

## Long-term community development within a researcher network: a social network analysis of the DREaM project cadre

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### Abstract

**Purpose** Results are reported from a study that investigated the extent to which an intervention to develop a community of library and information science researchers – the Developing Research Excellence and Methods (DREaM) project - was successful in meeting its main objective three years after its implementation. Of particular interest are factors that support or hinder network longevity.

**Design/methodology/approach** Data were collected by online survey/telephone and focus group. From quantitative data a Social Network Analysis (SNA) and network diagrams were generated. Focus group discussions were recorded and transcribed, and data from these analysed manually.

**Findings** Three years after the end of its formal funding period DREaM endured as a loose but persistent network. Social ties were more important than work ties, and network members with the highest network centrality held roles in academic institutions. Physical proximity between members was important to the maintenance of network ties. Actor status did not appear to have a bearing on network centrality.

**Research limitations/implications** Discussion is limited to consideration of community development amongst core members of the network only. The 'manufactured' nature of the DREaM network, and unique context in which it was formed, has implications for the generalisability of findings reported.

**Practical implications** Social infrastructure is key to the long-term health of a network initiative. Continued ad hoc support would strengthen it further.

**Originality/value** The findings add to understanding of factors important to the development of scholarly and learning communities. They extend contributions of earlier work that has deployed SNA techniques in library and information science research and research in other fields.

**Keywords** Developing Research Excellence and Methods, DREaM, DREaM Again, Library and Information Science Research Coalition, learning communities, networks, Scholarly networks, SNA, Social Network Analysis

**Paper type** Research paper

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## 1. Introduction

The broad goal of the AHRC-funded Developing Research and Excellence Methods (DREaM) project was to develop a UK-wide network of library and information science (LIS) researchers. The mechanism for this was the delivery of five network events in 2011 and 2012:

- A launch conference in London in July 2011;
- Three linked workshops held in Edinburgh and London (October 2011, January 2012 and April 2012);
- A concluding conference in London in July 2012.

A follow-up study in 2015, entitled DREaM Again, presented an opportunity to measure the impact of DREaM three years after the project ended. Thirty-two DREaM participants, who had attended the three research methods workshops in 2011 and 2012, completed surveys and contributed to focus group discussions in summer 2015. The analysis of the data collected from these two exercises allowed for an examination of the impact of the DREaM project as a whole, as well as consideration of the extent to which those 32 academics, researchers, practitioner researchers, and PhD students in 2012 (known as 'the cadre') who had participated in the workshops continued to operate as a community three years after its formal completion.

It was also possible over the course of this second project to verify anecdotal reports of the impact of DREaM. This was important in cases where outputs of members of the group, such as the textbook *Research evaluation and audit* (Grant, Sen and Spring, 2013), were being claimed as physical evidence of community engagement post-DREaM and regarded as part of the project's legacy.

The focus of this paper is the extent to which the DREaM cadre members were still in a network three years after the delivery of the initial DREaM project. The

evidence presented here demonstrates that the group continued to work as a loose, but persistent, network where social ties were more important than work ties, and with academics and researchers at its core. These findings are explored with reference to prior research that has deployed Social Network Analysis (SNA) to identify factors that influence network longevity. The study responds to general calls in LIS research such as that of Bawden and Robinson, (2013, p. 2590) to 'seek new insights in the overlap and interplay of the social and the individual' in practice, and others specific to SNA to take the opportunity of addressing gaps in knowledge related to the evolutionary nature of networks (Schultz-Jones, 2009, p. 626).

The findings are significant because they add to understanding of the factors that are important to the development of scholarly and learning networks, particularly in respect of changes in network density over time, network centrality and status, and the importance of physical location of network members. In doing so, they extend earlier work on networks in both LIS and other domains. More generally, this study represents a contribution to the wider body of literature that generates theoretical insight on group phenomena through the deployment of SNA. In addition, since this is a (rare) longitudinal study it contributes new knowledge on the evolution of a social network, and thus allows for consideration of the dynamic nature of network development.

A literature review sets the context for the longitudinal study of the DREaM network, both in terms of the wider body of work on networks and SNA and earlier publications on the DREaM project. This is followed by an account of the research design and implementation of DREaM Again, and the main findings generated from the study. Next the development of the network's topology over four years is considered with particular reference to the findings of prior research. Practical implications and recommendations are then discussed. The article concludes with a summary of the main contributions of the work, and an indication of further on-going research related to the DREaM network.

## **2. Literature review**

The study of social networks has a long history (Cooke and Hall, 2013, pp. 789-791). Indeed, some social network research dates from as far back as the nineteenth century (Wölfer, Faber and Hewstone, 2015, p. 46). Taking in account this long period of research interest in social networks, it is unsurprising that a recent co-citation and cluster analysis of a subset of its literature - on social networking sites - identified 2,565 articles and 81,316 citations for consideration (Shiau, Dwivedi and Yang, 2017).

A proportion of the published work on social networks makes reference to SNA as a valuable technique to (1) investigate the mechanisms and social structure that underlie group behaviour and (2) reveal the nature of networks reviewed (Wölfer, Faber and Hewstone, 2015). The network characteristics explored

include the evolution and structure of networks, the ties between network members and the social capital that they share, and the measurement of network value (Shiau, Dwivedi and Yang, 2017, pp. 394-395).

In recent years there has been a burgeoning of such studies. As illustration, Wölfer, Faber and Hewstone (2015) reported that a literature search on the records of a single database (PsychINFO) for the four year period from 2010 to 2014 identified 2,430 records relevant to SNA (p. 47). A number of reasons have been forwarded to account for this increased popularity of the technique. Writing from an LIS perspective in 2009, for example, Schultz-Jones argued that a growth of interest in information behaviour research, and an associated widening of the repertoire of research approaches to such work, could be related to the increased deployment of SNA (Schultz-Jones, 2009, p. 611). More recently the ready availability of software to complete complex calculations that were previously slow and difficult to accomplish, and 'a level of conceptual and statistical refinement that makes [SNA] an appealing method for all research fields that aim to explain behavior in general and social behavior within and between groups in particular' (Wölfer, Faber and Hewstone, 2015, p. 47) have been offered as explanatory factors for the growth in SNA research.

In her literature review on social network theory, and SNA as a means of exploring information environments, Schultz-Jones (2009, p. 592) noted the great variety in the types of networks analysed in the 373 papers that she identified for her study. Although Schultz-Jones completed this review almost a decade ago, this conclusion on the diversity of networks still holds in respect of recent research output. For example: Parkinson, Kleinbaum and Wheatley (2018) performed an SNA to uncover that similar neural responses predict friendship; Ryan and D'Angelo (2017 in press) chart network development amongst Kurdish migrants in London; Viry (2012) examines the impact of spatial dispersion of personal networks on social support in Switzerland; Vriens and van Ingen (2017) analyse the use of social media in discussion networks amongst 15-45 year-olds in the Netherlands; and Wölfer and Scheithauer (2014) use SNA to evaluate the impact of a school-based anti-bullying programme. SNA is also applied beyond the social sciences: Wölfer, Faber and Hewstone (2015) note, for example, applications in biology, zoology, and physics (p. 57).

