely take the corresponding online assessment once at any time within that week. More specifically, the new lessons opened every Wednesday and Thursday for both classes respectively and the one-week lesson period lasted until Tuesday and Wednesday one week later, respectively. By this way, we can observe the learning behaviors of both classes through the five opportunities (from lessons 1–5).

4.2. Measures

4.2.1. Learning performance

To verify possible significant differences of students in these classes, a pretest regarding background knowledge was conducted before the experiment. To assure pretest validity and reliability, 2 experts reviewed the content of the pretest, which was then tested by 56 students. After that, inappropriate questions were removed according to the corresponding difficulty and discrimination levels, resulting in 16 multiple-choice questions and Cronbach’s $\alpha$ being 0.83.

The quizzes in formative assessments directly reflect the posttest of the course. Thus, students using the system become familiar with the type of questions they are required to answer on their posttest. Formative assessment and the posttest have few overlaps. Even though both similar types of questions, the questions in the posttest are not directly copied from formative assessments, thus eliminating the problem of students memorizing questions and answers. In addition to formative assessments, the posttest content also comes from teaching materials ranging from lessons 1 to 5. The two classes received the same posttest content. The validity and reliability analysis of the posttest were handled the same as that of the pretest, resulting in 38 questions with Cronbach $\alpha$ at 0.82.
4.2.2. Participant social and learning activities

To analyze participant preference, both systems recorded participant activities as logged data, including login time, activity types (reviewing or testing), source IP (locations, such as home or school), and stay period (the time a visitor spends on the system). The SNAFA particularly recorded social message flow among peers for social network analysis. Two types of message flows are out-degree and in-degree. The former means that a student asks someone for help while the latter means that someone asks the student for help. System utilization is determined by the access time and the retention time where the former is the number of system login while the latter is the accumulated stay time of every login.

4.3. Pretest results

4.3.1. Pretest for two classes

In order to verify whether there are possible differences in background knowledge, we first conducted some pretest for these two classes: one class using TFA and the other class using SNAFA. Table 1 shows the results of the independent samples t-test, showing no significant difference in the average scores of the basic learning backgrounds between the two classes ($t = 1.86, p > .05$). The basic backgrounds of the students in the both classes showed no significant difference.

4.3.2. Pretest for the two group in the SNAFA class

To investigate in-depth phenomena of the impact of social network position within the SNAFA class, students in this class were further divided into two groups based on centrality to evaluate the effects of different centrality: degree and closeness. More specifically, a student whose degree was above the average was allocated in Degree High Group (Degree-HG), otherwise in Degree Low Group (Degree-LG). Similarly, to evaluate the effects of closeness, a student whose closeness was above the average was allocated in Closeness High Group (Closeness-HG), otherwise in Closeness Low Group (Closeness-LG).

Table 2 shows the results of the independent samples t-test, showing no significant difference in the average scores of the basic learning backgrounds between Degree-HG and Degree-LG ($t = -1.18, p > .05$) and between Closeness-HG and Closeness-LG ($t = -0.34, p > .05$). Regardless of the grouping is by degree or closeness, the basic backgrounds between both groups had no significant difference.

5. Results

5.1. Comparison between experiment class and control class

Table 3 shows that the numbers of members for each assessment in the SNAFA class are 38, 43, 43, 41, and 46 while those in the TFA are 31, 28, 26, 28, and 37. The participant rate in the SNAFA class steadily increased and outnumbered that in the TFA. The t-test results also show that the means of access time of FA2, FA4, and FA5 (except FA3) in the SNAFA class are significantly higher than those in the TFA class. Similarly, the means of retention time of FA2, FA3, FA4, and FA5 in the SNAFA class are significantly higher than those in the TFA class. FA1 has no significant difference on access time and retention time between the two classes because both classes are first time to take the first assessment of the experiment. At the beginning, student might have some difficulties in accessing the SNAFA and have little confidence with it. However, with the passing of time, students gradually receive more benefits from it. Interactions among peers in the SNAFA become frequent, which in turn enhance members’ belonging feelings to the community. Thus the differences of utilization between two classes become significant, especially in the later period. Table 4 shows that the mean of the posttest of the SNAFA class (mean = 69.75) is significantly higher than that of the TFA class (mean = 55.00) ($t = -3.55, p < .05$). This result unveils that the SNAFA can substantially increase the learning achievement.

