‘Seeing’ networks: visualising and evaluating student learning networks

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http://research.uow.edu.au/learningnetworks/

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EXECUTIVE SUMMARY

The trend for greater adoption of online learning technologies continues unabated within the higher education sector. These technologies provide students with greater flexibility in their studies and more timely access to learning materials and communication activities beyond the classroom. Despite the potential benefits these technologies bring, teachers are quick to note that the online environment commonly lacks the student learning cues that are available in more traditional modes of education delivery (face to face). For example, classroom cues that assist teachers in identifying which students require further support, who is engaged and who has cognitively "checked out" of the class activities. To date, the development of learning technologies has focused on content delivery and student interaction tools, in lieu of real-time learning analytics. This lack of development in learning analytics has revolved around two core issues. The first significant issue is the prohibitive costs commonly associated with application development for both extracting and visualising student interaction data. Secondly, there is a dearth of studies that have investigated the relationship between learning analytics and data requirements that would better assist teachers in the design and evaluation of learning and teaching practice.

This project aimed to address these deficits by investigating the development and adoption of a specific analytical tool called Social Networks Adapting Pedagogical Practice (SNAPP). SNAPP was designed to provide educators with real-time data in order to better support and evaluate student learning. This ALTC project developed SNAPP to seamlessly integrate into the various market leaders for learning management systems (LMS) and provide an automated means for extracting and visualising student online network data into an easily interpretable user-interface. The project findings identified that, while the monitoring of student social networks was effective in assisting educators in their support of student learning, the tool was predominately adopted in a retrospective and reflective format. More simply put, teachers largely used the tool to reflect on the effectiveness of learning and teaching activities after the course completion. The findings demonstrate that the visualisation of student learning networks using SNAPP is extremely effective in promoting reflection on teaching activities and rapidly assessing the overall effectiveness of the pedagogical intent post course completion. However, teachers require additional support and training to better understand the relationship between their implemented online learning activities and the resultant online student behavior and the established class social network relationships. Future research and professional development should seek to merge learning design with learning analytics and data interpretation. A sound understanding of learning design principles will greatly assist academics in better interpreting the learning analytics data into informed pedagogical action.

This ALTC project aimed to address the need for teachers to access student learning cues as an ongoing measure of how students are progressing and interacting within the online context. These learning cues are provided via diagrammatic representations of the learning network. This was achieved through the development of networking visualisation software which the project named Social Networks Adapting Pedagogical Practice (SNAPP). SNAPP was designed to rapidly extract and visualize student interaction data into an easily interpretable interface.

Table 1: Project outcomes and deliverables

This project built upon prior ALTC grants to:	Project deliverables
develop an automated processes for the extraction of LMS data in order to visualise student social networks	Software (SNAPP) automatically extracts LMS discussion forum data for the page currently being used. To download SNAPP: http://research.uow.edu.au/learningnetworks/
develop the software interface for teaching staff to visualise and interpret student networks	Key features include the ability to scale nodes based upon activity (i.e number of posts); scale connections (edges) based on post-reply strength; enable/disable the display of participant names; and filter the social graph based upon the number of interactions (degree).
provide the evaluative tools to rapidly identify individuals disconnected from the learning network	Teacher instructions are part of the SNAPP package, and outline several common patterns in social network diagrams as well as possible interpretations.
provide educators with the necessary tools to focus the often limited student learning support resources more effectively	This is achieved through the design of the SNAPP software and accompanying resources. Project evaluations found that although the resources existed to enable this to occur during class running, this was, however, largely used reflectively.
undertake international and national multi-campus case studies to investigate the relationship between student position within the learning network and engagement, and achievement of stated learning outcomes.	Studies were undertaken at UBC in Canada (n = 118). Studies also occurred in Australia at multiple sites (UQ – n =30, and UOW n = 255) (see 'Case Studies' section for further details) SNAPP has been adopted across 60 Countries and in excess of 200 Institutions
Dissemination and communication	3 Journal articles; 2 Book chapters; 6 Peer reviewed conference articles; 6 workshop presentations All resources and publications can be accessed at: http://research.uow.edu.au/learningnetworks/

Key findings

One of the project goals included international and national multi-campus case studies to investigate the relationship between student position within the learning network and engagement, and achievement of stated learning outcomes. Study participants were also invited to respond to an online survey evaluating the perceived effectiveness and value of SNAPP for teaching practice. Five key findings (and their parallel recommendations) emerged from the research and developmental work for this project.

1. SNAPP Usage

- SNAPP provided informative representations of student interaction data regardless of the timing and frequency of specific analyses

- analysis of student interaction data at the conclusion of a teaching unit was the most frequent usage by teaching staff
- untapped opportunity for teaching staff to act upon the results if accessing and using the SNAPP tool on a more iterative basis during the implementation of the teaching unit
- data derived from the SNAPP resource are primarily analysed from the perspective of the lead teacher (course coordinator, lecturer, tutor, etc.)

Recommendations: a) promote SNAPP as reflective teaching tool; b) emphasize the importance of learning design in professional development activities.

2. Common participant interaction patterns

- SNAPP has a social graph filtering feature allows participants with both high and low levels of participation to be readily identified and common learning network patterns were frequently reported by SNAPP users.
- the project documented and described the commonly observed network patterns and what these forms of data represent in the learning and teaching context (this was included in the instructor pack). These were: Participant/learner isolation (learner disconnected from the network), Facilitator centric (communication primarily though teaching staff), Non interacting groups, Bridging Roles (key participants bridge otherwise non-interacting groups), Facilitator Interaction with High Performing Students (facilitator concentrates on high-performing students).

Recommendations: a) promote awareness of common participation patterns as rendered within social network visualizations along with how they can be identified and what they mean, b) conduct further research into the intervention techniques and strategies that can be used to alter undesirable patterns of social interaction, c) promote SNAPP as a tool to collect evidence of facilitation/moderation skills for inclusion in teaching portfolios.

3. Learning Network data as lead indicators of student academic orientation and performance and online participation

- One SNAPP case study revealed a strong correlation between student achievement orientation (as assessed by Tan's (2009) learning dispositions survey) and the types of forums that the student will frequently participate in. For instance students demonstrating a strong learning orientation were found to participate frequently in forums established for learning discussions and resource sharing. Conversely, students with a strong performance orientation were more likely to interact via forums focused on addressing administrative and assessment related issues.
- A second case study investigated the relationship between student admissions data, academic performance and engagement in the learning community. The results indicate that while past exam scores are a sound indicator for future academic performance, they have no correlation to student engagement, sharing and collaboration with peers. In this instance, admissions criteria centered on interviews were demonstrated to be significant predictors of participation and engagement within the student learning community.

Recommendation: Promote further research into the use of social network data to monitor student engagement and forum participation to gain a better understanding of

student motivations and achievement orientations within the context of the implemented learning design.

4. Using Web 2.0 Technologies to Build Extensions for Multiple Learning Management Systems

- SNAPP has targeted student interaction data emerging from discussion activity, as the discussion forum is one of the most used tools available in almost all collaborative learning environments. Learning activities usually also include tools such as blogs and wikis. The natural extension of SNAPP would be to provide analysis for all of the available socially oriented tools.
- SNAPP demonstrates to the eLearning development community that problematic proprietary LMS issues can be overcome with Web browser based extensions. Access to proprietary systems and/or software upgrades and new versions have caused various technical nightmares for developers of eLearning software add-ons. SNAPP applied a different approach – that of using a web-based browser extension, to bypass these technical constraints and ensure the tool would work across multiple LMS and future upgrades.

Recommendation: a) promote the use of bookmarklets and browser extensions as a way to extend/ add functionality to tools within an LMS and other collaborative learning environments and to implement and evaluate new eLearning ideas; b) extend SNAPP capabilities to other tools used in collaborative environments such as wikis

5. Future directions for SNAPP

- Students did not have access to SNAPP but this was mentioned by teachers as a potentially powerful learning tool for students
- The results of the SNAPP user survey suggest that facilitators require a high level overview of the themes and concepts that emerge from student discussions. This is particularly important when interpreting data from large class sizes. This would result in semantic analysis of discussion fora (and possibly other collaboration tools) to display a map of conversation themes.

Recommendations: a) conduct research into how students can make use of such a tool, b) explore the inclusion of content analysis functionality embed within SNAPP

‘SEEING’ THE LEARNING NETWORK

Background

The implementation of information and communication technologies within the Higher Education sector continues to provide students with greater flexibility in their studies and more timely access to learning materials and communication activities beyond the classroom. However, in spite of the potential pedagogical advantages these technologies bring to bare, teaching staff are quick to note that the online environment lacks the multiple student learning cues that are available through more traditional modes of education delivery (face to face). For example, observing classroom cues that assist teachers in identifying which students may require further instruction and mediation. Technology adoption for online and blended learning has focussed more on the design and implementation of content delivery and student interaction tools and features. Tools and resources which help teachers evaluate the way students are utilising the online tools and interacting with each other have, to date, been largely neglected. More simply stated there are limited resources for teachers to access ongoing, informal learning indicators in the online environment. In general, student learning progress in the online medium is determined from formative or summative assessments – which occur only at set points during the semester. These processes require teaching staff to evaluate on an individual basis and in many cases the opportunity to provide timely learning support to struggling students has well passed. The online environment has suffered from a lack of readily available learning-progress data that can assist teaching staff in designing learning activities, and assessing and identifying individuals requiring early learning interventions.

The concept of learning analytics has emerged as a potential field for addressing the need for real-time informative data related to student learning, engagement, and sense of community. The concept of learning analytics has been fuelled by the rapid and ubiquitous adoption of learning management systems (LMS) in the higher education sector. LMS such as BlackBoard, Sakai, Moodle and Desire2Learn have extensive and almost complete market dominance. While these tools provide ready access for teachers building resources and activities in the online environment, they also provide a mechanism for capturing and tracking student activity. As such the student user data or learning analytics, can be mined and harnessed for integration into additional analytics applications and data visualization tools (Dawson & McWilliam, 2008).

The present suite of LMS offer a range of student tracking data or learning analytics, however, these tools and presentation format are complex and far removed from the specific learning context. This has resulted in the LMS analytical tools being poorly utilised (Dawson & McWilliam, 2008). The LMS analytical tools are more frequently adopted by University administrators seeking information related to user adoption for return on investment analyses or institutional technology reviews. The transformation of user-data from analysis to informed pedagogical action is for the vast majority of academic teaching staff, a complex and potentially labour intensive process (Dawson, Heathcote, & Poole, 2010). The development of more visually appealing and interpretable analytical tools may assist in moving forward from this current impasse.

Social learning

Preceding the movement for greater integration and use of learning analytics has been a push from educational researchers and designers for developing more socially oriented learning opportunities. Numerous researchers have demonstrated the diverse range of positive educational outcomes linked to the implementation of a social learning paradigm (Gabelnick, MacGregor, Matthews, & Smith, 1990; Levine Laufgraben & Shapiro, 2004; Tinto, 1993). For instance, Alexander Astin (1993), Richard Light (2001) and John Seely Brown and Richard Adler (2008) have all noted that the most influential factor determining an individual's future academic success, academic growth and development and persistence in a course of study is related to their social network. The development of a community of learners or a learning network has become the foundational educational practice for both online and offline education environments.

The growing development and sophistication of Web 2.0 technologies provide collaboration-focussed affordances that have been quickly seized upon by social learning advocates. However, to date Web 2.0 tools such as blogs, wikis, twitter, and document and presentation sharing have been poorly integrated into the Higher Education (HE) Information and Communication Technology (ICT) system. HE has invested heavily into LMS. As such, any integration of additional tools (such as blogs, wikis, etc.) has frequently been viewed as an add-on, in lieu of core functionality. It should be noted that the recently developed LMS vision outlined by Sakai 3.0 (Sakai-Foundation., 2010) largely reflects the future direction of ICT adoption into the HE sector. Current development associated with learning technologies promotes more of an ecosystems perspective where any tool is linked and integrated as required. The LMS largely available within Australian HE still represent a transmission model of teaching practice that currently overshadows the more pedagogically favoured social paradigm (Brooks, Panesar, & Greer, 2006). This is well demonstrated by Macfadyen and Dawson (2010) in their study of LMS tool usage in a large research intensive university. The authors noted that the 2 most utilised LMS tools are the content page for transmission of information and the discussion forum for student collaboration and social learning activities. Other more socially aligned resources and tools within the LMS were poorly adopted. Similarly, Brooks et al (2006) also highlighted the poorly developed LMS resources available for assisting educators in implementing social learning activities. Hence, the heavy reliance on LMS based discussion activities for promoting student to student interactions and engagement.

Given the high discussion forum adoption rate among teachers there is an opportunity to use this platform as a commencement point for assisting educators in further enhancing online education practice. A core component of this professional development process will be the provision of real-time learning analytics to assist in evaluating the impact of the designed learning activities and student online behaviour.

Learning analytics

The concept of "academic analytics" or "learning analytics" was first proposed by Wang and colleagues to describe the analysis of student user data from various ICTs (Wang & Newlin, 2000, 2002; Wang, Newlin, & Tucker, 2001). Wang et al were quick to note that these forms of student data and usage patterns may offer some potential towards the early identification of student academic success. Over the past few years there has been a rapid rise in the research, application and development of learning analytics. For instance, researchers such as Macfadyen and Dawson (2010) have utilised student ICT interactions to identify lead indicators of student academic performance. While,

Petropoulou, et al (2008) discussed the application of an analytics tool to guide teachers in developing and assessing collaborative based activities. At an institutional level, Central Queensland University has developed the indicators project to monitor and inform strategic decision making related to student and teacher support (Beer, Jones, & Clark, 2009), and Purdue University in the United States has developed the "signals program" to monitor student learning support. These few studies begin to highlight the diversity of applications for learning analytics from the aggregation of broad scale institutional data to individual teacher and student usage patterns. The complexity for learning analytics lies in how to better represent the data for assisting the end user in interpreting the wealth of available information.

In this context the adoption of social network methodologies provides a framework for evaluation and visualisation of the available student interaction data. This is well demonstrated by Reffay and Chanier (2002) who maintain that Social Network Analysis (SNA) is an effective evaluative tool to determine levels of student cohesion in a collaborative learning environment. The authors further note that the incorporation of SNA "would enable tutors to detect a problem or a slowdown of group interaction" (p.31) thereby providing an opportunity for early and timely intervention to better support student learning. Thus the development of a tool that affords both the visualisation and analysis of the network fostered through student forum discussions (Bakharia & Dawson, 2009), can act as an accurate lead indicator of online student engagement. The following section provides an overview of such an evaluative tool. Social Networks Adapting Pedagogical Practice (SNAPP) uses real-time social network visualisations to assist teachers in determining the effectiveness of their implemented learning design. In so doing, the tool also provides pedagogically meaningful insights into individual and group learning characteristics.