The work completed for the DREaM Again project presented in this article builds specifically on prior research that has applied SNA to explore the development of scholarly and learning networks. Such networks may be interdisciplinary and/or cross-sector (such as those investigated by Dimitrova, Wellman, Gruz, Hayat, Mo, Mok, Robbins and Zhuo (2013) and Rientes and Nolan (2014)), reside in the academy (for example. Mo, Hayat and Wellman, 2015), or be based in industry settings (for example, Powell, Koput and Smith-Doerr (1996) explored networks in biotechnology firms). Equally, these networks may be built around groups of individuals with specific interests. Examples include e-participation (Buckner and Cruickshank, 2008) and festival and events management (Jarman, Theodoraki, Hall and Knight, 2014).

The analysis presented below also represents a contribution to the body of published research that deploys SNA within a specific discipline, namely LIS. It adds to prior work that has been executed for a wide variety of purposes. These range from, for example, the analysis of a system designed to assess contributor reputations on an online question and answering site (Alam, Khusro, Ullah and Karim, 2017) to the generation of egocentric SNAs for a set of young job-seekers as part of a study of information seeking behaviours and use (Mowbray, Hall, Raeside and Robertson, 2018 in press). Theoretical papers that demonstrate the modelling of network features have also appeared in the LIS academic press (for example, Hosseini-Pozveh, Zamanifar and Naghsh-Nilchi (2016) and Mozafari, Hamzeh and Hashemi (2017)).

Less evident in LIS research that deploys SNA, however, are longitudinal studies of scholarly and learning networks. Indeed, of the material that Schultz-Jones (2009) identified in her review, just 2.7% (n=10) were longitudinal studies (p. 614), and of the four situated within LIS, two were analyses of citation networks (pp. 614-618). Schultz-Jones concluded that 'the evolutionary nature of networks remains underdeveloped. Examining how networks develop and change over time provides research opportunities across disciplines' (Schultz-Jones, 2009, p. 626). The work reported in this article responds in part to this call in that it seeks to provide a longitudinal perspective on connections between network members three years after the formal end of the programme that was first established to bring them together.

Specific findings of relevance to the question of network longevity are reported in published reports of prior studies. These indicate factors that maintain, or hinder, the long-term durability of networks. External support, for instance, has been highlighted as important. Specific interventions are helpful (Rienties and Nolan, 2014, p. 178), not least to nurture interpersonal ties, particularly for the purposes of enhancing collaboration across diverse communities that are geographically dispersed (Mo, Hayat and Wellman, 2015). In addition, when associated with funding, such interventions influence network morphology (Buckner and Cruickshank, p. 8).

Two other factors are reported in the extant literature as playing a clear role in the longevity of networks. The first is the existence of a strong nucleus of network members that act in a brokering role to maintain the network's dynamics of participation (Fontainha, Martins and Vasconcelos, 2015). The second is applicable in contexts where the network in question resides within, or is supported by, an online environment. Here it has been shown that online interactions are important to network health. For example, Vriens and van Ingen (2017 in press, p. 14) reveal that there is an association between social media use and dynamic interaction. Similarly, in another study it has been observed that network members who maintain high levels of one-to-one contact are also regular Internet users (Wellman, Dimitrova, Hayat, Mo and Smale, 2014, p. 491).

Given that the DREaM Again project also sought to compare two snapshots to reveal any changes in actor centrality and network density over time, it is worth considering earlier findings on these topics in respect of prior longitudinal studies. (Centrality is the degree to which an individual actor is near others in the network and the extent to which the person lies on the shortest path between others and thus has potential for control over their communication; density is the degree to which actors are linked to one another - parts of a path are dense if each of its points is reachable from every other (Cooke and Hall, 2013, p. 792, p. 796; Monge, 1987, pp. 245-246; Wölfer, Faber and Hewstone, 2015, p. 51)). In studies of networks of experts, it has been shown that hierarchy matters (Dimitrova, Wellman, Gruz, Hayat, Mo, Mok, Robbins and Zhuo, 2013, pp. 309-310). Thus it would be expected in the DREaM network that those in more senior positions would have greater centrality. On network density opinion is split. For example, in some cases the physical proximity of actors has been found to have an impact on levels of support between network members (Viry, 2012, p. 67; Wellman, Dimitrova, Hayat, Mo and Smale, 2014, p. 492). In others it has not (Fontainha, 2015, p. 15). Similarly, although some have observed that network density reduces with time, especially when the networks introduce other methods of information exchange (Buckner and Cruickshank, 2008, p. 8), elsewhere it has been seen to increase (Fontainha, Martins and Vasconcelos, 2015).

The literature review presented here provides a context for the longitudinal assessment of the DREaM network discussed below. Of particular relevance to a study that sought to chart network centrality and density over time are the insights from prior research into scholarly and learning networks on network longevity. The extent to which individual circumstances of network members influence network morphology over time (such as physical proximity to others and relative status) is also of interest, especially given the variety in findings on this question in prior studies.

### **3. Background: earlier papers on network development and the DREaM project**

It is worth noting here that the theme of network development in this particular context of the DREaM project has been explored in two earlier papers. The first focused on the widening the networks of cadre members [1]. This was presented at the *4<sup>th</sup> International Conference on Qualitative and Quantitative Research Methods in Libraries* (Brettle, Hall and Oppenheim, 2012) as a Critical Incidents Analysis (following the technique explained by Urquhart, Light, Thomas, Barker, Yeoman, Cooper, Armstrong, Fenton, Lonsdale and Spink, 2003). The account was drawn from the analysis of fifteen incidents that had been identified by individual cadre members as demonstrations of early impact of DREaM project

participation in 2012. It showed that the cadre members' networks had been enlarged through (1) growth of relationships with other DREaM project participants and (2) referral to the 'external' contacts of those encountered over the course of the project. For example, a cadre member explained how one of the speakers at the second DREaM workshop held in London in January 2012 recommended membership of a particular mailing list. Since joining the list, this individual had access to a community that was willing to respond to specific questions on her/his research. In addition s/he had discovered a new means of participating in online discussions of direct relevance to her/his research interests.