Letting a student being aware of the social relation with other students has a strong impact in finding the suitable partner (El-Bishouty, Ogata, Rahman, & Yano, 2010). With the SNAFA, students were easy to find the suitable helpers through the awareness of social and knowledge context. Appropriate peer helpers who have just learned something are often better able than teachers to explain it to their classmates in a way that is accessible (Nicol et al., 2006). Peer interaction also exposes students to alternative perspectives on problems and to alternative tactics and strategies. Alternative perspectives enable students to revise or reject their initial hypothesis, and construct new knowledge and meaning through negotiation (Nicol et al., 2006). With the SNAFA, students learn by studying and reflecting on the material in two ways: (1) by constructing answers to potential questions that will be posed to them on assessments, and (2) by providing collaborative feedback and assistance to other students (i.e. as a peer-tutor) to help their knowledge constructions about the material (Pear et al., 2002). Online social and knowledge awareness can enhance individuals’ intentions to perform online knowledge sharing. Students in the SNAFA class have more opportunity to brainstorm and to obtain deeper understanding of online questions in formative assessments, and thus improve learning achievements.

5.2. Investigations within the SNAFA class

5.2.1. Descriptive statistics

The descriptive statistics about message exchange are shown in Table 5. In the third row of Table 5, the number of asking messages for five formative assessments is 28, 30, 43, 60, and 56, respectively. Apparently, the stably-increasing number shows that students gradually

<table>
<thead>
<tr>
<th>Table 1</th>
<th>The independent samples t-test on pretest.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>N</td>
</tr>
<tr>
<td>Pretest</td>
<td>TFA class</td>
</tr>
<tr>
<td></td>
<td>SNAFA class</td>
</tr>
</tbody>
</table>

$p < .05$. 
were aware of the benefits of the SNAFA and thus used more frequently. The number of responses is in the fourth row. The response rates in the fifth row are 82%, 83%, 86%, 90%, and 91%, respectively. The average response rate reaches 88% approximately. At the beginning, students may intend to test the SNAFA and do not concern whether the request will respond. However, after acquiring substantial help from peers, students may respond asking messages from peers as possible as they can due to reciprocity between giving and obtaining information. This phenomenon can be explained by Erickson and Kellogg (2000) who pointed out that in a social awareness system, learner are easier to carry on coherent discussions; to observe and imitate others’ actions; to engage in peer pressure. These scenarios may also stimulate these members to visit the SNAFA more frequently. These gradually-increasing response rates also conform to Wasko and Faraj (2005) argument that people are more willing to share their knowledge when they are structurally embedded in the network.

Table 2
The independent samples t-test on pretest.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree-LG</td>
<td>27</td>
<td>35.73</td>
<td>22.52</td>
<td>−1.18</td>
</tr>
<tr>
<td>Degree-HG</td>
<td>26</td>
<td>42.54</td>
<td>19.01</td>
<td>0.34</td>
</tr>
<tr>
<td>Pretest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Closeness-LG</td>
<td>27</td>
<td>38.15</td>
<td>21.52</td>
<td>−0.34</td>
</tr>
<tr>
<td>Closeness-HG</td>
<td>26</td>
<td>40.12</td>
<td>20.67</td>
<td></td>
</tr>
</tbody>
</table>

* p < .05.

Table 3
The independent samples t-test on access time and retention time for all formative assessments.