SNAPP

The Social Networks Adapting Pedagogical Practice (SNAPP) tool was designed to provide educators with real-time access to the developing student social relationships and interactions within an online discussion. The student interaction data and the social network visualisations act as a diagnostic tool that affords teachers the opportunity to reflect on the observed network behaviour and determine if this is aligned with the intended learning design. Earlier research has demonstrated the high level of adoption of the discussion forum by online educators. Thus, SNAPP was designed specifically to extract and visualise all interactions that occur within this communication medium. To facilitate ease of use and broader adoption SNAPP embeds the social network metrics and visualisations within the LMS, with the rendering of the sociogram (social graph) alongside the threaded message display. While the threaded discussion view provides an indication of the number posts and the depth of message threads, it is challenging for teachers to interpret these results for making informed decisions regarding levels of peer interaction (Dawson & McWilliam, 2008). Moreover, the complexity associated with determining levels of student engagement and peer networking is further compounded as class size increases. For example, Figure 1 illustrates two separate threaded forums with similar depth and structure. Extracting this forum data and rendering into a graphical representation provides teachers with a quick visualisation that can be easily interpreted and evaluated against the learning activity outcomes.

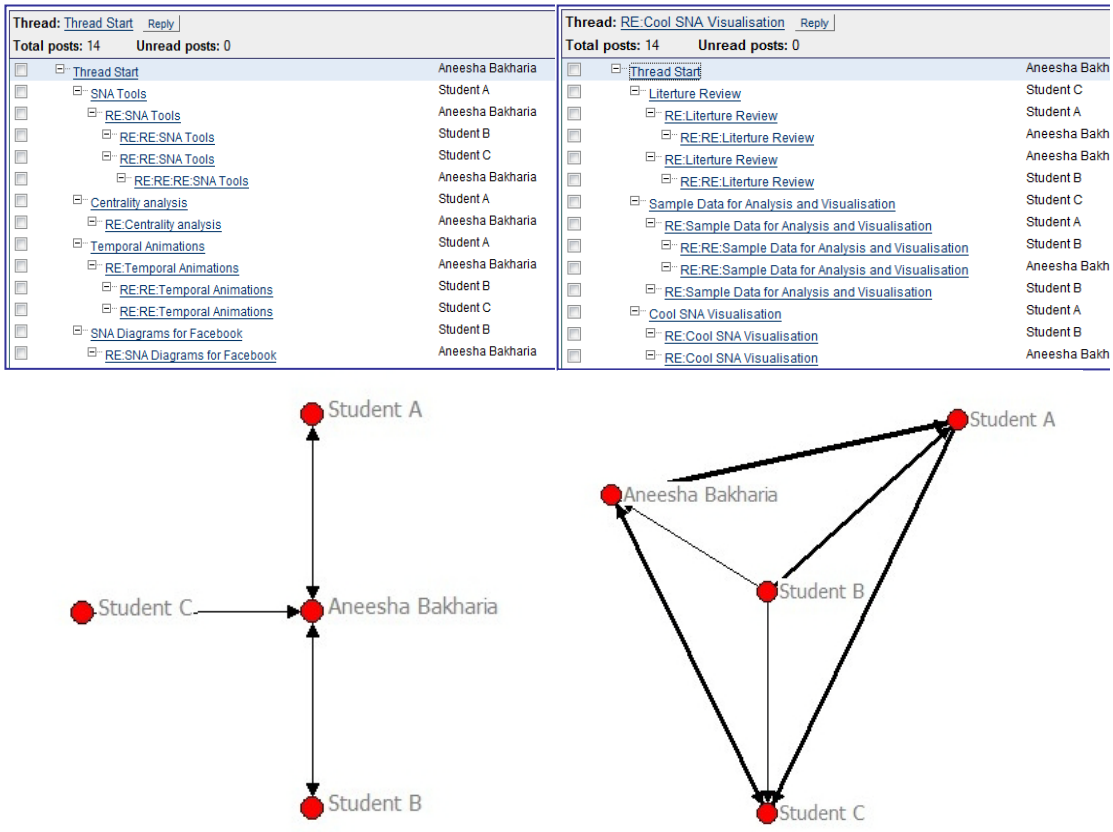

Figure 1: Threaded forum display vs social graph visualisation

Understanding Social Interaction

A common feature associated with both commercial and open source LMS is the capacity to capture and retain information related to user interactions. This data provides a rich source of information that can be harvested for informing strategic decision making at an institutional level or guiding teacher interventions and learning design. In spite of the volume of potential of this data there has been limited access to the systems database to further explore and develop analytical resources. Access to these systems has been largely prohibited as a result of licensing concerns (commercial) or the potential heavy system load (open source and commercial). However an alternate solution is available that avoids licensing implications and load on the system back-end. This solution relates to the extraction of user-interaction data from the threaded discussion forums. The forum contains all user-interaction data occurring between participants within the threaded view (See figure 1). Consequently, the discussion forum contains all the necessary data to establish the user-relationships and networks properties required for social network analysis. For example, an individual poster and respondent/s, time stamp and message subject are all required for further network analysis and rendering. This data succinctly resides in the discussion forum providing an opportunity to extract and then construct the social network. Additionally, the message replies are readily identified through page indentation from the parent message. Therefore, forum participants can be easily represented as nodes within the social network and relationships between individual users established using the post-reply interaction.

The benefits of this approach relate to the speed at which the data and associated visualisations can be generated, and the removal of any requirement to access the systems database. As previously noted this technique rapidly decreased the

development time without compromising project quality. The translation of the network from threaded discussion to social graph is demonstrated in Figure 2. This example outlines a 4-person threaded discussion containing 7 messages. The data is represented as a social graph including node and edge attributes such as the number of posts made by each individual and the number of messages exchanged between participants. This message exchange data also serves to provide an indication of the strength of any relationship between 2 nodes (participants).

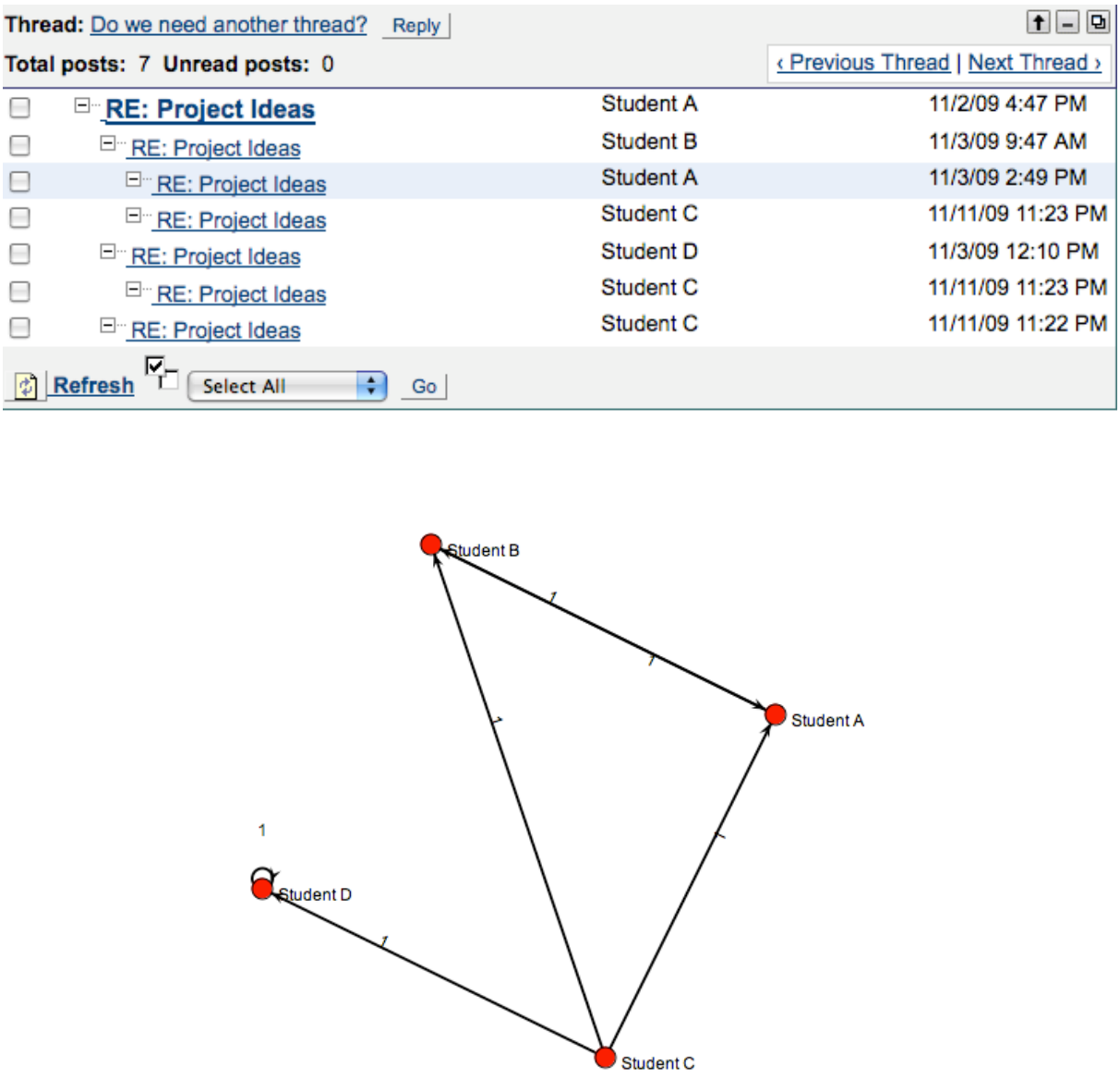

Figure 2: Converting forum post-reply data to social interactions

Design Guidelines

The process used by SNAPP to build network relationships from the discussion forum is akin to previous models developed for Internet Relay Chat (IRC). In essence, SNAPP visualises the relationships that form as participants respond to one another via discussion messaging. This is well exemplified by Mutton (2004), who applied an IRC bot (PieSpy) to monitor chat channels and construct relationships occurring between participants. As each IRC user has a unique identifier it is possible to establish where connections are being formed. This principal can be applied to LMS and in particular discussion forum activity.

In relation to forum participation the level of exchanges between 2 nodes (students or teachers) can be used as an indicator of relationship strength that has evolved. SNAPP was initially designed to extract post-reply interactions from discussion forums in Blackboard and WebCT. Additionally, the design specifications demanded that the extracted forum interaction data be available for export into more sophisticated social network analysis tools such as NetDraw (Borgatti, 2002) for further analysis and manipulation. However, as application development unfolded and practitioner adoption increased the distinct educational value-add was identified. Thus, SNAPP rapidly evolved to incorporate inline social graph visualisations while still maintaining streamlined installation and usage. The key guidelines governing the design and development of SNAPP are discussed below:

- *Simplified installation and usage*
  It is difficult to design a server side extension that integrates with a variety of popular LMS, as different extension frameworks and programming languages are employed. SNAPP as a result has been developed as a client-side bookmarklet requiring only a Web browser for installation and access. Users simply “drag” the bookmarklet link to their browser toolbar for installation. SNAPP can then be triggered, by selecting the toolbar link, when a forum from any of the supported LMS is displayed.

- *Cross LMS, browser and platform support*
  A key design aspect of SNAPP was to mainstream the use of SNA within the educational institution context. To achieve this aim it is essential to support commonly used commercial and open source LMS and the dominant versions and varieties of Web browsers and platforms. As such, SNAPP currently supports Blackboard, WebCT and Moodle and is compatible with Internet Explorer, Firefox and Safari on Windows and Macintosh platforms.

- *Real-time forum data analysis*
  SNAPP performs data extraction and analysis in real-time. When a forum is accessed, a facilitator is able to trigger SNAPP, view the emerging network structure and instigate facilitation changes if necessary.

- *In-line visualisations and social network metrics*
  SNAPP utilises the JUNG library (O’Madadhain, et al., 2005) to render the social graphs. The interactive features (e.g. centrality measures and filtering) were incorporated into the interface after consultation with end-users. The SNAPP interface is shown in Figure 3. The features adopted reflect the commonly used core functions previously performed in NetDraw (Borgatti, 2002). Various graph layout algorithms are provided and SNAPP allows the user to:
    - scale nodes based upon number of posts;
    - scale connections (edges) based on post-reply strength;
    - enable/disable the display of participant names;

- zoom in and out; and
- filter participants based upon the number of interactions (degree).

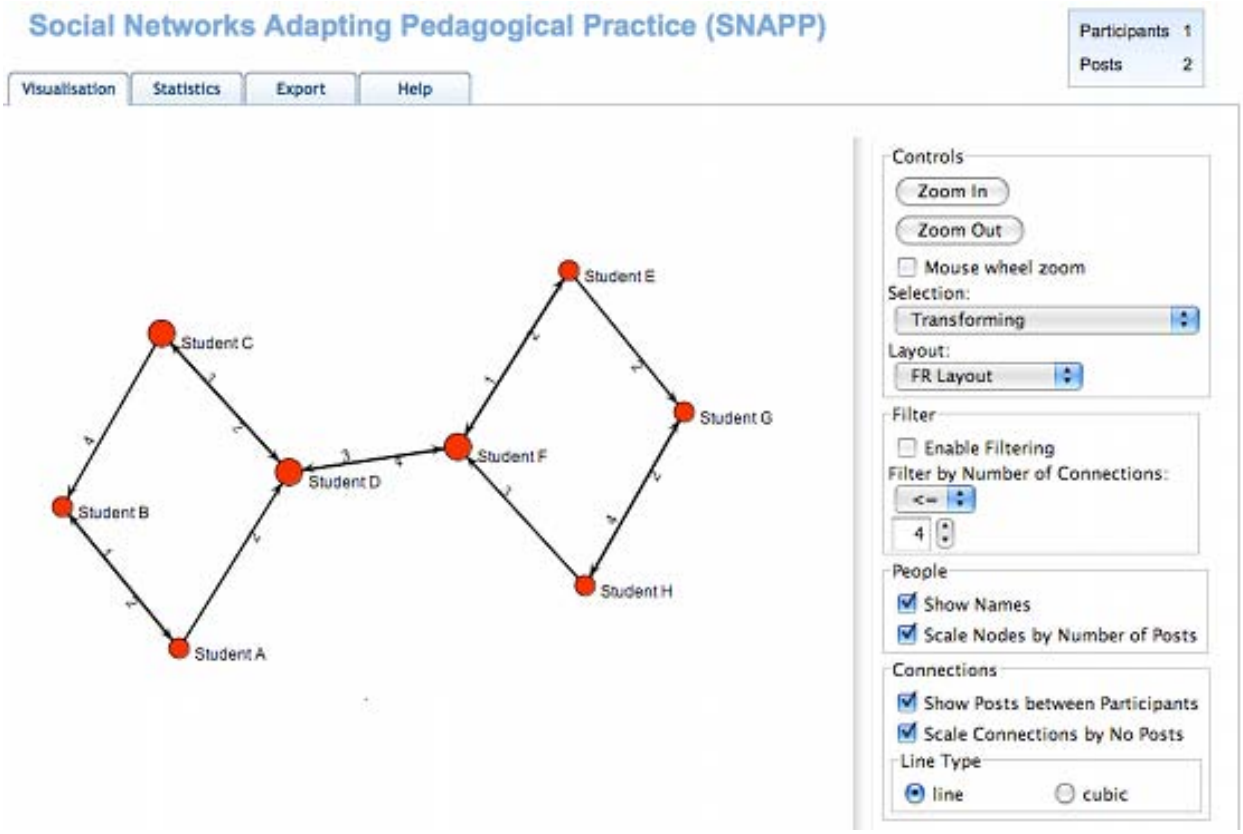

Figure 3: The SNAPP Interface

- *Support popular Export Formats*
  The social network data extracted from a forum is available as VNA and GraphML formats. While SNAPP provides in-line social graph visualisations, it is not within scope to replicate the complex functionality found within tools like NetDraw (Borgatti, 2002). It is still envisaged that users will utilise NetDraw for more complex and sophisticated social graph layout and analytics.