In a later paper Cooke and Hall (2013) explored the development of two types of relationships between the DREaM cadre members between 2011 and 2012. The first was concerned with the social ties between members, and was labelled 'social interactions'. The second – 'knowledge awareness' – referred to individuals' understandings of the research expertise of other members of the cadre. These findings allowed for the characterisation of the network as a whole (Cooke and Hall, 2013, p. 790).

Cooke and Hall's analysis of 2013 showed that the links between cadre members were initially heavily centralised around a small number of people who worked as academics/researchers and academic librarians (p. 796). However, at the conclusion of the three DREaM workshops, the network was more evenly linked, with less dependence on the two or three densely-networked actors identified at the start of the project. By 2012 most academic librarians had stepped into the centre, and public librarians and PhD students had moved inwards from the periphery of the network (p. 796). It was evident by the formal end of the last of the three DREaM workshops that the participants had gained a greater knowledge of (1) 'who knows what' (this had doubled in the seven-month period between the first and third workshop) and (2) to whom to turn for discussion of particular research ideas or dilemmas (almost doubled) (p. 801). This was evident in the change of density of the network. Similarly, the average number of ties between actors for each category showed doubling and near-doubling (p. 796). The number of cliques (i.e. the maximum number of network members who have all possible ties present among each other (Luce and Perry, 1949 cited by Wölfer, Faber and Hewstone, 2015, p. 50)) in the network had also grown (Cooke and Hall, p. 798). Such findings were considered important for a discipline that tends towards fragmentation across sectors and suffers from a gap between practitioners and researchers (Cooke and Hall, p. 787).

In the 2013 paper Cooke and Hall also highlighted the appetite of the cadre members to continue their relationships, as evidenced in their workshop evaluation forms at the conclusion of the formal programme (p. 800). They also stated that the 'challenge in the LIS community is now going to be to maintain the existing links and further develop the network so that it evolves into a self-sustaining and continuously developing supportive community for LIS research' (p. 801). The DREaM Again project provided an opportunity to examine the

extent to which the cadre members continued to operate as a network without the formal support offered by the initial AHRC project funding.

#### **4. Research design and implementation**

The DREaM Again project set out to address five research questions:

1. Have the DREaM workshop participants innovated in the workplace since 2012?
2. Has their post-DREaM research determined services provision or influenced the LIS research agenda?
3. To what extent can they point to any impact of their post-DREaM research on end-user communities?
4. Has the DREaM network opened up new opportunities for their research?
5. Do they continue to operate as a network?

Data for analysis to address these questions were collected in 2015 by online questionnaire implemented using NoviSurvey, and by focus groups held in Edinburgh and London. Some respondents also provided information by email and by telephone. UCINET software (version 6.582) was used to generate the SNA from the quantitative data, and the network diagrams presented below were created using the Netdraw package (version 2.153). These applications are commonly used in this type of research (Wölfer, Faber and Hewstone, 2015, p. 48). The focus group discussions were recorded and transcribed, and then the data from these were analysed manually.

This use of mixed methods is in line with prior work of a similar nature, such as that of Mo, Hayat and Wellman (2015), who collected additional data from network members by interview in their study, and Ryan and D'Angelo (2017 in press), who advocate that 'different combinations of quantitative, qualitative and visuals... offer richer sets of data and insights [and] better connect conceptualisations – and ontologies – of social networks with specific methodological frameworks' (p. 10).

In this paper, findings on community development as related to the fifth research question listed above (only) are explored: the other research questions are to be addressed in future publications. The key data for this purpose were binary level responses (Wölfer, Faber and Hewstone, 2015, p. 48) provided when respondents identified from a list of all DREaM workshop participants whether they had (in 2015) continuing work and/or social interactions with the named individuals (i.e. whether or not a tie for each category still existed). For example, work interactions might include collaborative writing projects, event organization, or passing on requests for paper reviewing; social interactions could refer to sharing photographs related to hobbies on Twitter, or meeting in person for coffee. Such details allowed for the measurement of the number of work-related and social ties within the group, and the topology of the network



according to these links. Any references to the continued operation of the network in the focus group discussions, or supplied by email, were also considered relevant to answering question five, especially when they provided details of contextual or environmental factors of importance to network development. It was anticipated that these would contribute to a better understanding of the longitudinal mechanisms of group dynamics in the DREaM network, and that this would have the potential offer wider contributions to the LIS domain and social network research in general.

The plans for the DREaM Again project were publicly announced in June 2015, first in an invited paper at the *Third International Seminar on LIS Education and Research* in Barcelona (Hall, 2015b), then again in the opening keynote paper at the *European Association for Health Information and Libraries* (EAHIL) conference (Hall, 2015a) at which a number of DREaM project participants were present. The survey went live the same month and was open for four weeks. The cadre members were alerted of its existence through targeted emails, tweets, and LinkedIn messages.

The SNA presented below is based on responses from thirty-two of the individuals who took part in DREaM workshops, including the project co-investigators. This group comprised thirteen librarians, seven academics and university researchers, six PhD students, and six others (for example, independent consultants, officials in LIS professional bodies). Twenty-nine provided the details for the SNA in their survey responses; the remainder (3) did so by telephone.

Ten people also took part in focus groups held in Edinburgh (four participants) and London (six participants) between July and September 2015. These were conducted to gather qualitative data for analysis to answer the full range of research questions (as noted above). As such, the conversations were wide-ranging. For example, participants spoke about: the value of individual training sessions (including that on SNA) at the DREaM workshops and the extent to which they had implemented their learning in practice; their publications activity post-DREaM; whether or not they believed that their own research in the previous three years had delivered impact on others in terms of services delivery or policy formulation, whether directly or indirectly; and the influence of the mode of delivery of the DREaM workshop series on their own approach to event organisation. The conversations were audio-recorded, while a scribe took notes of the topics discussed. They were later transcribed, manually coded, and their content analysed. Of particular interest to the theme of this paper were comments on DREaM-inspired networking at these focus groups. In Edinburgh, for example, the participants dwelt on the positive effects of maintaining contact with other members of the cadre to access advice, and the constraints that geographical isolation places on opportunities for face-to-face meetings.

All those who provided data for the project were assured that their responses would be treated as confidential and that no individual would be identifiable from the report of the findings.

Although the response rate for this study is impressive in terms of the proportion of cadre members who took part, this population is a just small subset of all those who were involved in the DREaM project in 2011 and 2012. Taking into account the delegates at the two DREaM conferences, a total of more than two hundred people actively engaged in DREaM over the course of its 18-month duration (Cooke and Hall, 2013, p. 791). The reach of the project extended further through remote consumption of the online outputs from the project. These included around 80 blog posts, 800 tweets, and numerous web pages, SlideShares, SoundClouds and Vimeo videos (Library and Information Science Research Coalition, 2012). Thus the question of the extent to which an intervention to develop a community of LIS researchers in the UK was successful in meeting its main objective three years post-implementation is only answered here with reference to those who played a role at the implementation's core. A further limitation of this work is that the project team respected one survey respondent's request for exclusion from the SNA.