<table>
<thead>
<tr>
<th>Class</th>
<th>N</th>
<th>Access Time</th>
<th>SNAFA</th>
<th>Retention Time</th>
<th>SNAFA</th>
</tr>
</thead>
<tbody>
<tr>
<td>FA1 (Formative Assessment 1)</td>
<td></td>
<td>Access Time</td>
<td>SNAFA</td>
<td>Retention Time</td>
<td>SNAFA</td>
</tr>
<tr>
<td></td>
<td>31</td>
<td>1.23</td>
<td>0.42</td>
<td>−0.65</td>
<td></td>
</tr>
<tr>
<td></td>
<td>38</td>
<td>1.13</td>
<td>0.41</td>
<td>−0.93</td>
<td></td>
</tr>
<tr>
<td>FA2</td>
<td></td>
<td>Access Time</td>
<td>SNAFA</td>
<td>Retention Time</td>
<td>SNAFA</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>1.00</td>
<td>0.00</td>
<td>−3.18*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>43</td>
<td>1.23</td>
<td>0.48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FA3</td>
<td></td>
<td>Access Time</td>
<td>SNAFA</td>
<td>Retention Time</td>
<td>SNAFA</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>1.15</td>
<td>0.46</td>
<td>−1.36</td>
<td></td>
</tr>
<tr>
<td></td>
<td>43</td>
<td>2.12</td>
<td>3.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FA4</td>
<td></td>
<td>Access Time</td>
<td>SNAFA</td>
<td>Retention Time</td>
<td>SNAFA</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>1.04</td>
<td>0.19</td>
<td>−3.04*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>41</td>
<td>1.38</td>
<td>0.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FA5 (Close to the posttest)</td>
<td></td>
<td>Access Time</td>
<td>SNAFA</td>
<td>Retention Time</td>
<td>SNAFA</td>
</tr>
<tr>
<td></td>
<td>37</td>
<td>1.97</td>
<td>0.96</td>
<td>−3.35*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>46</td>
<td>3.98</td>
<td>3.91</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p < .05.

Table 4
The independent samples t-test on posttest.

<table>
<thead>
<tr>
<th>Class</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posttest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TFA class</td>
<td>52</td>
<td>55.00</td>
<td>21.37</td>
<td>−3.55*</td>
</tr>
<tr>
<td>SNAFA class</td>
<td>53</td>
<td>69.75</td>
<td>20.89</td>
<td></td>
</tr>
</tbody>
</table>

* p < .05.

Table 5
The features of requested messages.

<table>
<thead>
<tr>
<th>FA#</th>
<th>FA1</th>
<th>FA2</th>
<th>FA3</th>
<th>FA4</th>
<th>FA5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The number of questions</td>
<td>34</td>
<td>41</td>
<td>40</td>
<td>40</td>
<td>46</td>
<td>201</td>
</tr>
<tr>
<td>The number of asking messages</td>
<td>28</td>
<td>30</td>
<td>43</td>
<td>60</td>
<td>56</td>
<td>217</td>
</tr>
<tr>
<td>The number of response message</td>
<td>23</td>
<td>25</td>
<td>37</td>
<td>54</td>
<td>51</td>
<td>190</td>
</tr>
<tr>
<td>The response rate</td>
<td>23/28 = 82%</td>
<td>25/30 = 83%</td>
<td>37/43 = 86%</td>
<td>54/60 = 90%</td>
<td>51/56 = 91%</td>
<td>190/217 = 88%</td>
</tr>
<tr>
<td>SD (The number of asking message)</td>
<td>1(20)</td>
<td>1(19)</td>
<td>1(23)</td>
<td>1(42)</td>
<td>1(25)</td>
<td>1(129/217 = 60%)</td>
</tr>
<tr>
<td></td>
<td>2(6)</td>
<td>2(10)</td>
<td>2(19)</td>
<td>2(17)</td>
<td>2(20)</td>
<td>2/217 = 33%</td>
</tr>
<tr>
<td></td>
<td>3(2)</td>
<td>5(1)</td>
<td>3(1)</td>
<td>4(1)</td>
<td>3(8)</td>
<td>3(11/217 = 5%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4(1)</td>
<td>4(2)/217 = 1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5(2)</td>
<td>5(3)/217 = 1%</td>
</tr>
</tbody>
</table>
Finally, in the last row, the asking messages are classified according to $SD$. For example, $1(20)$ in the first column represents that among 28 asking messages in FA1, 20 messages were sent to a candidate who has $SD=1$ with a seeker. It is noteworthy that even experiencing five formative assessments, students still prefer asking a candidate who has closest $SD$ for help. In each assessment, on average, around 60% of asking messages are sent to a candidate who has direct connection ($SD=1$) with a seeker while around 33% are sent to whom have $SD=2$. In this case, we also observe that $SD$ influences the decision of selecting a helper in the SNAFA. Students still prefer to ask for the helpers who have closest pre-existing friendship with them in the real world even in a virtual collaborative learning environment.