- *Simplify SNA*
  Simplify SNA concepts for users that are not SNA experts. As the primary target end-user is understandably not a SNA expert, the presentation of the available data must be in a format that facilitates interpretation within the educational context. In short, any visualisations must provoke reflection on practitioner action.

- *Multi-forum support*
  The majority of LMS provide teachers with the capacity to concurrently run multiple forums as a part of a particular learning design. This is frequently used when allocating specific discussion activity around course content or modules. As a result student relationships formed in one individual forum may not arise in an alternate – despite being assigned to the same course. Thus, given the diversity of ways discussion activities can be implemented within a course curriculum it was necessary to ensure that the tool could extract network data from multiple

discussion sites. Thus, SNAPP users have the functionality to generate social graphs from pre-selected forums within a course.

Findings

This ALTC project aimed to address the need for educators to access student learning cues as an ongoing measure of how their students are progressing within the online context. The research involved several specific case studies to identify common social network activity patterns and lead indicators of student learning outcomes. Study participants were also invited to respond to an online survey evaluating the perceived effectiveness and value of SNAPP for teaching practice. The following discussion addresses the key research findings and associated recommendations deriving from the project.

1. SNAPP Usage Affordances of Embedding Real-Time Social Network Analysis and Visualisation with Discussion Fora within Learning Management Systems (LMS)

The Social Networks Adapting Pedagogical Practice (SNAPP) tool, displays a social network diagram of participant interaction within a discussion forum. The visualisation is displayed below the threaded forum layout and can be triggered at any time by a forum facilitator (course coordinator or tutor). The SNAPP tool serves to deliver real-time participant interaction that is easily accessible by facilitators at any time within course or learning activity progression. The findings from the project indicate that social network analysis provides informative representations of student interaction data regardless of the timing and frequency of specific analyses. For instance, the analysis of student interaction data at the conclusion of a teaching unit provides ample information for reflection and improvement upon practice. However, there is far greater opportunity for teaching staff to act upon the results if accessing and using the SNAPP tool on a more iterative basis. The affordances of real-time social network analysis stem mainly from the ability to detect negative social patterns while a course or learning activity is in progress. This allows facilitators with adequate time to analyse the emerging pattern of interaction, determine appropriate intervention and moderation techniques and evaluate whether their interventions have been able to alter participant interaction patterns.

Recommendations

- SNAPP is promoted as an evaluative tool designed to represent network patterns emerging from collaborative learning activities that facilitate and promote reflection on teaching practice;
- SNAPP is extended to include other tools in collaborative learning environments such as blogs and wiki's;
- Further research is undertaken to focus on how students can benefit from real-time indicators of social interaction and position within a social graph.

2. *Common Participant Interaction Patterns Related to Student Engagement and Isolation*

Based on the project findings and participant feedback, SNAPP has been developed to include a social graph filtering feature that allows participants with both high and low levels of participation to be readily identified. Low levels of interaction can be interpreted as an indicator of student isolation (McDonald, Stuckey, Noakes, & Nyrop, 2005). The results from this current study suggest that common learning network patterns are frequently encountered. A key outcome of the project was to document and describe the commonly observed network patterns and what these forms of data represent in the learning and teaching context. For example the following patterns were frequently observed by the study participants:

- *Participant/learner isolation:*
  This pattern is characterised by dense interactions occurring between central and numerous nodes. However, conspicuously absent are instances of no interaction occurring among isolated individuals. These isolated nodes represent participants that have made posts that have not been responded to by other participants. This should act as an early warning indicator for teaching staff to further examine the root cause of the lack of interaction. Further intervention may be necessary to ensure that the isolated individuals are included in the rapidly emerging community. These forms of interventions are particularly critical in large classes and during the initial collaborative phase.

- *Facilitator centric patterns:*
  A star shaped interaction pattern (Figure 4) is the signature pattern of an "answer-person" (Welser, Gleave, Fisher, & Smith, 2007). Interaction occurs between the facilitator and individual participants but not between participants. The facilitator centric pattern is an indication that the participant interaction required to achieve knowledge sharing and collaboration may not be occurring (Marcos-Garcfa et al., 2009). This form of pattern quickly highlights the alignment between instructor pedagogical intent and student behaviour. In some instances such as mixed mode classes this type of pattern may illustrate the question and answer intent of the online environment and that more social learning activities are carried out in alternate venues. However, the network pattern can also indicate an over emphasis on teacher interventions. Hence, early identification affords an opportunity for implementing alternate learning activities that better promote the types of student interactions that are more aligned with the socially oriented pedagogical model (e.g. group learning; learning community, etc.).

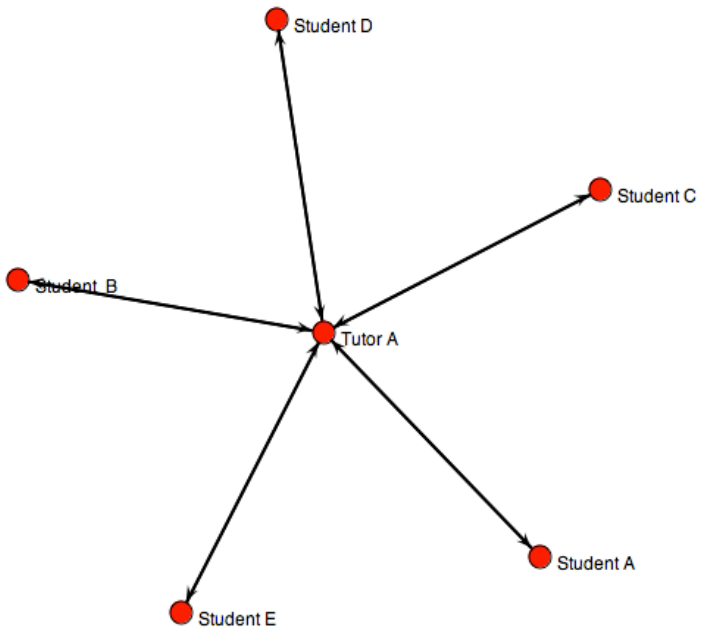

Figure 4: Example sociogram for the facilitator centric pattern

- *Non interacting groups:*
  The identification of structural holes (Burt, 1992) within the learning network (Figure 5) can be an indicator that disparate cliques or groups are developing. While this can illustrate the emergence of strong relationship bonds between individuals in a clique, it may also represent a diminishing level of diversity and does increase the likelihood of group think (Uzzi & Spiro, 2005). The data may also reveal the continuance of prior relationships or alignment of similar characteristics. As McPherson, et al (2001) well noted, "similarity breeds connections" (p.415). While perceived similarities can be used to initiate discussions it is through longer term interactions involving a diversity of experiences, values, and understandings where learning, innovation and creativity is ultimately cultivated and fostered (Dawson, 2009; McWilliam & Dawson, 2008).

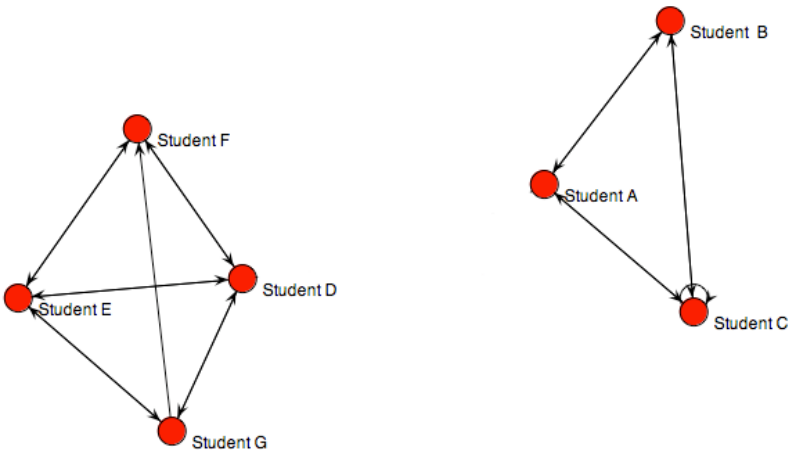

Figure 5: Example sociogram depicting the presence of structural holes

- *Bridging Roles:*
  Similar to patterns related to structural holes, the bridging roles pattern represents discussions occuring within identifiable groups. These groups are then linked via a small number of key participants. These individuals act as a "bridge" between groups and play an important role in forming collaborations between disparate groups. From a learning and teaching perspective the identification of these key individuals can assist in garnering group opinion, evaluations or the dissemination of vital information.

- *Facilitator Interaction with High Performing Students:*
  Active discussion is occurring, with the facilitator interacting only with dominant central participants. Numerous participants with a low number of connections exist in this pattern. The facilitator in this scenario tends does not attempt to reply to un-responded posts or try to incorporate periphery participants within the discussion. Colour coding nodes based upon academic performance (grades) can reveal that the learning network evolves into segregated clusters of high and low performing students. (Figures 6a and 6b) (Dawson, 2009).

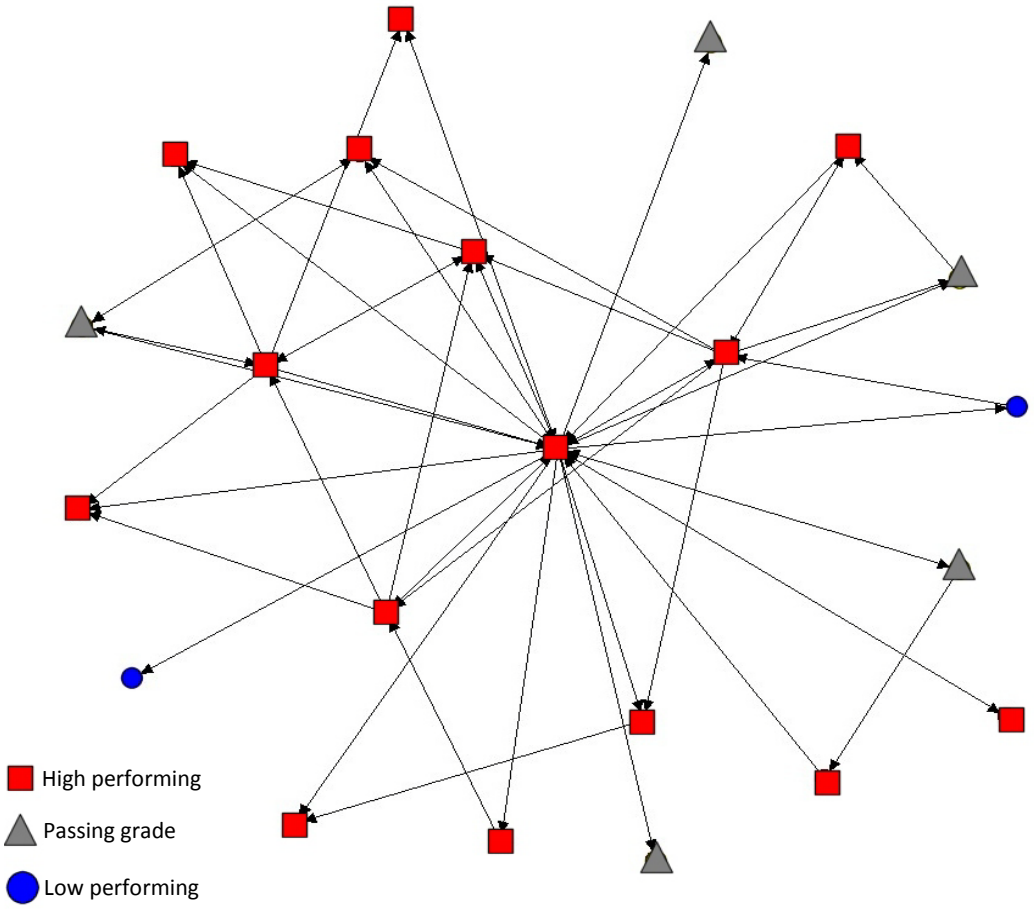

Figure 6a: Example ego-network of an identified 'high performing' student (90th percentile group).

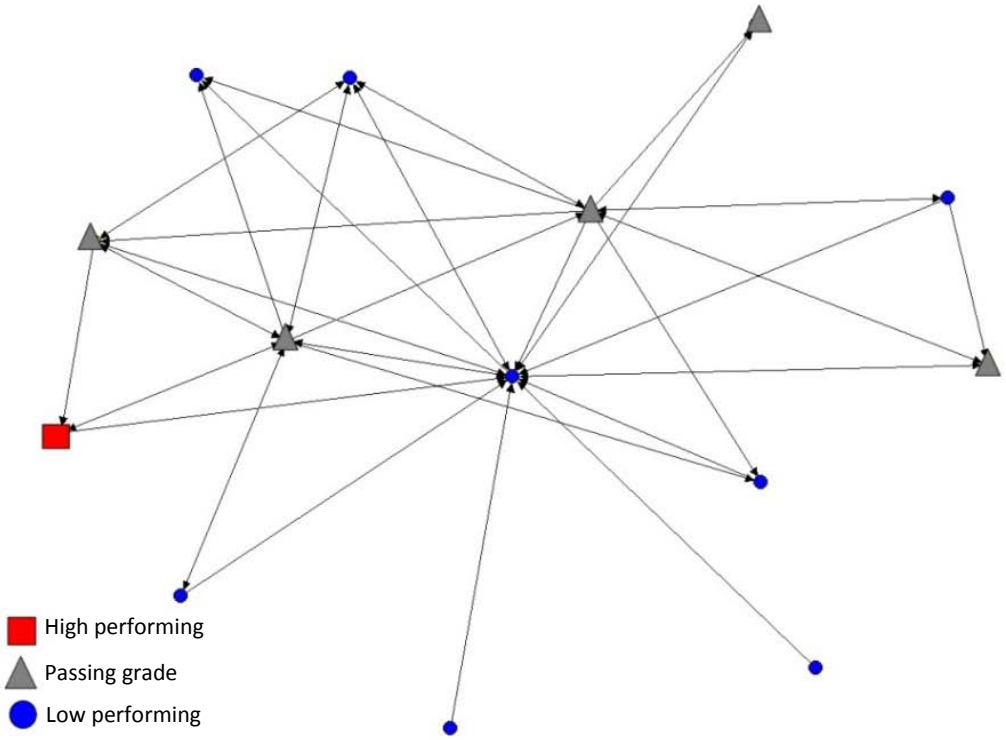

Figure 6b: Example ego-network of an identified 'low performing' student (10th percentile group).