To be viable, a network needs to be grow, or at least renew its membership as an on-going process. Since this study only considered the 32 cadre members, these aspects of network viability were not considered. A more sophisticated analysis than the one presented below might also deploy tie weighting (Wassermann and Faust, 1994, p. 574), apply hypothesis testing (for example, to establish whether or not the nodes with fewest connections in 2011 would become disproportionally networked over the duration of the project, i.e. until the middle of 2015, and loosen faster afterwards), and treat connectedness in more detail according to type of actor (for example PhD student or academic researcher).

## **5. Findings: network ties three years after implementation of the DREaM project**

The data for the sociograms processed using UCINET are presented below in four figures. In these each node represents an individual, and the same label is used for the same person in all sociograms to allow for comparisons to be made.

The actor type of individuals is represented by the shape of each node represented in the sociograms, as summarised in Table 1. These classifications are consistent with those used in the previous SNAs of the group undertaken in 2011 and 2012 (Cooke and Hall, 2013, pp. 797-799).

**Table 1: Actors represented in the sociograms**

Actor type	Represented in sociograms as	Node names	Total in network
Librarian – public	Circle	AB, B	2
Librarian – academic	Square	I, J, T, X, Y	5
Librarian – health	Triangle with upwards point	AC, G, O	3
Librarian - other sector	Hatched square	AE, AF, D	3
Academic or university researcher	Circle framed in square	C, E, M, N, P, Q, R	7
PhD student	Triangle with downwards point	AA, AD, AG, H, L, U	6
Other e.g. independent consultant, professional body representative	Diamond	F, K, S, V, W, Z	6
<b>TOTAL</b>			<b>32</b>

The analysis below considers the network in terms of work-related and social ties. It is illustrated by four sociograms. These show:

- Figure 1: work-related ties between all actors
- Figure 2: social ties between all actors
- Figure 3: links between actors where both work and social ties co-exist
- Figure 4: work-related and social ties between all actors

Since the goal of addressing research question 5 (noted above) was to establish whether or not the DREaM cadre members still operated as a network three years after the DREaM project officially ended, the focus of the analysis is its network density and the centrality of the actors.

In each sociogram the arrowheads represent the directions of the ties. Ties that show two arrowheads are *bidirectional*. A total of 496 bidirectional ties is possible in a network that comprises 32 actors. Those with just one arrowhead are *unidirectional*. The maximum number of possible unidirectional ties between the 32 nodes in this network is 992 [2].

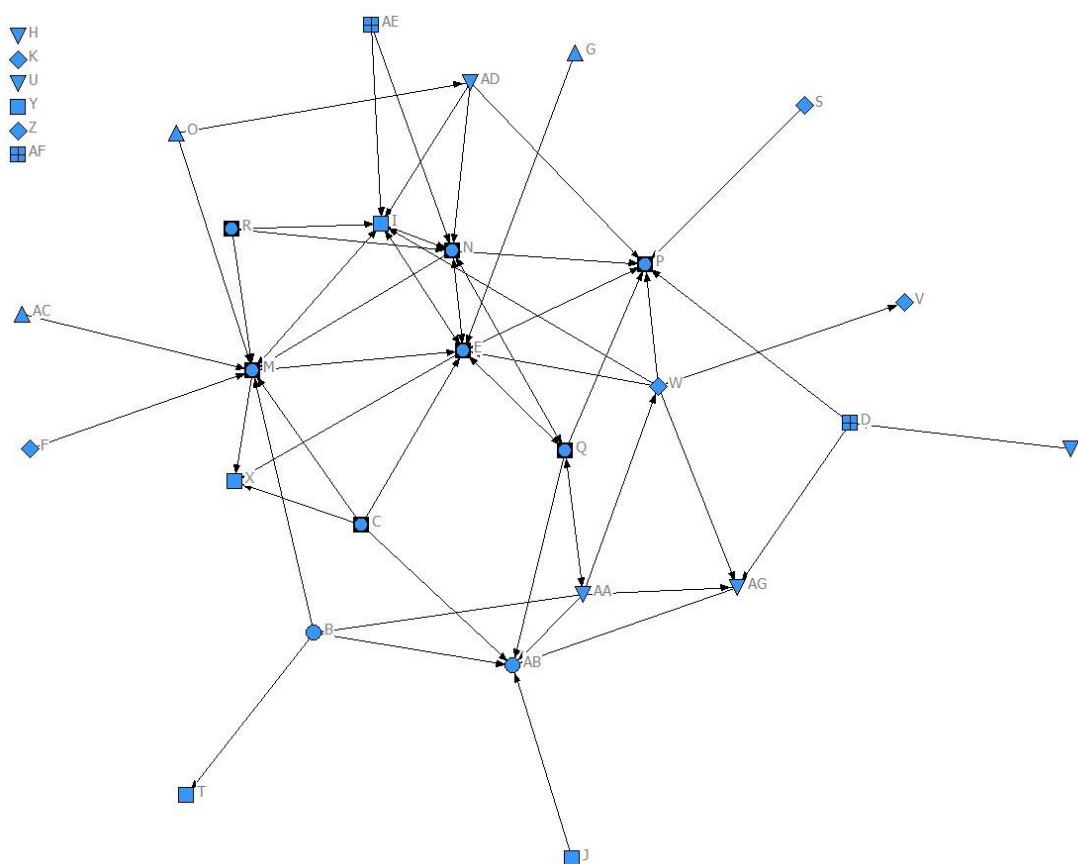
It should be noted that analyses of this nature often uncover a lack of uniform bidirectionality in a network (as noted, for example, by Wölfer, Faber and Hewstone, 2015, pp. 48-49). For example, in the first sociogram displayed below (Figure 1) it can be seen that actor T identified an unreciprocated work-related tie with B. (The arrow pointing *towards* the actor identifies the unreciprocated relationship.) It is possible to suggest reasons why one actor might have a different conception of his/her relationship with another. For example, a PhD student may have an understanding of the terms ‘social’ and ‘work-related’ that is different from that of a public librarian. However, participants in this project

were asked simply to note the *existence* of ties rather than explain the reasoning behind their classification. Thus the data are presented as self-reported by the participants without follow-up questioning.

### 5.1 Work-related ties

Figure 1 shows work-related ties in the network.