5.2.2. Centrality versus posttest

Table 6 shows that the mean of the posttest of the Degree-HG (mean = 76.27) is significantly higher than that of the Degree-LG (mean = 63.23) ($t = -2.35$, $p < .05$). It also shows that the mean of the posttest of the Closeness-HG (mean = 73.96) is higher than that of the Closeness-LG (mean = 65.54) ($t = 1.47$, $p > .05$) although it does not reach significance. These results unveil that in the SNAFA, centrality indeed has certain influences on the posttest. Cho et al. (2007) claimed that central members in a collaborative social network tended to get higher final grades. Moreover, a student with higher degree centrality means that he/she has more directed ties with peers, indicating that he/she has more resources and opportunities to get supports. This autonomy makes him/her less dependent on any specific other students, and hence more powerful (Hanneman et al., 2005). However, a student with higher closeness centrality does not imply that he/she has more direct ties with others, but only means that he/she has a closer distance to all peers than a student with lower closeness centrality. Thus a student may not have obvious advantages because he/she still gets used to ask for help from the others who have direct ties with him/her (as shown in Table 5).

5.2.3. Centrality versus message flow

Table 7 shows that the mean of the out-degree of the Degree-HG (mean = 7.58) is significantly higher than that of the Degree-LG (mean = 0.89) ($t = -3.24$, $p < .05$). Also, the mean of the in-degree of the Degree-HG (mean = 7.69) is significantly higher than that of the Degree-LG (mean = 0.78) ($t = -2.77$, $p < .05$). Table 8 shows that both means of out-degree and in-degree of the Closeness-HG are significantly higher than those of the Closeness-LG. These results are the same whenever the grouping is by degree or closeness, unveiling that both centrality indices have the same results on the analysis of message flows in the SNAFA. It also indicates that students with higher centrality are more likely to take advantage of the social network position to ask for help, compared to those with lower centrality. And vice versa.

### Table 6

The independent samples $t$-test on the posttest.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>$T$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posttest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree-LG</td>
<td>27</td>
<td>63.23</td>
<td>20.23</td>
<td>-2.35*</td>
</tr>
<tr>
<td>Degree-HG</td>
<td>26</td>
<td>76.27</td>
<td>19.82</td>
<td></td>
</tr>
<tr>
<td>Closeness-LG</td>
<td>27</td>
<td>65.54</td>
<td>18.81</td>
<td>-1.47</td>
</tr>
<tr>
<td>Closeness-HG</td>
<td>26</td>
<td>73.96</td>
<td>22.35</td>
<td></td>
</tr>
</tbody>
</table>

* $p < .05$.

### Table 7

The independent samples $t$-test on message flow between the Degree-LG and the Degree-HG.

<table>
<thead>
<tr>
<th>Ask for help</th>
<th>Group (Degree centrality)</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>$T$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out-degree (Asking)</td>
<td>Degree-LG</td>
<td>27</td>
<td>0.89</td>
<td>4.24</td>
<td>-3.24*</td>
</tr>
<tr>
<td></td>
<td>Degree-HG</td>
<td>26</td>
<td>7.58</td>
<td>9.70</td>
<td></td>
</tr>
<tr>
<td>In-degree (Be asked)</td>
<td>Degree-LG</td>
<td>27</td>
<td>0.78</td>
<td>2.04</td>
<td>-2.77*</td>
</tr>
<tr>
<td></td>
<td>Degree-HG</td>
<td>26</td>
<td>7.69</td>
<td>12.55</td>
<td></td>
</tr>
</tbody>
</table>

* $p < .05$.

### Table 8

The independent samples $t$-test on message flow between the Closeness-LG and the Closeness-HG.