While SNAPP provides the forum facilitator with the capacity to visualise an emerging pattern in real-time and early opportunity to implement learning interventions to improve engagement, there is still a need for identifying and documenting successful facilitation techniques. Future research and SNAPP enhancements will need to focus on how patterns can be detected automatically and provide facilitators with suggested intervention techniques and activities. Furthermore, the social network diagrams provide evidence of the success of learning activities seeking to encourage knowledge creation and sharing. Social network diagrams saved prior to key interventions, serve to illustrate the network evolution that results from the learning interventions. SNAPP also enables social network snapshots to be taken in real-time for inclusion in a teaching portfolio. The use of SNAPP for this context needs to be further integrated and researched.

Recommendations

- Promote awareness of common participation patterns as rendered within social network visualisations;
- Distribute information of the common patterns, how they can be identified and their relation to various social network metrics;
- Conduct further research into the intervention techniques and strategies that can be used to alter undesirable patterns of social interaction;
- Promote SNAPP as a tool to collect evidence of facilitation/moderation skills for inclusion in teaching portfolios.

3. *Lead indicators of student academic performance and online participation*

The case studies undertaken for this project indicate that the social network data presented by SNAPP can be used as a significant lead indicator of student academic performance and online participation. The findings of the study revealed a strong correlation between student achievement orientation (as assessed by Tan's (2009) learning dispositions survey) and the types of forums that the student will frequently participate within. For instance students demonstrating a strong learning orientation were found to participate frequently in forums established for learning discussions and resource sharing. Conversely, students with a strong performance orientation were more likely to interact via forums focused on addressing administative and assessment related issues.

A second case study investigated the relationship between student admissions data, academic performance and engagement in the learning community. The results indicate that while past exam scores are a sound indicator for future academic performance that are not significantly correlated with student engagement, sharing and collaboration with peers. In this instance, admissions criteria centered on interviews were demonstrated to be significant predictors of participation and engagement within the student learning community.

The results derived from the case studies have further implications for motivating and engaging students rapidly within the first few weeks of course commencement. Student motivation is a significant contributor to student drop out rates (Moore & Kearsley, 2005). The admissions criteria, learning dispositions survey and monitoring social network engagement data can therefore, assist educators with identifying the primary drivers for individual student motivation. The integration of social network engagement data early in the course implementation can be used to target and personalise learning activities to reduce attrition and promote more robust learning engagement.

Recommendations

- Promote further research into the use of social network data to monitor student engagement and forum participation to gain a better understanding of student motivations and achievement orientations within the context of the implemented learning design.

4. *Using Web 2.0 Technologies to Build Extensions for Multiple Learning Management Systems*

SNAPP has been designed to perform social network analysis and visualisation on discussions forums in popular LMS such as Blackboard, WebCT, Moodle and Desire2Learn. Prior ALTC projects have indicated that the discussion forum is one of the most commonly adopted tools within the LMS suite (Dawson & McWilliam, 2008). Consequently SNAPP has targeted student interaction data emerging from discussion activity, as the discussion forum is one of the tools available in collaborative learning environments. Learning activities usually also include blogs and wikis. The natural extension of SNAPP would be to provide analysis for all of the available socially oriented tools.

The SNAPP tools architecture is unique as it allows the LMS to be extended in ways previously thought to be too complex or beyond technical capacity. In the first instance the single code base, written in Javascript, is able to target multiple LMS and be

extended further to support additional systems. While most LMS offer an extension framework, all use different programming languages and proprietary Application Programmable Interfaces (API). The extension frameworks available only allow new tools to be added and don't provide a means for existing tools to be enhanced. Certain LMS such as Desire2Learn for example do not provide an extension mechanism. This restricts any future enhancements to the products vendor. Due to these deficiencies, it has been difficult to alter and enhance tools to support specific learning outcome requirements. To ensure the achievement of the project outcomes, the SNAPP project team introduced techniques that are commonly used to extend and alter web applications such as Gmail and Twitter with Web browser based extensions. While this research outcome is of a technical nature, it is valuable to be documented and shared to illustrate how pedagogical LMS enhancements and research experimentation within closed systems can be further realised and potentially mainstreamed.

SNAPP has been implemented as a client side Web browser based extension using a popular technique known as a bookmarklet. A bookmarklet is a link added to a Web browser's toolbar, that inserts additional programming code into the currently viewed Web page. The programming code can extract or alter the Web page currently being viewed, in this case any page within a LMS. This ability allows SNAPP to be triggered when a facilitator is viewing a forum. The social network visualization is rendered below the forum and serves as an alternate representation to the threaded tree view of interaction.

It is currently time consuming and costly to implement new functionality within a collaborative tool. Researchers and educators frequently suggest novel initiatives relating to learning and teaching practice and the use of institutional ICTs. However, the implementation is frequently impeded by the need to redevelop the base level features already provided by the institutionally endorsed LMS as a separate tool before their ideas can be realised. Various standard system administrative features such as authentication also need to implemented. The techniques used by SNAPP, allow learning and teaching initiatives to be implemented on top of existing systems. This allows research funding and time to be focussed on the development of core research ideas and greatly reduces the amount of development time required, as standard system component do not require re-invention and duplication. The use of client side tools, also eases the deployment process. The SNAPP bookmarklet is able to be easily installed by simply dragging a link to their browser toolbar. This is an important feature and enables the deployment of experimental features to a subset of users without adversely impacting the large university wide community. The success and broad applicability of this approach is well demonstrated in the number of institutions now utilizing the SNAPP resource. At the time of writing - SNAPP had been adopted across 17 countries and over 50 higher education institutions.

Recommendations

- Promote the use of bookmarklets and browser extensions as a way to add functionality to tools within an LMS and other collaborative learning environments
- Promote the use of bookmarklets and browser extensions to extend multiple LMS and collaborative learning environments with a single code base
- Encourage the use of bookmarklets and browser extensions as a rapid and cost effective means for researchers to implement and evaluate new ideas

5. Future directions for SNAPP

The findings from the study indicate that the data derived from the SNAPP resource are primarily analysed from the perspective of the lead teacher (course coordinator, lecturer, tutor, etc). While there are numerous learning and teaching advantages that can be leveraged from students analysing their own network patterns, at this stage of the adoption cycle the tool has been confined to the context of a teacher. As the resource gains more leverage and familiarity in evaluating learning and teaching activities it is foreseeable that students will also access the network data to reflect on their personal interactions and where they are positioned within the broader learning network. To facilitate this future expansion and adoption the SNAPP resource has been designed so that both students and teaching staff can readily access the visual representations of the group interactions.

While SNA provides insight into the relationships formed between participants it does not provide an indication of the overall quality of the relationship or the topics discussed or resources exchanged. The results of the current study suggests that facilitators require additional real-time evaluative tools that can provide a high level overview of the themes and concepts that emerge from the various collaborative learning activities. This is commonly noted when interpreting data from large class sizes.

Study participant: SNAPP has the potential to provide accurate and systematic view of discussion and way to accurately look at social networking analysis.

Study participant: At first it was just interesting. Later when I learned more about the diagrams I could see how to respond.

Study participant: Made me think how to engage all students and I could quickly see that not all students were engaging

Teaching staff note that additional information regarding semantic analyses will better complement and assist educators in designing specific and targeted learning interventions. For instance:

Study participant: I could respond to the data more if I could quickly see what students are discussing

Study participant: A disadvantage of SNAPP is you can't tell whether or not students are discussing on task content

The complexities surrounding the development of a real-time semantic analytical tool that is embedded within the framework of the various commercial and open source LMS cannot be understated. However, while still in development, this current research project has identified some potential emergent fields that may be present a solution to this challenge. For instance, topic modeling is an unsupervised machine learning content analysis technique that is able group together participant submissions (blog posts, comments, discussion forum posts, contributions to wiki's) that are related based upon word usage. The incorporation of such content analysis functionality within SNAPP, would allow facilitators to obtain a high level overview of contributions made in a collaborative environment. Although content analysis is beyond the scope of this initial project, the future developmental plans of SNAPP have included this form of functionality to be provided to both teaching staff and students. In essence, all members of the

learning community will have ready access to the network analyses and an overview of the primary topics of discussion.

Recommendations

- Explore the inclusion of content analysis functionality embed within SNAPP
- Conduct research into how students can make use of such a tool.

Interpreting SNAPP – Example structural patterns and teacher action

The findings from the study indicate that academics adopting SNAPP were impeded by a lack of understandings of how implemented learning activities relate to the student user behaviour in discussion forum activities. In essence, unless glaring differences in teacher expectations arose, there were minimal interventions applied for the duration of the course and learning activity. However, through the analysis of the case studies, teacher training and workshops a number of common network patterns were observed. As research in learning analytics and social network analysis within the education context grows there will be further opportunity to explore and comment on the frequency of the learning network patterns.

This section describes the frequently encountered SNAPP network visualisations (sociograms) and the interpretation of these diagrams with reference to teaching and learning practice. While this section discusses the interpretation of the commonly encountered network patterns it is important to note that the educational context the learning activity is positioned in, will largely influence any conclusions that can be drawn.

Facilitator Centric Patterns

The sociogram in Figure 7 illustrates a 'facilitator' centric pattern or “wagon-wheel pedagogy”. This network indicates that the dominant flow of exchanges has primarily occurred between the facilitator and individual learners. The pattern demonstrates minimal learner to learner exchanges. In this instance, the central actor is more commonly referred to as an ‘answer person’ (Welser, et al., 2007). This network pattern was commonly encountered in discussion forums dedicated to Frequently Asked Questions. In these instances one to one relationships mediated by the instructor are desired and encouraged.

While in certain learning and teaching contexts this social network pattern may be highly appropriate, the pattern does not represent good social learning engagement. Where more social oriented learning activities have been introduced this network clearly indicates that further intervention is required to re-align the observed student behaviour with the pedagogical intent. For example, if the purpose of the forum is to foster knowledge sharing and creation, this type of generated sociogram would indicate there is a need to better scaffold the discussion in order to engage a greater diversity of learners. A facilitator centric pattern is frequently observed in the early stages of a collaborative activity. During the initial stages of the online course a facilitator’s primary function can be seen to guide and scaffold discussion. However, as the discussion evolves towards a more community oriented pattern, the role of the facilitator would transition towards a co-collaborator. This is well exemplified in Figure 8. In this example, there is a large core of active collaborators. We would argue that this social graph represents the appropriate alignment between student online interactions and implementation of a social learning pedagogy. In short, Figure 8 is a lead indicator of a student lead community.

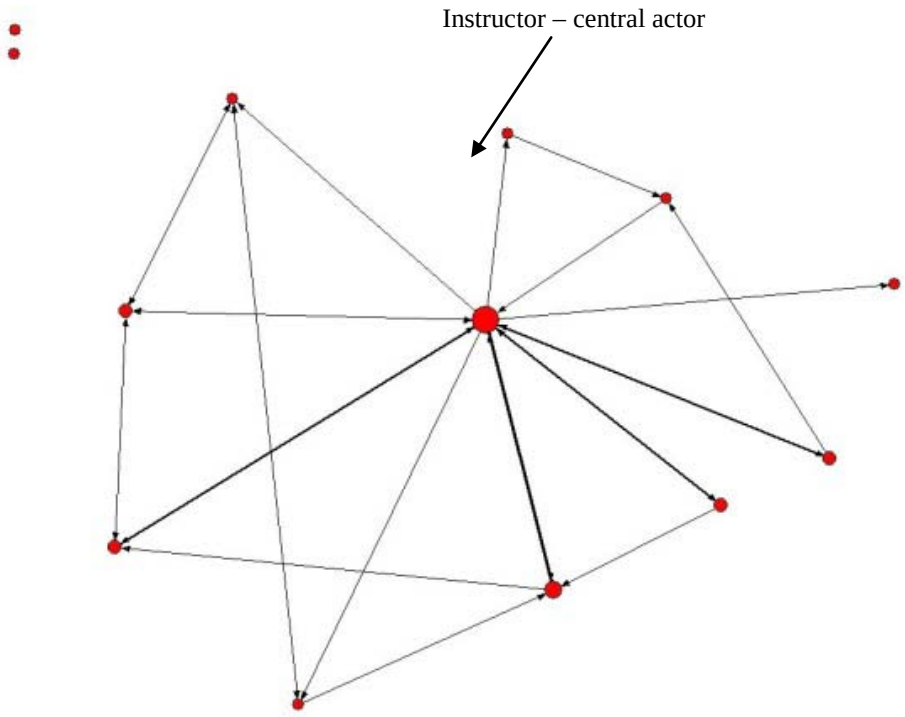

Figure 7: Interaction only occurs between the facilitator and participants

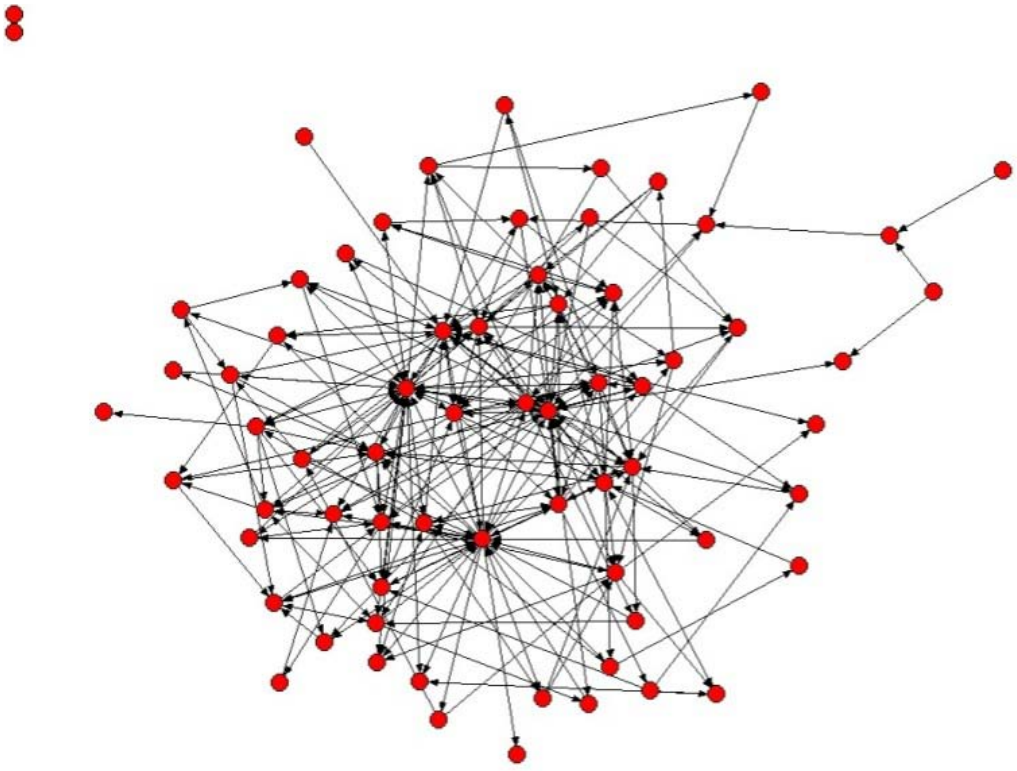

Figure 8: Interaction levels indicative of a learning community

The rapid visualisations developed from SNAPP were highlighted by academics as a key feature to determine overall levels of student engagement. For instance:

Study Participant: Displaying student participation, students who are leading vs students who do more listening - reception.