**Figure 1: work-related ties**



The data portrayed in this sociogram show that half of the cadre members (16/32) stated that they continued to have work-related ties with at least one other three years after the DREaM project ended. In total sixty work-related ties exist in the network (when each bidirectional tie is counted as two unidirectional ties). Thus the average number of ties per actor is 1.88 (60/32). The network density, which is calculated by dividing the actual number of ties (in this case 60) by the maximum possible (992), is 0.0605. This figure indicates that approximately 6% of all potential ties in the network actually exist in practice.

Sixteen members of the cadre declared that they no longer had any work-related ties with any of the other members of the group. However, only six of them (AF, H, K, U, Y and Z) can be excluded from the main network displayed in the

sociogram because nine others in the cohort *did* identify continued work-related ties with ten of the sixteen (as is the case for T and B, as noted in the example above). Thus just under a fifth (6/32) can be classed as no longer being part of the network from the perspective of work-related ties, whereas four-fifths had maintained some form of work contact with at least one other member.

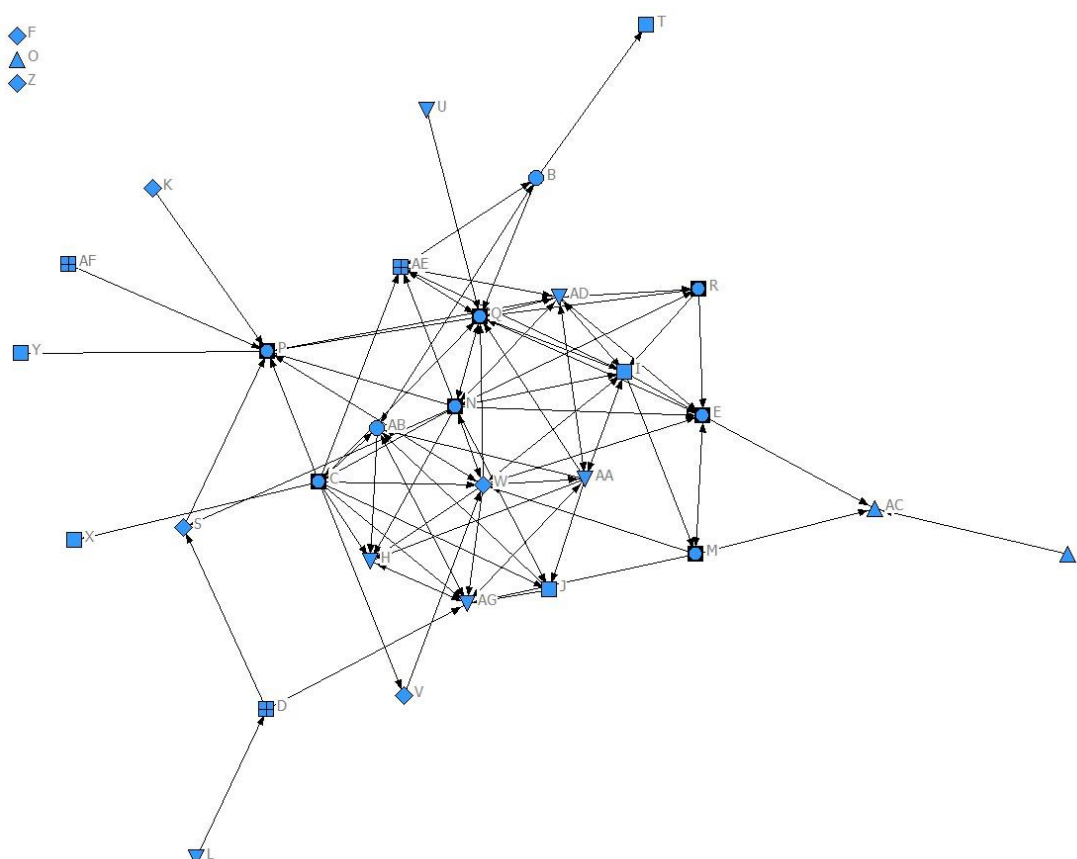
The network is mostly centred on the academics and university researchers and one academic librarian, who claim the largest number of ties, albeit that many are unreciprocated.

In this analysis of work-related ties half the actors (16/32) were identified as holding membership of thirteen cliques. The four largest cliques each have four members. Rounded down, the average number of actors in each clique is three.

## 5.2 Social ties

Social ties in the network are depicted in Figure 2.

**Figure 2: social ties**



There are 100 ties in this network when each bidirectional tie is counted as two unidirectional ties. Thus the average number of ties per node is 3.13 (100/32). The density of the network is 0.1008 (100/992), i.e. around 10% of possible ties exist in practice. The number of cadre members outside the network in this case

(3) is half that shown in Figure 1. These figures show that the DREaM cadre members enjoyed stronger social (as opposed to work) connections three years after the formal completion of the project that initially brought them together. Discussions in focus groups revealed that these social ties extend to members of the cadre sharing photographs related to their mutual interests, in particular hobbies and leisure pursuits.

Also of note in Figure 2 is the variety of actor type in the centre of the network depicted. There is greater diversity here: whereas those with greatest centrality according to work-related ties are university employees (as depicted in Figure 1), the group of actors at the centre of this network includes public library and PhD student representation.

The analysis of social ties amongst the actors revealed that almost two-thirds (20/32) held membership of twenty-two cliques. The size of clique ranges from three to six members, with the average number of actors in each clique at four is larger than that for work-related ties.

An overview of clique memberships is provided in Table 2. Just one actor (X) had work-related clique membership only. The rest either held membership of cliques for both work and social ties (15), or solely for social related ties (5). (Eleven actors held no clique memberships at all.)