<table>
<thead>
<tr>
<th>Ask for help</th>
<th>Group (Closeness centrality)</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>$T$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out-degree (Asking)</td>
<td>Closeness-LG</td>
<td>27</td>
<td>0.89</td>
<td>4.24</td>
<td>-3.24*</td>
</tr>
<tr>
<td></td>
<td>Closeness-HG</td>
<td>26</td>
<td>7.58</td>
<td>9.66</td>
<td></td>
</tr>
<tr>
<td>In-degree (Be asked)</td>
<td>Closeness-LG</td>
<td>27</td>
<td>0.26</td>
<td>0.76</td>
<td>-3.28*</td>
</tr>
<tr>
<td></td>
<td>Closeness-HG</td>
<td>26</td>
<td>8.23</td>
<td>12.36</td>
<td></td>
</tr>
</tbody>
</table>

* $p < .05$.

### Table 9

The independent samples $t$-test on retention time between the Degree-LG and the Degree-HG.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>$T$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retention time</td>
<td>Degree-LG</td>
<td>27</td>
<td>122.52</td>
<td>105.31</td>
</tr>
<tr>
<td></td>
<td>Degree-HG</td>
<td>26</td>
<td>353.54</td>
<td>213.12</td>
</tr>
<tr>
<td>Access time</td>
<td>Degree-LG</td>
<td>27</td>
<td>7.15</td>
<td>4.07</td>
</tr>
<tr>
<td></td>
<td>Degree-HG</td>
<td>26</td>
<td>12.73</td>
<td>8.58</td>
</tr>
</tbody>
</table>

* $p < .05$. 

---

versa students with higher centrality easily become a potential helper whom peers seek to. This result conforms to Beauchamp’s argument (1965) that members occupying central locations can be very productive in communicating information to the other members.

Notably, as shown in Table 7, the out-degree (asking) within the Degree-LG group is a highly skewed distribution. The system logs showed that within the Degree-LG group, 26 students sent no message and only one student sent 22 messages. Similarly, the in-degree (be asked) within the Degree-LG group is a highly skewed distribution. The system logs showed that within the Degree-LG group, 21 students received no asking-for-help messages and 5 students received less than 3 messages while only one student received 10 messages. On the other hand, the Closeness-LG group also has quite similar circumstance as the Degree-LG group as mentioned above. These observations show that degree (or closeness) centrality does not completely dominate the message flows. Few students within Degree-LG (or Closeness-LG) group still took the advantage the provided functions of the system to ask or be asked for helps.

5.2.4. Centrality versus utilization

Table 9 shows that the mean of the retention time of the Degree-HG (mean = 353.54) is significantly higher than that of the Degree-LG (mean = 122.52) (t = –4.97, p < .05). Also, the mean of the access time of the Degree-HG (mean = 12.73) is also significantly higher than that of the Degree-LG (mean = 7.15) (t = –3.04, p < .05). Table 10 shows that both means of retention time and access time of the Closeness-HG are significantly higher than those of the Closeness-LG. These results are the same whenever the grouping is by degree and closeness, unveiling that both centrality indices have the same results on the analyses of retention time and access time. It also unveils that students with higher centrality utilize the SNAFA more frequently than those with lower centrality. Because students with higher centrality are more likely to ask for help or be asked, they may spend more time on reviewing the responses and responding to askers. Students who have asked peer assistance may concern whether responses come back. On the other hand, students may pay attention in whether someone has asked assistance to him. These phenomena become one of the reasons why students with higher centrality utilize the SNAFA more frequently than those with lower centrality. Providing students with the SNAFA sustains connections among peers to the online learning community, especially for those students with high centrality. Students with higher centrality identify themselves as a part of the virtual community. The sense of belonging to a community stimulates the students to engage in knowledge sharing and acquisition (Dawson, 2008).

Interestingly, few students who have more message flows within Degree-LG (or Closeness-LG) group also particularly spent more time than the others within the group. For example, the retention time and access time of the student who sent 22 messages are 356 min and 8 times, respectively. The retention time and access time of the student who received 10 asking-for-help messages are 203 min and 12 times, respectively. If these two students were removed from the Degree-LG group, the group has Mean = 109.96 and SD = 96.49 for retention time; Mean = 6.92 and SD = 4.11 for access time. The t values respectively become –5.30 and –3.06 for retention time and access time, which are higher than the original t values (–4.97 and –3.04) in Table 9.