Study participant: Made me think how to engage all students and I could quickly see that not all students were engaging

The primary intent and manner in which the discussion forum activity is firstly implemented and secondly scaffolded is integral in the prevention of central actor network structures (as demonstrated in Figure 7). For example, Aviv et al (2003), maintain that there is a link between non-structured asynchronous learning activities and the formation of the "answer person". Learners within well designed and structured forums take on greater triggering and bridging roles, develop more cohesive groups and participate in higher levels of knowledge sharing and construction. Conversely, learners operating in a non-structured forum, form fewer cliques, achieve limited knowledge construction and are more reliant on the instructor to lead discussion and questioning. The integration of a strong learning design focus for online activity integration will assist educators in engaging students in a more socially oriented and participatory network. The analytical reports provided by SNAPP can assist in the rapid detection of poor student engagement or the increasing dominance of an "answer person". For example, Figure 9 illustrates the use of splitting connection strength by post-reply data. The in- and out- degree metrics also serve to give an indication of which role is predominantly the forum thread initiator.

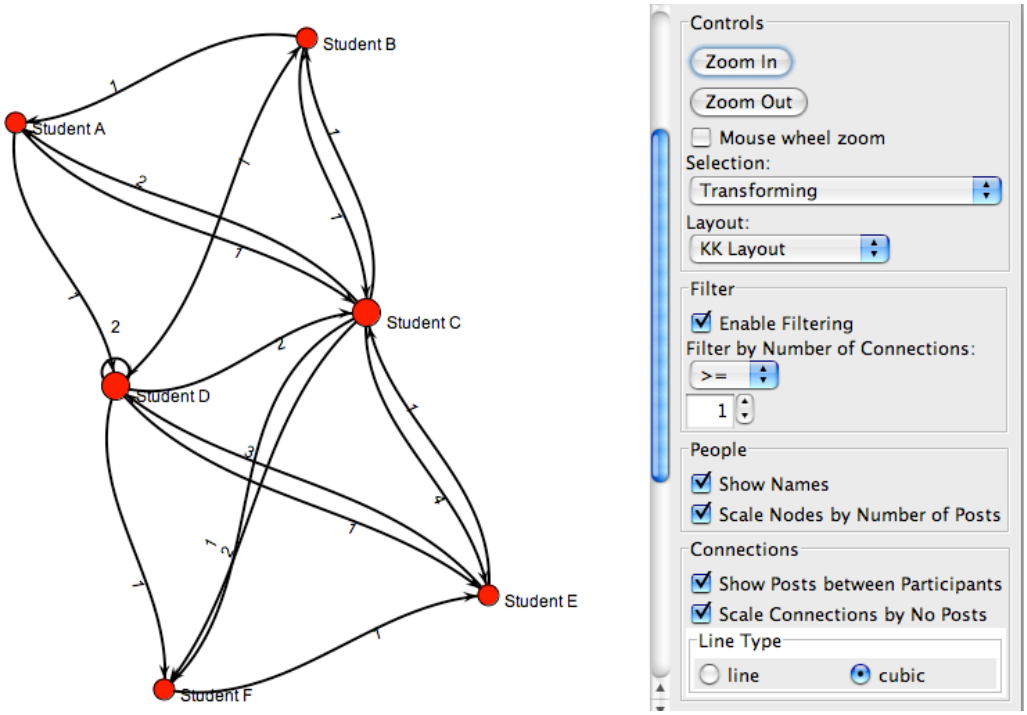

Figure 9: Using SNAPP to explore directional flow between participants

Learner Isolation

Students who are unable to establish peer to peer relationships commonly report feelings of isolation and exclusion (Dawson, 2008; McDonald, et al., 2005). Numerous studies investigating the importance of peer relationships for student learning outcomes, grades, development and satisfaction all indicate that isolation is a key factor contributing to student attrition (see for example: Gabelnick, Mac Gregor, Matthews, & Smith, 1990; Light, 2001; Rovai, 2002; Rovai & Wighting, 2005; Seely Brown & Adler, 2008; Tinto, 1993, 1998). Again the rapid identification of the social relationships that evolve within the online environment can assist teachers in mediating student to student introductions and interactions to minimise node isolation and fragmentation. For example, a node with limited or no connections (low in and out degrees) on a social graph is representative of an isolated student. SNAPP visualisations include all forum participants as nodes, hence any student with no established relationship is represented as a participant who has made a post/s, but not received any replies. Dawson (2007, 2008) has also demonstrated that in these instances students – disconnected or isolated from the learning network tend to report high levels of dissatisfaction in course and teaching evaluations. SNAPP includes the capacity to filter the social graph based upon the number of connections a participant has made (see Figure 10). This feature facilitates the rapid identification of all students with minimal numbers of established relationships. This feature is particularly useful as class size increases and forum postings escalate beyond a manageable level.

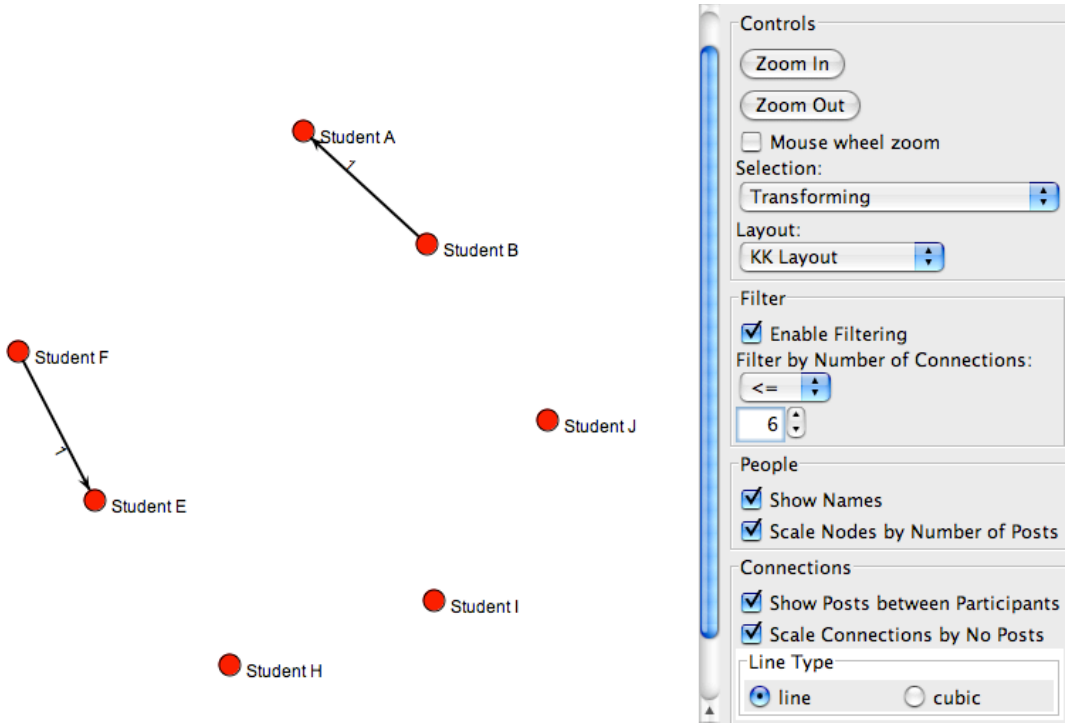

Figure 10: Using the SNAPP degree filter to isolate students with limited connectivity

CASE STUDIES

Predicting student achievement orientations

A case study investigating the correlation between a student's achievement orientation and their motivation to participate in certain types of discussion forums related to either performance or learning was conducted with first year medical students at the Graduate School of Medicine (GSM), University of Wollongong (Dawson, Macfadyen, & Lockyer, 2009). A survey instrument developed by Tan (2009) to classify students according to their learning dispositions was utilised to quantify student achievement orientations within the study. The Tan (2009) survey instrument is made up of five factors which include learning goals, performance goals, personal innovativeness, cognitive playfulness – creativity, and cognitive playfulness – curiosity. The results from the learning disposition survey were then correlated with forum usage. The case study established 2 separate forums. The first focused on areas related to assessment and administration issues, while the second forum centered on learning discussions and sharing of resources. The findings of the study suggest a strong correlation between student achievement orientation (Table 2) and the types of forums that the student will frequently participate within. Students with a strong learning orientation were found to participate frequently in forums established for learning discussions and resource sharing. Students with a performance orientation were more likely interact within a forum focused on addressing administative and assessment related issues (Table 3).

The findings of the study suggest a strong correlation between student achievement orientation and the types of forums that the student will frequently participate within.

Table 2: Self -reported learning and performance goal scores

	Total	Males	Females
LG	Mean = 48.62	Mean = 48.16	Mean = 49.05
	(SD = 5.14)	(SD = 5.74)	(SD = 4.54)
PG	Mean = 40.93	Mean = 39.46	Mean = 42.33
	(SD = 7.11)	(SD = 7.50)	(SD = 6.53)
* LG Range	29.00 – 56.00	29.00 – 56.00	37.00 – 56.00
* PG Range	26.00 – 56.00	26.00 – 56.00	27.00 – 56.00

* LG and PG factor scores can potentially range from a minimum of 8 to a maximum of 56

Table 3: Correlation between social network properties and self-reported achievement orientations

	Total forum postings	Learning and Sharing forum	Administration forum
a All students			
LG	r = 0.291*	r = 0.375**	
PG			r = 0.393**
b Male students			
LG	r = 0.327*	r = 0.392*	
PG			r = 0.435*
c Female students			
LG		r = 0.376*	
PG			r = 0.367*

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
a N = 76, b n = 38, c n = 39

The results of the case study has implications for the types of generic discussion forums that are relavant to a student cohort and where facilitation could be better targeted. Student motivation is a significant contributor to student drop out rates (Moore & Kearsley, 2005). The learning dispositions survey instruments in conjunction with the network data therefore, play a significant role in rapidly identifying the drivers for student motivation. The ongoing monitoring of the student interaction data can be used to develop more personalised learning activites.

Further details regarding the study can be located in:

Dawson, S., Macfadyen. L. & Lockyer, L. (2009*). Learning or performance: Predicting drivers of student motivation.* In Same places, different spaces. Proceedings ascilite Auckland 2009. http://www.ascilite.org.au/conferences/auckland09/procs/dawson.pdf.

Lead indicators of Student Admissions

This case study investigated to what extent medical students' standardised admission testing results vs their admission interviews correlated with both academic performance and engagement in the student learning community. The study was conducted at the University of Wollongong from medical student admissions data from the 2007/8 cohort compared with the same cohort's interaction data within course discussion fora via learning analytical data derived from SNAPP.

While past grades appear to select for future academic performance they do not provide an indication of the types of student engagement qualities that are also highly desired (such as communication).

The process for student admissions to University relies to a large degree upon the demonstration of prior academic grades commonly obtained via standardised testing practices. While the debate continues regarding the advantages and deficiencies of this system, there is currently a renewed interest in the adoption of more broad-based admissions practices. More simply put, universities are seeking criteria that can provide an indication of both the potential for academic success as well as the types of qualities and attributes that are frequently referenced in graduate outcomes documentation. These qualities and attributes are commonly cited as leadership, communication, innovation, and creativity.

The findings indicate that prior academic performance in standardized tests were a significant indicator of future academic success (as measured by end of year test scores). However, Admissions interview scores also demonstrated a significant relationship to academic performance. However, in relation to participation in the learning community only interview scores demonstrated a significant relationship. In this case study, the significant correlations were observed between interviews and closeness ($r = 0.311$, $p<0.05$), and between interviews and eigenvector scores ($r = 0.152$, $p<0.05$). The results indicate that no significant correlations exist between the SNA measures and standardized testing criteria (Table 4)

The results of the case study begin to highlight the importance for broad-based admissions practices. While past grades appear to select for future academic performance they do not provide an indication of the types of student engagement qualities that are also highly desired (such as communication or leadership). As Carol Dweck's (2000) research well illustrates, continuous emphasis on assessment will ultimately lead to performance focused students. Thus, when performance on testing is the basis for admission, savvy students will rapidly prioritise tasks to ensure they remain highly competitive and ahead of the game. During activities requiring engagement with peers may be interpreted as a moment of competition in lieu of a collaborative learning opportunity.

Table 4: Correlation between social network centrality measures and student admissions criteria

	Centrality measure	Interview	Portfolio
All students	Degrees		
	Betweenness		
	Closeness	r = 0.311	
	Eigenvector	r = 0.152	
Female	Degrees		
	Betweenness		
	Closeness	r = 0.296	
	Eigenvector	r = 0.114	
Male	Degrees		
	Betweenness		
	Closeness	r = 0.308	
	Eigenvector	r = 0.171	
2007 Cohort	Degrees		
	Betweenness		
	Closeness	r = 0.198	
	Eigenvector		
2008 Cohort	Degrees	r = 0.296	
	Betweenness	r = 0.267	r = 0.260
	Closeness	r = 0.333	
	Eigenvector	r = 0.280	r = 0.263

Only variables of significance are listed (P<0.05)
No significant correlations were observed between centrality measures and prior grades based criteria

Further details regarding the study can be located in:

Dawson, S., Macfadyen, L., Lockyer, L. & Mazzochi-Jones, D. (2010). From neural to social: Medical student admissions criteria and engagement in a social learning environment. In C.H. Steel, M.J. Keppell, P. Gerbic & S. Housego (Eds.), *Curriculum, technology & transformation for an unknown future.* Proceedings ascilite Sydney 2010 (pp.292-301). http://ascilite.org.au/conferences/sydney10/procs/Dawson-full.pdf

Mainstreaming SNAPP

The Centre for Educational Innovation and Technology (CEIT) at the University of Queensland is currently conducting a case study to identify the critical factors related to the mainstreaming of the SNAPP tool across the institution. This study represents an attempt to identify the core enablers and inhibitors to innovation adoption for a large HE institution. The participants were selected from a diversity of discipline areas across schools and faculties at UQ. Participants included Engineering, CEIT, Social Work and Education. The key questions that the case study aimed to address include:

- What type of training and support structure are necessary to facilitate mainstream adoption of SNAPP?
- How can instructors be convinced that using SNAPP is worthwhile?
- What do instructors see as the value of SNAPP? What are the shortcomings? What are the 'like to haves'?
- Are there common social network interaction patterns that emerge from various pedagogical signatures? Is the emergence of these patterns easily identifiable early within the course progression?
- How can instructor intervention and facilitation be used to improve student interaction?

Academic staff… valued the step-by-step SNAPP usage instructions, {and} identified a clear need for professional development relating to the design of collaborative learning activities, the interpretation of emerging social graphs and intervention techniques.