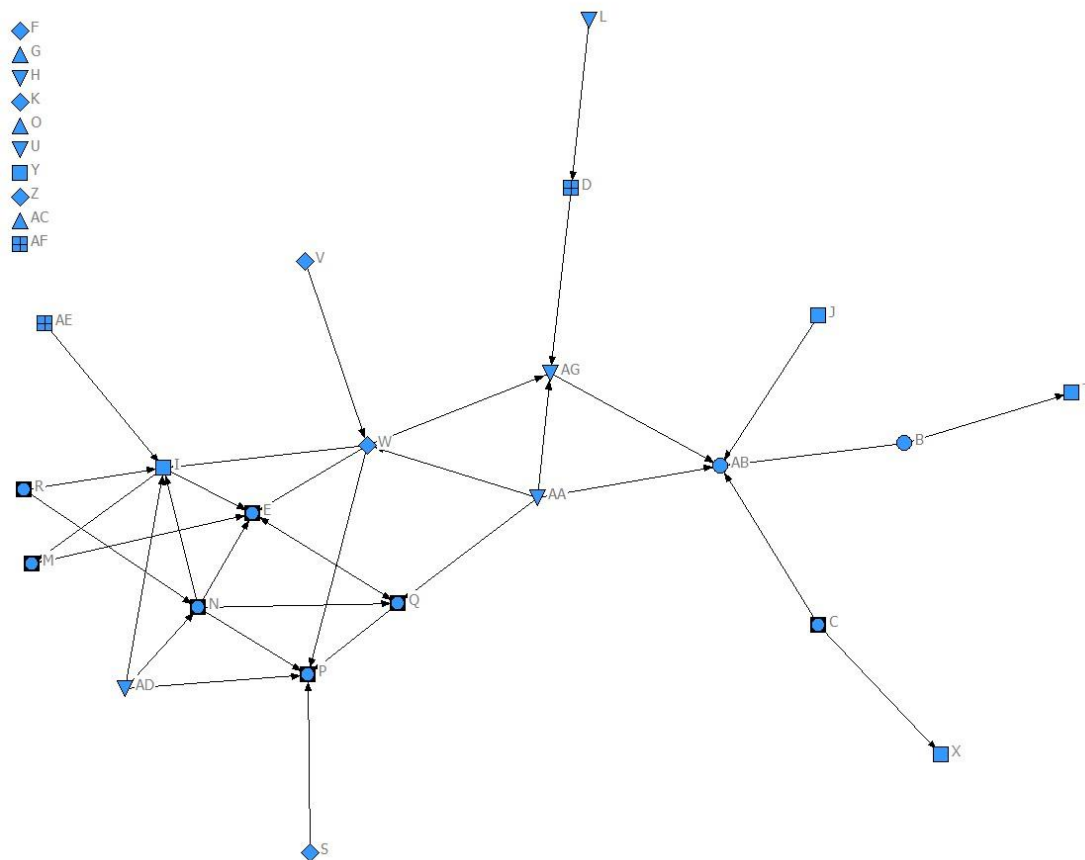
**Table 2: Overview of clique memberships**

<b>Work-related ties only</b>	<b>Social-related ties only</b>	<b>Both work and social related ties</b>	<b>No clique memberships</b>
1 actor: X	5 actors: AC, H, J, S, V	15 actors: AA, AB, AD, AE, AG, B, C, E, I, M, N, P, Q, R, W	11 actors: AF, D, F, G, K, L, O, T, U, Y, Z

### *5.3 Consideration of work-related and social ties together*

Depicted in Figure 3 are the links between actors who share both work and social ties.

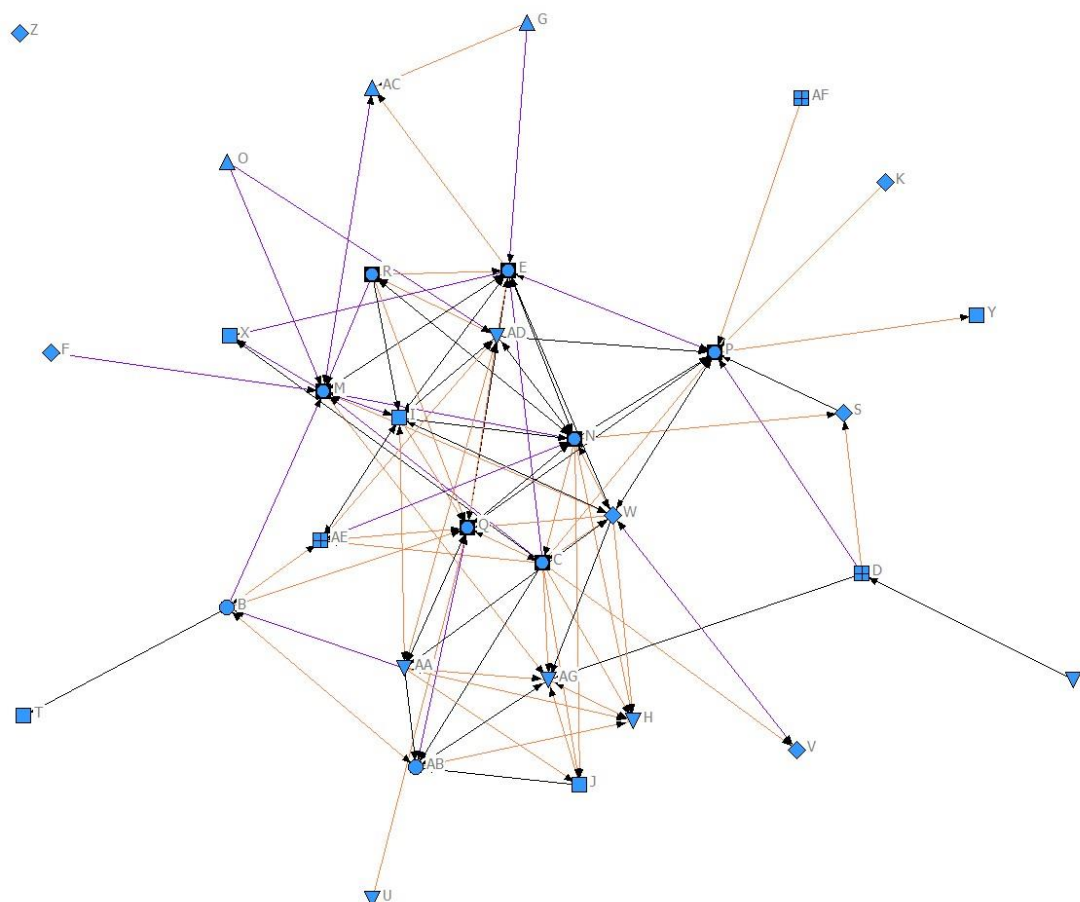
Figure 3: shared work and social ties



Twenty-two members feature in the linked section of the sociogram. The ten members who fall outside may have had work or social ties with the other twenty-two in 2015, but they did not enjoy *both*. The value of this sociogram is that it identifies the actors who are central to the network as a whole. These are academics/university researchers E, N, P and Q, and academic librarian I. Given that one of DREaM's aims was to create a network of academics and researchers, this finding is not unexpected.

Figure 4 shows work-related and social ties between all actors. This indicates some reported connection to the network for all but one member of the DREaM cadre.

Figure 4: all work-related and social ties



## 6. Discussion: development of network topology 2011-2015

While it is worth considering the topology of the DREaM network in 2015 with reference to similar work in 2011 and 2012 (Cooke and Hall, 2013), it should be noted that *direct* comparisons cannot be made. This is first because the data that generated the earlier sociograms in the 2013 paper were not collected on the same basis as those in 2015. The focus of the earlier SNA was made explicit as: ‘individuals’ awareness of the research expertise and knowledge of other participants, and social/interactional links across the network’ (Cooke and Hall, 2013, p. 795). In the DREaM Again project it was work and social ties. In addition, although all data for the two studies were collected from the majority of the members of the cadre, the composition of the two groups was not identical (as explained above).