5.2.5. Correlation analysis

Since centrality significantly influences message flow, utilization, and posttest, a Pearson correlation analysis between them was further employed. Table 11 shows the results and reveals that both centrality indices have a significant positive correlation with these variables: message flow (i.e. in-degree and out-degree) and utilization (i.e. retention time, and access time). Degree centrality has significant positive correlation with the posttest (the correlation = 0.315, p < .01) but the correlation between closeness centrality and the posttest do not reach significance. Since a student still prefers to ask for the helpers who have a direct connection with them (i.e., SD = 1), degree centrality has more substantial correlation in in-degree, comparing to closeness centrality. Similarly, a student with higher degree centrality has more direct resources to get supports so that degree centrality has more substantial correlation with out-degree than closeness centrality. As the inferences reported in last subsection, higher in-degree and out-degree contribute to higher utilization and more opportunity to share knowledge and discuss with the others. As a whole, degree centrality thus has more substantial correlation with these variables, comparing to closeness centrality. Thus, degree centrality could be a better index than closeness centrality for predicting learning activities in an e-learning environment which supports social network awareness.

6. Conclusion

This work proposes online formative assessments with social network awareness. Students are able to be aware both peer’s social context and knowledge context, facilitating students to select the appropriate helpers to ask for correct answer and detail explanation when
encountering problems in assessments. In this work, social-context information particularly includes nimbus, centrality, and social distance. Knowledge and social-context awareness regards as a scaffold, trying to raise the opportunities of peer interaction and collaborative feedback within a community. The SNAFA system is further developed, which allows students to effortlessly maintain both context awareness of peers and further presents them in text form and ego-centered sociogram.

The findings are as follows. Firstly, the SNAFA has better utilization and learning achievement, compared to the Traditional Formative Assessment (TFA). Secondly, within the SNAFA, the response rate of a help asking is quite high. Students still prefer to ask for the helpers who have closest pre-existing friendship with them in the real world even in a virtual collaborative learning environment. Thirdly, centrality (i.e. social network position), which represents by two indices: degree and closeness, indeed plays an important role in the SNAFA. Different centrality indeed affects learning achievement. Students with higher degree centrality have a significantly better learning achievement than those with lower degree centrality. However, students with higher closeness centrality have no significant difference with those with low closeness centrality in learning achievement. Also, different centrality significantly affects message flow. That is, students with higher centrality (regardless of degree and closeness) are more likely to take advantage of the social network position to ask for help and vice versa. Students with higher centrality are more likely to become a target helper that peers seek to. Similarly, different centrality also significantly affects utilization. That is, students with higher centrality (regardless of degree and closeness) utilize the SNAFA more frequently than those with lower centrality. In other words, the SNAFA sustains connections among peers to the online learning community, especially for those students with high centrality. Finally, both centrality indices have a significant positive correlation with message flow, utilization, and the posttest. Notably, degree centrality has more substantial positive correlation with these variables, comparing to closeness centrality. Degree centrality could be a better index than closeness centrality for predicting learning activities in an e-learning environment which supports social network awareness.

According to Dawson (2008), while the discussion forums are the primary mode of communication among students and educators in an e-learning environment, additional communication exchanges outside of the forum are still likely to have occurred. That is, the number of communication exchanges undertaken within a class (i.e. the SNAFA class or the TFA class) external to its designated system is unknown, which may affect the accuracy of evaluation results. However, this concern can be eliminated because both classes have the same circumstance. This work still has another concern. Some self-regulated students may incline to use the SNAFA frequently to acquire more resources and benefits from it. This intention may influence their settings of existing friendship and even social and learning activity in the SNAFA environment. For example, a self-regulated student may set broader existing friendship, resulting in his/her high centrality. Whether self-regulated behavior and centrality have significant interaction effects in the SNAFA environment needs further investigation.

In SNAFA, the default sorting criterion is SD. Although a student can refer to different items (i.e. SD, WD, KD…) of candidates, in general, he/she would select a desired helper according to his/her most concerned item. Thus, even if the default sorting is depending on the other field, for example, KD, it should have limited impacts on the results. More specifically, if a student most concerns SD, 1 he/she probably sorts the list by SD or 2) he/she is likely to look for the helpers who have the highest SD value even the list is sorted with the other field. However, such speculation still needs further verification which can be parts of the future work.

References