Interim results indicate that while the Academic staff participating in the case study valued the step-by-step SNAPP usage instructions, they also identified a clear need for professional development relating to the design of collaborative learning activities, the interpretation of emerging social graphs and intervention techniques. These early findings serve to reinforce the idea that mainstreaming SNAPP or other learning analytical tools will require a commitment to both learning design and social network analysis training.

The value of SNAPP was seen in the ability to locate isolated students by filtering the social network diagram based upon activity levels but specific functionality in relation to locating (highlighting) students, filtering by date and performing content analysis were requested by participants.

The study highlighted the emergence of a number of common social network patterns. The integration of learning design with learning analytics will better assist instructors in identifying and responding to these social network patterns.

Teaching with SNAPP

At the University of Wollongong, the post-graduate subject Legal and Professional Issues was designed to foster a deep understanding of how these themes relate in clinical practice. The subject aims to assists students in establishing a framework of operation for their future clinical decision making (Wallace & Hellmundt, 2003). The subject attracts a diverse enrolment generally between 20 and 30 postgraduate students. This cohort includes a large contingent of international students (where English is a second language) as well as students with no prior undergraduate qualifications (Wallace & Hellmundt, 2003). The course design includes both on-campus classes with a series of inter-related online discussions. The learning design emphasises a student centred approach with the instructor playing a role of active co-facilitator of knowledge. Thus, the online discussions are critical to provide an avenue for resource sharing and knowledge construction.

"SNAPP allowed me to easily pinpoint those students who seemed familiar and happy with this method of interacting (and to 'use' them to act as catalysts for the activity of other students). Since I have used this learning design no student has failed…"

Participation in the online discussions, are 'rewarded' per se as this forms a component of the overall marking scheme. Students are rewarded for their capacity to elicit responses from other students in their small online discussion group (four - six students). The proportion of marks awarded for this criterion grows incrementally from Online Discussion one through to Online Discussion three, mirroring increased development of key skills core to the course: debate, argument, discussion, reflection and hypothetical thinking.

The SNAPP tool was used to provide information in a diagrammatic form that assisted the teaching staff to understand the flow of discussion that took place between students in the different groups. The lead teacher commented: "SNAPP allowed me to easily pinpoint those students who seemed familiar and happy with this method of interacting (and to 'use' them to act as catalysts for the activity of other students). Since I have used this learning design no student has failed GHMB923 and the requests for extensions of due date (for the major assignment have dropped - now I might get one or two requests for extensions of one or two days that relate to emergency matters".

In future, there is the potential for students to use the pictorial version of their online interactions in monitoring their own performance – i.e. self-evaluate (and not rely solely on the teacher feedback). Teaching staff experimented with this concept by drawing a couple of versions of the SNAPP output on the White board and eliciting student discussion regarding the network composition.

CONCLUSION & FUTURE DIRECTIONS

The momentum surrounding learning analytics is rapidly building. This is well evidenced through EDUCAUSE, (arguably the largest Higher Education association dedicated to learning technologies and pedagogical practice), actively promoting collaborations and engagement in learning analytics. The organization is garnering support to undertake development and research related to learning analytics and its application within learning and teaching practice. This current ALTC project has provided a strong framework for developing future work in the field of leaning analytics. The project identified a multitude of lead indicators around student online learning behavior that can better assist educators in supporting student learning.

The SNAPP tool integrates with popular open source and commercial Learning Management Systems to provide social network analysis and social graph visualisations of online discussion forum interactions. The social graph is an aggregated visualisation of emerging student to student and student to facilitator relationships. This information provides educators with a real-time visual representation of the threaded discussion forum and therefore, serves as a social interaction diagnostic instrument. For example, feedback from the study participants indicates that the tool was used to engage students disconnected from the learning network in order to promote stronger class interactions. In essence, the tool was used to foster an active and engaged learning community.

Study participant: …it [SNAPP] provided me with information in diagrammatic form that assisted me to understand the flow of discussion that took placed between students in the different groups.

Study participant: I was more targeted at times to engage some of the more disconnected students

Study participant: Made sure I do not dominate the discussion and made sure everybody is engaged.

Study participant: The students I thought were doing most of the participation where not the ones doing so.

Through the case studies and participant adoption the ALTC project has been able to commence documentation of common network structural patterns that evolve through various implemented discussion forum activities. However, while the threaded discussion is a popular collaborative tool in education, it is only one of a vast set of ICT tools in the creation of learning activity sequences. Other tools such as blogs, micro-blogs, wikis, and social bookmarking that exist within the institutional LMS or personal learning environments play an important role in knowledge construction and sharing. Thus, future development of analytical tools such as SNAPP must seek to incorporate data from all socially oriented learning tools regardless of source. This feature will become increasingly important as Web 2.0 adoption into education practice increases. To date, discussion activity remains the primary tool used by Higher Education practitioners for student collaborative engagements (Dawson & McWilliam, 2008; Dawson, McWilliam, & Tan, 2008; Macfadyen & Dawson, 2010).

SNAPP is available to academic staff via a website at http://research.uow.edu.au/learningnetworks/index.html. Due to the simple installation requirements and the ability for social network diagrams to be displayed within a forum, a natural progression of this research would be to enable semantic analysis; forum

evolution animations; and instructor annotations surrounding forum based learning interventions. For example, the following comments highlight the need for additional analytical features to be associated with SNAPP.

Study participant: I'd like to see the ability to colour code different students. I'd also like to be able to select a time window for network visualization.

Study participant: I'd like to be able to track community development over time...kind of like 'time lapse' photography! One of the goals of XXXXX is to create an interactive class community, so SNAPP can potentially provide real data to show whether it's happening.

Study participant: … what content and topics the students are discussing – like a cloud tag

It is apparent that the trend towards great adoption of ICTs will continue in HE globally. As a result there will be a growing emphasis on the use of collaborative ICTs to promote pedagogical practices oriented towards social learning. This provides new opportunities for teacher, designers and students alike to engage in social data in order to monitor and evaluate the observed social behaviour with the implemented learning environment. In this context, tools such as SNAPP help better position educators as informed pro-active facilitators of learning in contrast to reactive teachers.

PUBLICATIONS AND MEDIA

Journal Articles

- Macfadyen, L. and Dawson, S. (2010). Mining LMS data to develop an "early warning system" for educators: A proof of concept. *Computers & Education*, 54(2): 588-599.
- Dawson, S. (2010). 'Seeing' the learning community: An exploration of the development of a resource for monitoring online student networking. *British Journal of Educational Technology*, 41(5), 736-752
- Dawson, S., McWilliam, E., & Tan, J. (2011 – in press). Measuring creative potential: Using social network analysis to monitor and develop learners' creative capacity. Australasian Journal of Educational Technology

Book Chapters

- Bridgstock, R., Dawson, S. & Hearn, G. (2010). Cultivating innovation through social relationships: A qualitative study of outstanding Australian innovators in science & technology and the creative industries. In A. Mesquita (editor*), Technology for Creativity and Innovation: Tools, Techniques and Applications*.
- McWilliam, E., Dawson, S. & Tan, J. (2010). Less Elusive, More Explicit: The Challenge of 'Seeing' Creativity in Action. In J. Sefton-Jones and P. Thompson (editors), *'Researching creative learning'*. Routledge.

Conference Presentations

- Dawson, S., Macfadyen, L., Lockyer, L. & Mazzochi-Jones, D. (2010) From neural to social: Medical student admissions criteria and engagement in a social learning environment. *ASCILITE 2010,* Sydney, Australia. Dec 5-8.
- Dawson, S., and Macfadyen, L. (2010) "Seeing Community": Visualising and Interpreting Student Learning Networks *ASCILITE 2010 Workshop,* Sydney, Australia. Dec 5-8.
- Dawson, S., Bakharia, A. & Heathcote, E. (2010). SNAPP: Realising the affordances of real-time SNA within networked learning environments. *Network Learning Conference 2010*, Aalborg, Denmark.
- Dawson, S., Macfadyen. L. & Lockyer, L. (2009). Learning or performance: Predicting drivers of student motivation. In Same places, different spaces. *Proceedings ascilite Auckland 2009*. http://www.ascilite.org.au/conferences/auckland09/procs/dawson.pdf
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- McWilliam, E., Tan, J. and Dawson, S. (2009). Going Digital in Schools: Why is it still so difficult? *AARE, 29 November – 3 December*, Canberra, Australia

Resources

- Social network visualisation tool (SNAPP) – The developed software extracts student discussion forum data into exportable formats for social network visualisation and analysis. This resource and associated instructions and exemplars are available at: http://research.uow.edu.au/learningnetworks/

Workshops and Media engagement

SNAPP was presented at the following events:

- Teaching and Learning Week, University of Wollongong, October 2009
- Teaching and Learning Week, Macquarie University, October 2009
- Teaching and Learning Week, University of Queensland, November 2009
- Special Interest Group Electrical Engineering, University of Queensland, December 2009
- Invited display, Teaching and Learning Expo, Blended Learning Conference, University of Queensland, June 2010
- Teaching and Learning Week University of British Columbia, 2010

SNAPP is listed as an exemplar analytics tool in the EDUCAUSE "7 Things You Should Know About Analytics" report (http://www.educause.edu/Resources/7ThingsYouShouldKnowAboutAnaly/202736).

SNAPP is listed in the 2011 Horizon Report by the New Media Consortium (http://wp.nmc.org/horizon2011/sections/learning-analytics/#11)

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APPENDIX 1

Social Networks Adapting Pedagogical Practice (SNAPP)

Version 1.5

User Guide

The University Of Queensland
AUSTRALIA

Contents

Notes: Although correct at the time of writing, elements of the SNAPP interface may change during routine updates. This guide uses examples for Windows and Mac OS X. There is no difference in functionality between operating systems.

Credits

Content Development:

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Cyprien Lomas & Aneesha Bakharia, Centre for Educational Innovation and Technology (CEIT)

Editing and Design:

Andrei Baltakmens, Teaching and Educational Development Institute (TEDI)

What is SNAPP?

Social Networks Adapting Pedagogical Practice (SNAPP) is a software tool that allows you to visualize the network of interactions resulting from discussion forum posts and replies. SNAPP extracts data on discussion forum interactions in Blackboard and other Learning Management Systems (LMSs) and displays the data as a network diagram, which allows teachers to identify patterns of user behaviour rapidly.

Compatibility

SNAPP is compatible with Mac OS X and Microsoft Windows, and operates in Microsoft Internet Explorer (IE) , Mozilla Firefox and Safari.

SNAPP has been developed to extract discussion forum interactions from Blackboard (versions 7, 8, and 9).

Features

SNAPP analyses forum postings to provide information on:

- the total number of posts
- the number of posts per user
- posting frequency; SNAPP lists the number of posts and replies to posts made by each individual
- who has been interacting with whom and who is connecting various groups

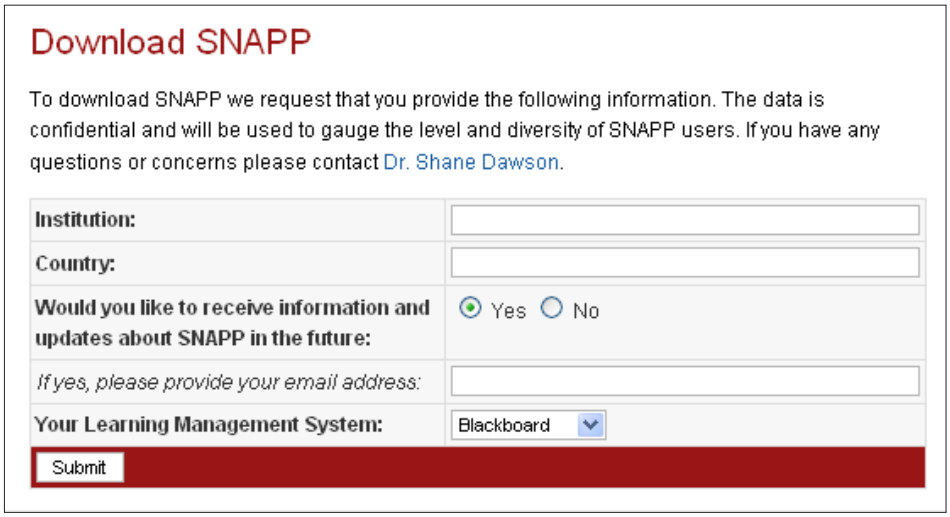
You can export forum interaction data for:

- GraphML
- NetDraw VNA

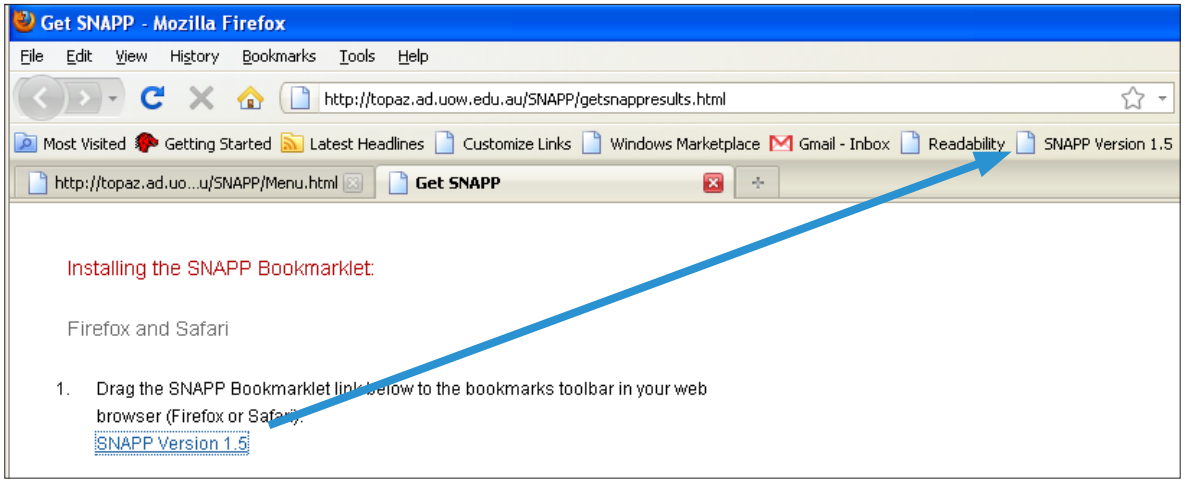
Installing SNAPP

SNAPP is a simple bookmarklet added to your browser toolbar:

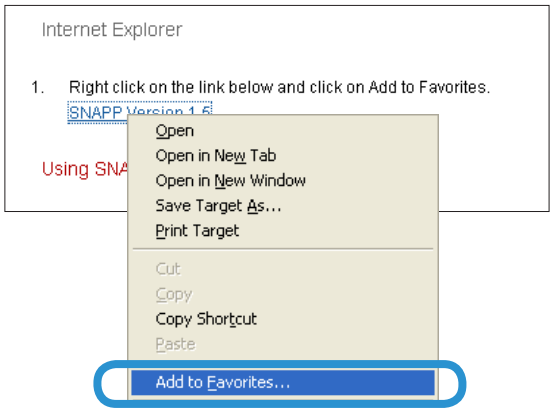
1. Start your Web browser and go to the **Download SNAPP** page: http://topaz.ad.uow.edu.au/SNAPP/Menu.html



2. Complete the download form. Enter the name of your institution and country (required). Optionally, select **Yes** and enter your e-mail address to receive SNAPP updates.
3. Click **Submit**. The **Installing the SNAPP Bookmarklet** page opens.
4. Add the SNAPP bookmarklet link to your browser:
   - **Firefox and Safari**: Drag the **SNAPP Version 1.5** link to the Bookmarks toolbar.