The levels of density of the network reported above for 2015 show that this dropped considerably in the three year period following the completion of the DREaM project: 42% for expertise awareness and 39% for social interaction in 2012 (Cooke and Hall, 2013, p. 796), as contrasted with 6% for work-related ties and 10% for social ties in 2015. This drop is in line with observations on network topology changes over time in some other studies - although not all



(see, for example, Fontainha, Martins and Vasconcelos, 2015). Buckner and Cruickshank (2008) identified that to maintain density the network needs ongoing resourcing (p. 8). In the case of DREaM the actors lost the resource of the hosted events after 2012 (although they were able to maintain information exchanges using other platforms such as social media, and through personal face-to-face contact). Similarly, the average number of ties between actors dropped in this period: from 13.91 and 12.71 to 1.88 and 3.13. These drops may imply a very high depreciation rate on the social capital generated in the initial investment in DREaM. However, in some respects these results are not unexpected given that the members of this group were gathered together physically for the DREaM project workshops three times between October 2011 and April 2012 (at least – some members also attended one or both of the DREaM conferences too), but had no obligation to interact with one another ever again after the third DREaM workshop, whether virtually or face-to-face.

Perhaps of more interest here is the indication that that the social ties are more important than work-related ties in the 2015 analysis: there are more social ties than work-related ties in the network; there is greater diversity in the membership of centralised figures in the social ties network; there are more cliques for social ties; and the cliques are slightly larger. This 'dominance' of the social is in contrast with the position in 2012 at the end of the last DREaM workshop. However, it replicates the position at the start of the workshop series in 2011. This may indicate that while 'artificial' programmes to bring research communities together can only do so much to support sustained work-based relationships (because, as one focus group respondent explained 'opportunities [to collaborate] don't come up'), they can create social capital that endures into the future (albeit this asset will depreciate unless the network is sustained by recruiting new members). Thus foundations for renewed work connections at a later date, for activities such as research collaborations or the organisation of professional events, are laid with the network embeddedness exhibited in these social ties.

Also of note are the central figures within the DREaM network over the course of its history. In 2011 the network was heavily centralised around a small number of academics/researchers and academic librarians (Cooke and Hall, 2013, p. 796). By the third of the DREaM workshops in 2012, academic librarians, public librarians and PhD students had improved their centrality and the network was less dependent on a small number of actors at its core (p. 796). The analysis of the 2015 data for work-related ties shows that academics/researchers regained their position, and thus their network power and influence, as the most central actors in the network, although there was a greater number of them at the core than was the case in 2011. However, in terms of social ties, which arguably are more important to this group, there is representation in the centre from the public library and PhD student communities. These findings reveal that positions of network centrality in the DREaM network are less associated with status as has been reported elsewhere (Dimitrova, Wellman, Gruz, Hayat, Mo, Mok, Robbins and Zhuo, 2013, pp. 309-310). This may also be an indicator of the

durability of the DREaM network (or a version of it) into the future with those at the core in 2015 playing the broker role in a similar way to those at the nucleus of the community of learning examined by Fontainha, Martins and Vasconcelos (2015). A further general conclusion to be drawn is that centrality varies according to different functions of a network. This is illustrated here with university employees most central to the 'work' network, and the inclusion of public library staff and PhD students with central actors in the 'social' one.

Participants at the focus groups acknowledged that the ties across the network had loosened over time. Some expressed regret over this, and there was evident enthusiasm for future DREaM events to take place to bring everyone together again. One DREaM cadre member said that she 'would like to be in contact with folk more, but life gets in the way. A more formal arena would be appreciated'. Another actor in the study reported here said 'it would be nice to have one-to-one conversations, which can't be done on Twitter'. The analysis of focus group data also revealed that where geographic proximity existed, there was closer networking. For example, those at the Edinburgh focus groups, who were all based in Scotland's Central Belt, indicated that they met at Scottish events and/or collaborated on Scottish matters. A key practical issue here, however, is access to funding to support such activities on a formal basis. Without this, the social capital developed in earlier facilitated events risks further erosion.

These comments on the value of physical proximity reflect research findings reported by Mo, Hayat and Wellman (2015), who note that 'scholars' interests in networking opportunities... may not easily translate into actual interactions', and observe that collaborations mostly occur within the same discipline and geographic area. This question of physical proximity has also been noted in the wider SNA literature in respect of social support in personal networks: Viry (2012), for example concludes that individuals located at a distance from their network ties experience more transitive support than those who are near to theirs (p. 67), and Wellman, Dimitrova, Hayat, Mo and Smale (2014) highlight the value of face-to-face encounters in the creation and maintenance of online contact (p. 492).

The results presented here are particularly interesting due to the context in which the DREaM cadre network was formed. It has to be borne in mind that all cadre members had actively signed up to a project which had network creation as its primary goal. In addition, they were educated in the methods deployed for the research project reported here: SNA was introduced as a research method in the first of the three DREaM workshops. Therefore, DREaM cadre members were not engaging in *organic* networking behaviours. Nor were they even taking advantage of *opportunistic* networking as precipitated by a social or work-related event such as a conference. Instead, they were practising networking behaviours within a manufactured environment that was created specifically, and with their knowledge, for extended network development within a community of practice. As such, it is likely that a level of self-awareness amongst

the sample impacted their behaviours (for example, providing additional motivation to contribute). This is both a limitation of the method and a key facet of this work's originality. One possibility is that the DREaM programme strengthened the bonds between the group members, and forged the notion of community. If so, this may have been a key factor in the cadre's network development. However, the 'manufacturedness' of the network may also be a limitation in terms of the generalisability of the findings to other contexts and similar projects wherein network development is reliant on the intuitive/subconscious understanding of the actors.

The other main limitations of the work are those more commonly cited in other studies that rely on SNA, including issues related to the reliability (or not) of self-reported data and missing data due to non-participation in the study (as reported elsewhere, for example Wölfer, Faber and Hewstone, 2015, pp. 57-58). The snapshot approach that focused on cadre membership is also somewhat artificial since this only allowed for consideration of ties between members at a particular time and did not account for others who might legitimately be classed as new members of the DREaM network through their association with cadre members after 2012 (for example, the contributors to *Research Evaluation and Audit* (Grant, Sen and Spring, 2013)). The irony here, of course, is that networks need to be refreshed for sustainability. For example, in the case of the DREaM network it could be argued that it reduces in size each time a member retires). However, a change in membership renders the execution of a genuine longitudinal SNA impossible. A further limitation of this study relates to the difficulties of comparing networks developed in one context with others. For example, it is likely that the differences cited above between the findings of Fontainha, Martins and Vasconcelos (2015) and other similar studies, for instance in respect of changes in network density, may be due to its nature as an online learning network, or other particular characteristics of the community in question.