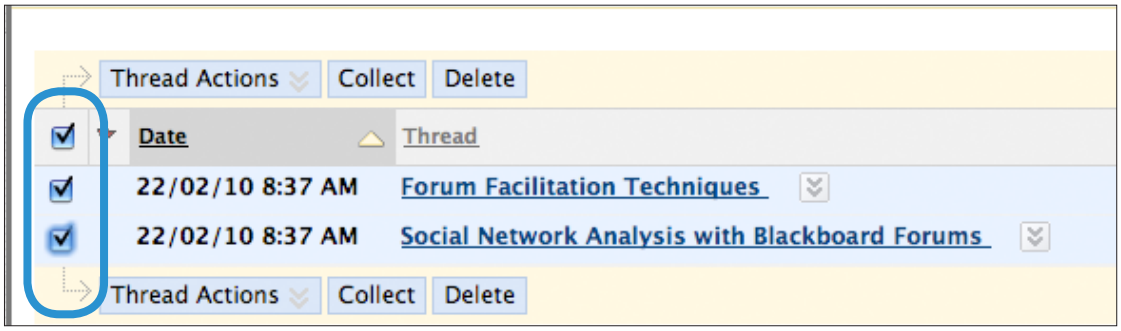
   - **Internet Explorer**: Right-click the **SNAPP Version 1.5** link and click **Add to Favorites**.



Using SNAPP with Blackboard

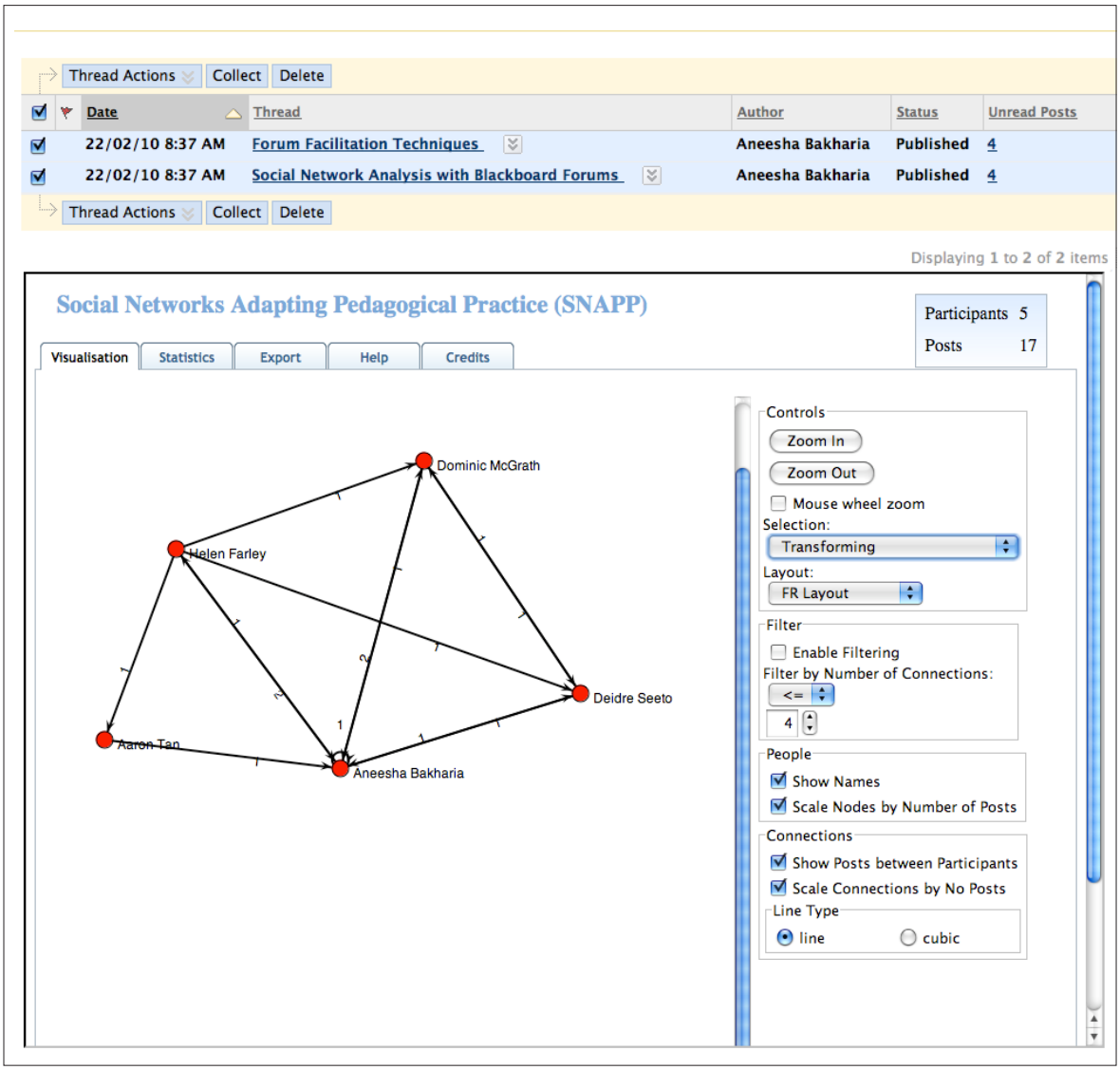
1. Start your Web browser and log in to Blackboard. Go to the Discussion Board in your Blackboard course and click a forum link. The threads within the forum are displayed.

2. Select the checkboxes next to forum threads that you want to analyse.



3. Click the SNAPP bookmarklet (on the **Bookmarks** toolbar in Firefox or the **Favorites** menu in Internet Explorer).

4. SNAPP extracts the forum post and reply data for each selected thread and displays the SNAPP interface in the current page. By default, SNAPP displays the network visualisation. The SNAPP **Controls** pane is on the right.



Using the SNAPP interface

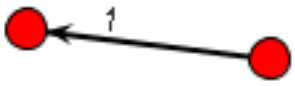
The SNAPP interface has five tabs. Click:

- **Visualisation** to view and adjust the network diagram.
- **Statistics** to view posting frequency data in a table.
- **Export** to export GraphML or to the .vna format. The .vna format can be opened in NetDraw for additional analysis and visualisation.
- **Help** to view the SNAPP Help online.
- **Credits** to view details of the SNAPP development project.

Working with the network visualisation diagram

Basic information about the discussion forum is displayed at the top right of the SNAPP **Visualisation** tab.

In the network diagram each individual is represented by a circular *node*. Each interaction is represented by a connecting line and a number (which shows the number of posts made between two individuals).



By default, the weight (thickness) of each line indicates the number of posts. An arrow on the line indicates the direction of the post between two individuals.

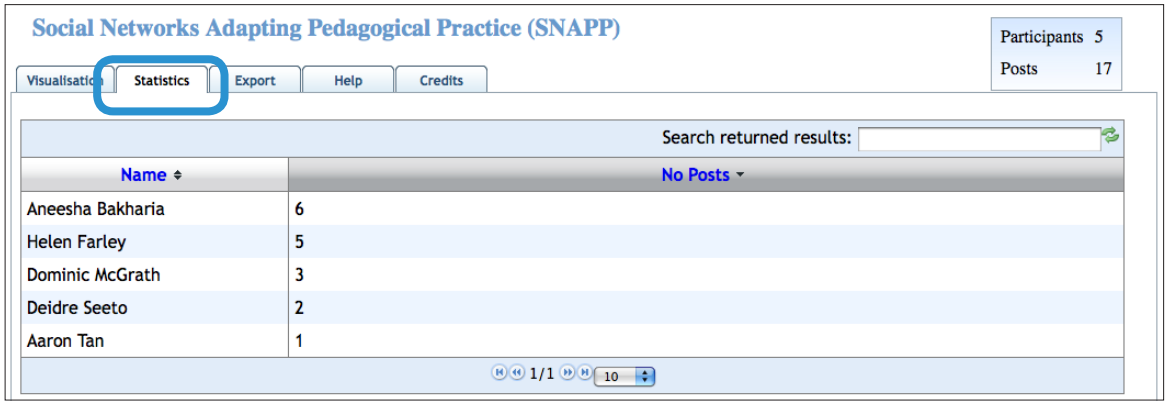
Hover the mouse pointer over a node to view node-specific data.

Viewing individual forum activity

To view statistics for individuals in the forum, click the **Statistics** tab.

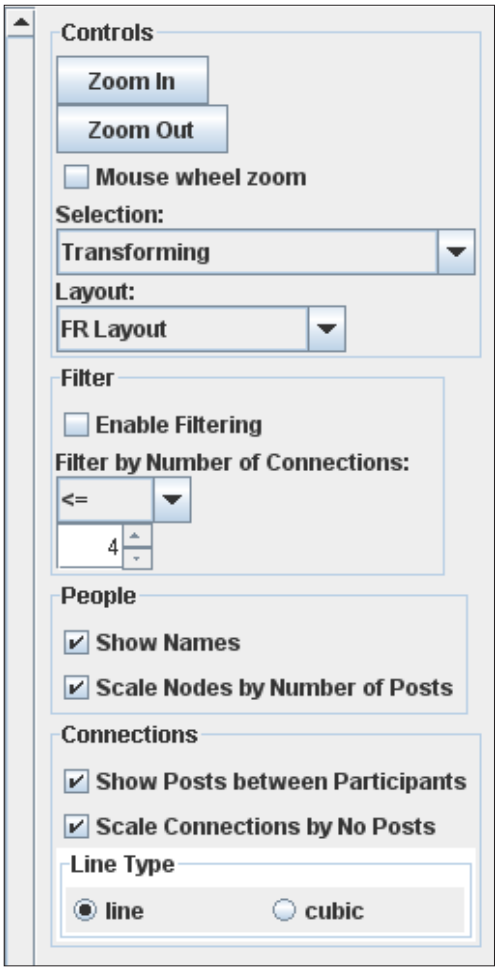
The table lists the number of posts and replies to posts made by each individual, in descending order of activity.

Enter a name in the **Search returned results** box to view the number of posts by an individual.



Changing the network diagram

Use the **Controls** panel to change the network diagram.



Zoom

- Click **Zoom in** or **Zoom out** to resize the diagram.
- Select **Mouse wheel zoom** to zoom in and out using the wheel button on your mouse.

Layout

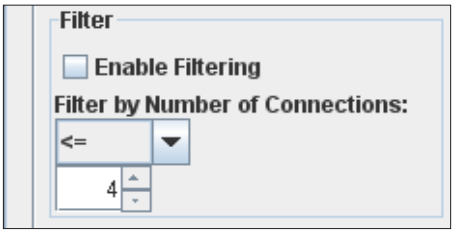
- To change how the network diagram is rendered by SNAPP, select a layout algorithm from the **Layout** drop-down list.
- To change the diagram manually, from the **Selection** drop-down box, select:
  - **Transforming** to move the diagram by dragging it in the visible window (you can also scroll to see parts of a large diagram).
  - **Picking** to move individual nodes by dragging them; for example, to see them better or to make the diagram easier to view.

Viewing names and connections

- The names associated with each node are displayed by default. Clear **Show Names** to hide node names.
- Nodes are scaled (sized) by the number of posts by default. Clear **Scale Nodes by Number of Posts** to make all nodes the same size.
- The number of posts is shown with each connection by default. Clear **Show Posts between Participants** to hide the number of posts.
- The thickness of each line is proportional to the number of posts by default. Clear **Scale Connections by No Posts** to make all lines the same.
- Under **Line Type**, select **line** (the default) to show all connections as a straight line. Select **cubic** to use a curved line.

Filtering

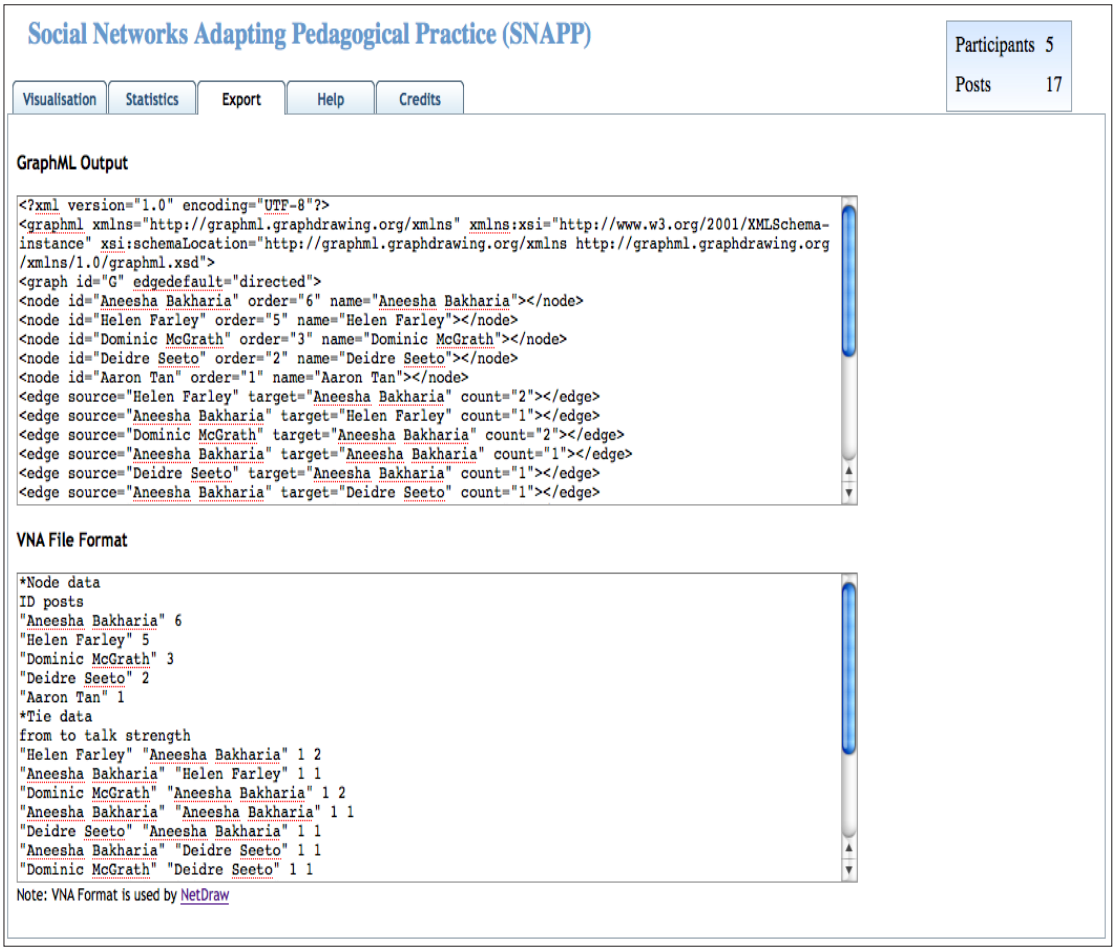
To filter content by the number of connections (for example, to see people with four or more posts only):



1. Under **Filter**, check **Enable Filtering**.
2. Under **Filter by Number of Connections** select the filter criteria (greater than or equal to (> =) or less than or equal to (< =)) from the drop-down list.
3. Enter the number of connections in the box under **Filter by Number of Connections**.

Exporting data

To extract SNAPP data for importing to a graphics program so you can view and manipulate the network diagram further, click the **Export** tab.



Output is displayed in GraphML (an XML-based file format) and VNA, used by NetDraw.

1. Select and copy the text in the **GraphML Output** or **VNA File Format** text box.
2. Start Notepad or a similar plain-text editor, and paste the copied text into a new file.
3. Save the exported data. To open the graph with NetDraw, save the text file as *.vna.

Both of these visualisation software packages are available for free download.

GraphML:

- For more Information on the GraphML format, go to http://graphml.graphdrawing.org/

NetDraw:

- To download NetDraw, go to http://www.analytictech.com/Netdraw/netdraw.htm
- To download the NetDraw Manual, go to http://www2.optimice.com.au/documents/ONANetdrawGuideBasic.pdf

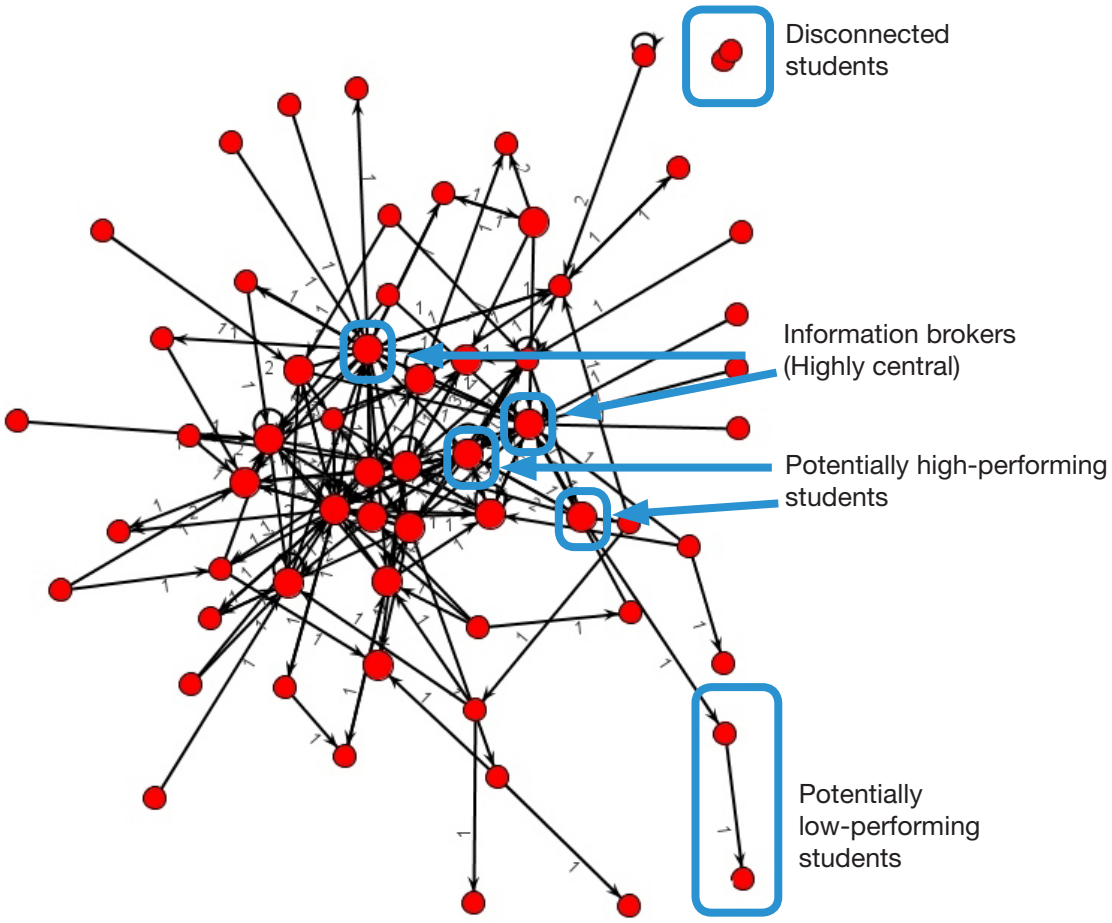
Interpreting the Social Network Diagram

Most of the data generated by an LMS includes the number of sessions (log-ins), dwell time (how long the log-in lasted), and number of downloads. This tells a lot about content retrieval in a transmission model of learning and teaching, but not about how students are interacting with each other in more socio-constructivist practice. Discussion forum activity displayed in a network diagram is a better indicator of student interactions.

What can a network diagram tell me?

A network diagram provides a snapshot of communications, helping you identify the levels of engagement and network density in online learning activities. A network diagram of your students' discussions online can:

- identify key information brokers within a class.
- identify disconnected (at risk) students.
- identify potentially high and low performing students, so you can plan interventions before you mark their work.
- indicate the extent to which a learning community is developing.
- provide a "before and after" snapshot of what kinds of interactions happened before and after you intervened or changed your learning activity design. This is useful to see what effect your changes have had on student interactions and for demonstrating reflective teaching practice (through a teaching portfolio, for example).
- allow your students to benchmark their performance without the need for marking.



There is no set interpretation of a social network diagram, as this is highly context-dependent. However, different patterns can indicate different online behaviour, and represent the way participants are interacting, when taken together with the context.

Social networking terms

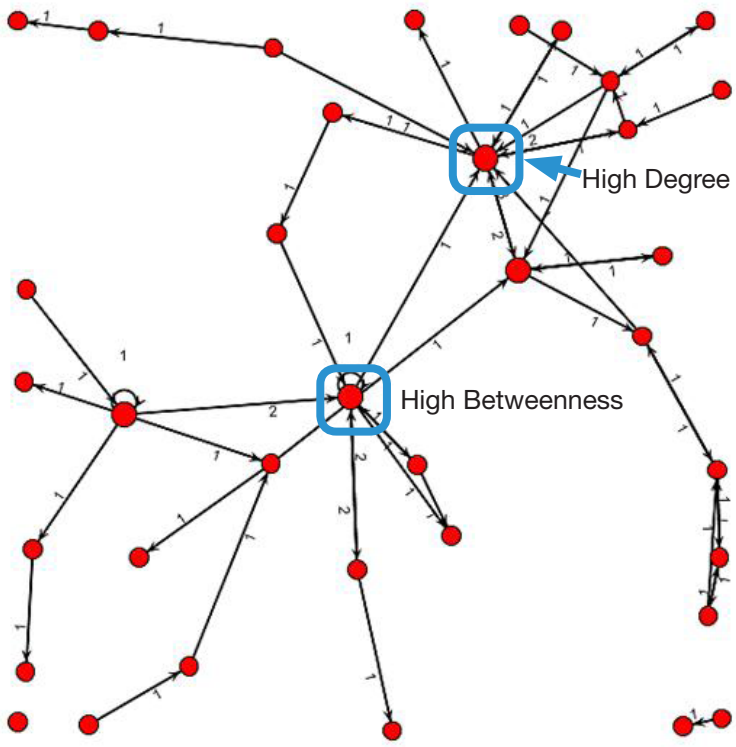
Social network analysis involves calculating various statistics to determine information about the network as a whole and each individual's place in the network.

Network centrality measures

Centrality indicates the social power of a person (node) based on how well they connect the network. *Degree* and *Betweenness* are centrality-related metrics:

- Betweenness measures the influence of an individual over the network as a whole. Individuals with high betweenness are brokers between different groups and can therefore control the information flow.
- Degree describes the number of links or ties that this individual has to others within the network. *In degree* lists the number of posts made by others to an individual and *out degree* measures the number of posts this individual made to others.
  If an individual has a reasonable out degree value but a low in degree number, this suggests they could be at risk of feeling isolated within the group, or that they are considered an expert and are simply answering other participants' questions (this can often be typical of a Q & A forum where the instructor answers all the questions).

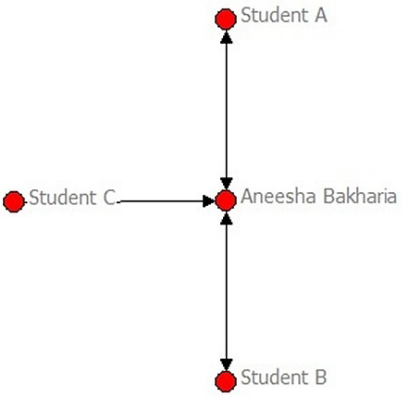
The following diagram is an example of betweenness. In a face-to-face network, the individual with a high betweenness value is the only link between the individuals at the bottom left and those at the top right, and thus could be assumed to have exclusive additional information about each group. In an online environment, this is mitigated by all participants, generally speaking, having access to all conversations in the discussion forum. However, this individual, through creating linkages in various groups, may have access to additional information when the conversation is taken out of the discussion forum, and have developed a greater awareness of who might provide expertise in which area, in case of need.

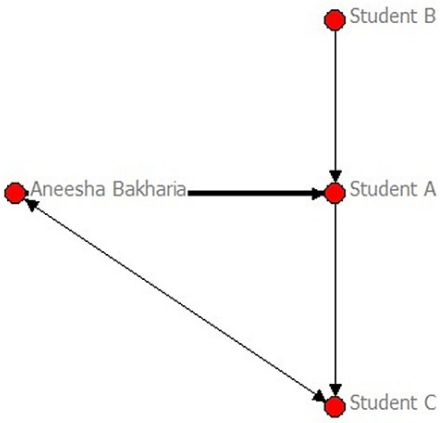


Comparing patterns in networks

Example 1: Student interaction

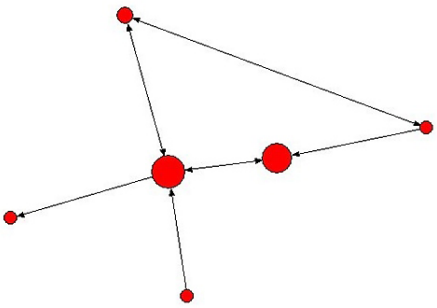
The following example illustrates two discussion forums, both with 14 posts and 4 participants. Although they look very similar, they reveal different interactions. In the first forum, Aneesha is brokering the information, supplying information to the students A, B and C, and answering individual questions. In the next example, Aneesha is supplying a lot of information to Student A, some to Student C and students are beginning to interact more with each other.



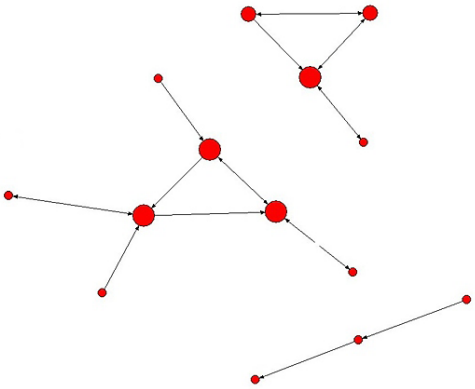


Example 2: Instructor mediation and student interaction

In this second example, also with small numbers, two different forums reveal very different sets of interaction.



A: Instructor-mediated



B: Multiple groups

The first forum represents a question and answer, instructor-mediated model; there is a clear information broker in the middle and little to no interaction between other participants.

The second forum is almost the opposite: there are three separate groups discussing between themselves, but little cross-over of information (granted, the information in discussion forums is available to all to read).

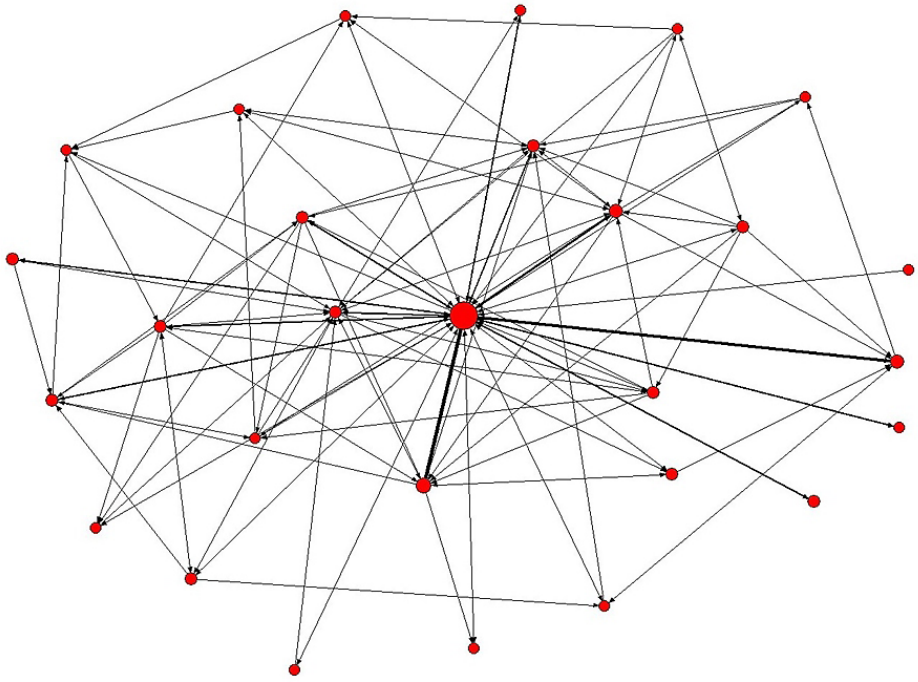
Depending on the intentions of the discussion activity, this can tell the facilitator/instructor about how their implemented discussion activities are going. The diagrams above might confirm the instructor's intent (for example, if they were responding in a Q & A forum in example A or set some small group work in B), or it may reveal additional information about student group interactions.

Example 3: Instructor reliance or community of practice?

In this example, the largest node is the instructor, and the instructor is the most active participant. Although students are also discussing amongst themselves, there is a lot of direct interaction with the instructor.

In this case, the instructor was hoping for a community of sharing among the learners – and this does appear to be developing, despite current reliance on the instructor. This kind of network shape is often indicative of the beginning of a semester of a course that encourages students to engage with each other. While students are getting to know each other, they can be finding their way around and the instructor might still be heavily involved in introducing topics for discussion, clarifying issues, and so on.

The instructor in this case made some changes to her facilitation of the forum to be more in line with her goal of having a student-led community. By monitoring the discussion activity, the instructor can see if her interventions are working.



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