## **7. Practical implications and recommendations from the DREaM Again project**

The analysis above shows that the value of the initiative under scrutiny eroded over time in terms of network density. This is not uncommon for scholarly and learning networks that are supported by short-term funding (see, for example, Buckner and Cruickshank, 2008). Expectations of network value amongst those keen to develop similar networks in the future – both funders and participants – should be moderated accordingly. Nevertheless the DREaM network continued to generate a degree of return three years after the AHRC's initial investment through the connections that had endured. This is evident in the finding that all but one of the actors were still connected to the network as a whole.

It may also be useful for future initiatives, such as those supported by UK research council networking grants, to include provision for continued

lightweight investment beyond the formal delivery of organised events. These could serve as further impetus for network members to maintain their links. Given that the findings here (and in other prior studies as noted above) prioritise physical over virtual contact, those hoping to develop networks that are active into the long-term should find a way to support further ad hoc face-to-face activities at which members can renew and refresh contact with one another.

The social element of network development emerged in this study as an important factor of network longevity. Thus opportunities for social interaction, focused on engagement in activities that have little or nothing to do with the work-related aspects of the networks' remit, such as those organised for the DREaM network members (see Cooke and Hall, 2013, p. 788), should be nurtured in networks. Efforts to do so increase social capital amongst network members and underpin future work-related networking.

The experience of the DREaM project also indicates the value of social media as a form of network infrastructure: it furnishes another 'place' in which network members can maintain contact with one another. This finding aligns with those of Vriens and van Ingen (2017 in press, p. 14) and Wellman, Dimitrova, Hayat, Mo and Smale (2014, p. 491) who identify that the greater the online contact, the more dynamic the interactions between strongly-tied network members. Further, this finding relates to conclusions from other work in broader realms of LIS research such as that on knowledge sharing which concludes that 'social media [broadens] ambient (or peripheral) awareness of the network... through making skills more visible... and... furnishing access to a wider set of resources' (Buunk, Hall and Smith, 2017). Hence an additional practical recommendation from this study is that network development should pay attention to the building of an online infrastructure suitable to support communications between, and beyond, face-to-face meetings of network members.

A further infrastructural recommendation relates to individuals at the centre of networks. In line with the work of Fontainha, Martins and Vasconcelos (2015), it is recommended that networks nurture core members to guarantee their durability. The findings on network centrality in this study, which showed that those at the centre of the DREaM network were different for each type of ties ('work-related' and 'social') indicate that membership at the core may vary according to the different facets of the network in question. Thus the role of leading work from the nucleus of a single network may be assigned to different sets of members according to different network goals.

This work has also demonstrated the practical value of SNA for (1) for network measurement and (2) as an intervention to check the health of the network. In addition it shows that qualitative data collected in focus groups can provide context and examples to illuminate findings from an SNA. Other researchers will be able to draw on this practice in future similar projects, bearing in mind the limitations of such an approach as outlined above.

## 8. Conclusions and further work

Taking into consideration the limitations of the context of the network under scrutiny as identified above, DREaM Again adds to the understanding of factors that are important to scholarly and learning network development. By relating the findings from the analysis of the data from 2015 with those reported in 2011 and 2012 (Cooke and Hall, 2013), following methods deemed 'to sustain an epistemologically sound approach to social network analysis over time' (Ryan and D'Angelo, 2017 in press), morphological changes within the DREaM network have been presented and discussed. Some of the findings drawn from the analysis are broadly in line with those from previous similar studies (for example, that by 2015 the DREaM network was not as tight or dense as it once was). Others were not anticipated at the outset. For example, that social ties assumed greater importance in holding the group together in 2015 than they had at the conclusion of the DREaM project workshops in 2012 is somewhat surprising, especially given that DREaM was initially established as a work-related network.

Although rooted in LIS research, the theoretical and practical contributions of this study are relevant to researchers in other domains. Those with interests in the evolution and structure of networks, and ties between network members, will be particularly interested in consideration of factors of network longevity in a *longitudinal* analysis that extends prior knowledge. This is valuable because reports of longitudinal changes in networks are not well-represented in the SNA literature - most likely due to the practical problems of following cohorts over time, as noted above.

The DREaM Again study has extended understanding on particular aspects of network shape, notably network density and actor centrality. Here it has been possible to furnish further evidence on how these change, and to highlight, for example, that earlier findings on the role of status in centrality may not be applicable across all contexts. Here also on-going debates in respect of the role of the physical proximity of actors as a factor of network longevity have been considered. In this case it has been demonstrated that co-location is important to the maintenance of contact beyond the formal lifetime of a funded networking initiative.

Further work on the data set could extend the SNA reported here, both in respect of the DREaM network in particular, and scholarly and learning networks in general. Acknowledgement that social networks are highly dynamic that are subject to change in their topology (Liben-Nowell and Kleinberg, 2004, p. 1019), for example, points to the value of conducting friend-of-a-friend measurements beyond the cadre. This would shed light on the relationship between the 'core' (original) network and any emerging community that, in turn, would need to be sustained by new membership. There is also scope for SNA researchers to consider more fully factors of network longevity, especially in respect of those

that appear to be context-dependent, such as the impact of status on network centrality.

Additional work in progress considers the other impacts of the DREaM project in terms of how the learning from the workshops has been applied in practice since 2012. Indications from the SNA that those who were most central (in general) in the DREaM network in 2015 (as shown in section 5.1 above) were also (a) the most likely to have collaborated with other cadre members since 2012, and (b) the most productive in terms of research output will be explored in the second paper from the DREaM Again project. This future work will respond directly to calls for research on social networks to consider the outcomes of network relationships in providing value to individuals and groups (for example, Schultz-Jones, 2009). This is a theme that has recently been deemed a 'crucial research topic' (Shiau, Dwivedi and Yang, 2017). Thus DREaM Again will build on earlier research (for example, Rienties and Nolan, 2014) by meeting the need of 'future studies [that] will focus on elaborating the mechanisms of collaborative interactions among scholars in... networks and assess how this structure promotes or hinders performance of these scholars as well as the productivity of their projects within their scholarly network' (Mo, Hayat and Wellman, 2015 p. 131).

## Notes

[1] The other impacts of the DREaM project related to (1) influencing methodological choice and research design decision in project work, (2) increases in knowledge and research confidence, (3) strengthened abilities in demonstrating research knowledge in the workplace, and (4) the generation of new resources to share.

[2]  $k*(k - 1)$  see

[http://faculty.ucr.edu/~hanneman/nettext/C7\\_Connection.html#connection](http://faculty.ucr.edu/~hanneman/nettext/C7_Connection.html#connection)

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