Group-works: Exploring multiplex networks, leadership and group performance

Purpose: The purpose of this paper is to explore the effect of "multiplex" (multiple overlapping) networks and leadership on group performance in a higher education setting.

Design/methodology/approach: Using a combination of social network analysis and interviews, the authors employ a case study approach to map the connections between academic group members. This paper analyses the relationship between this mapping and academic performance.

Findings: The authors identified two dimensions which influence group effectiveness: multiplex networks and distributed-coordinated leadership. Where networks are built across tasks, inter-relationships develop that lead to greater group performance.

Practical implications: Where group members create a dense hive of interconnectivity and are active across all group tasks, and also informally, this increases the opportunity for knowledge sharing. When this is similarly experienced by a majority of group members, there is positive reinforcement, resulting in greater group effectiveness.

Originality/Value: This paper highlights the importance of the richness of formal ties in knowledge intensive settings. This paper is the first to differentiate between formal connections between colleagues related to different tasks within their role. This suggests that dense configurations of informal ties are insufficient; they must be coupled with strong ties around formal activity and demonstrative leadership.

Article Classification: Research paper

Keywords: Multiplex networks, Higher Education, Performance, Social Network Analysis, Social Capital, Distributed leadership.

Introduction

Many changes have taken place within the UK Higher Education (HE) sector recently including: research funding cuts, changes in funding models (Browne, 2010), pressures for enhancing contributions to the 'knowledge society', and heightened vocalisation of expectations regarding teaching (Gunn and Fisk, 2013). These changes place universities under increasing financial pressure, and limited resources are available to fulfil a multitude of activities (Moran and Powell, 2018). With academics needing to publish high quality research, build external links and demonstrate research impact, this increases pressure on the already escalating demands associated with teaching.

Much has been written about the changing role of academic staff, where administration and service tasks increasingly encroach on the traditional domains of research and teaching (Nickson, 2014; Gornall and Salisbury, 2012). For research, the higher ranked the university department is in the Research Excellence Framework (REF)[i], the more government funding it receives for its research activities, and the higher its perceived esteem within the sector. The Teaching Excellence Framework (TEF) in England, raised contentious issues of workload amongst academics creating a paradox of increasing quality research alongside greater teaching engagement (e.g. Darabi et al, 2017; Spurling, 2015). The first TEF results, announced in June 2017, revealed that many top tier research-intensive universities failed to achieve the levels of teaching excellence that many middle-ranking universities did. Initiatives such as the National Students Survey[ii] and media-led rankings are also indicative of the increased focus on student experience and satisfaction.

Despite the increased focus on teaching excellence, research remains the dominant measure of prestige across much of the sector and among academics themselves. With the distribution of government funding for research increasingly reliant on the quality and

quantity of research outputs generated by academics (Ng and Pemberton, 2013) it is important to understand how performance is affected by organisational structures and leadership. Recent research has also considered how social capital promotes research productivity in academia, identifying the number of ties between co-workers, position within the network and diversity as having a positive effect (Gonzalez-Brambila, 2014).

This paper explores how informal and formal networks within the knowledge-intensive setting of the UK Higher Education environment are organised. It argues that the personal and positional power of leaders within academic groups can have an influence on the effectiveness of how these academic communities perform. The authors use multiplex network mapping to understand the ways different groups within the same school worked and performed.

Multiplex networks of formal and informal ties

Within social network theory, analysis of network structures and node (actor) positions has been related to group outcomes (Granovetter, 1973). A key debate explores the dichotomy between emergent networks and orchestrated networks where much analysis has focused on the type of network and its relationship to effective knowledge creation and transfer (Clegg et al, 2016; Kilduff and Brass, 2010). Informal networks, by increasing the strength of ties between actors, have been found to improve social capital, knowledge flows and group effectiveness (Oh et al, 2004). Until recently, less attention has been placed on understanding the effect of layered and complex networks (Aalbars et al, 2014; Tasic et al, 2019).

Research has focused on the effect of *density of ties* (the more members that have ties to each other, the higher the density) on *effectiveness* (i.e., successful task completion) with some arguing that higher density increases effectiveness (e.g., Hansen, 1999) and others that it

hinders effectiveness (Burt 1997; Gonzalez-Brambila, 2014). Balkundi and Harrison (2006), in a meta-analysis of studies, found that teams with dense configurations of network ties, particularly ties based on friendship (i.e., informal ties), tended to attain their goals better. Oh et al (2006) demonstrated that informal socialising ties did contribute to group effectiveness. Oh et al. (2004) also discussed how different resources can be generated through social relations and how they may then contribute differentially to organisational performance outcomes.

A recent development has been the consideration of the effect of "multiplex" networks, i.e., those where both formal and informal ties exist between actors simultaneously. Research suggests that the presence of a multiplex network has a positive effect on resilience, performance, trust, knowledge flows and innovation (Ferriani et al, 2012; Soda and Zaheer, 2012; Tasic et al, 2019). Aalbers et al. (2014) researched networks in organisations and found that formal relations, which include formally mandated quasi-structures (e.g., groups organised around a task), can contribute as much to knowledge transfer as informal ones. Importantly they also found that combined formal and informal ties (i.e. a multiplex network) were rich ties that stimulated knowledge transfer more than the formal or informal ties alone. By encouraging the overlap of the social networks within an organisation, the management of the organisation can facilitate and enhance innovative activity. Similarly, Ferriani, et al. (2012) found that both social interaction and economic exchanges contributed to the emergence of network multiplexity in a longitudinal network analysis. However, in looking at the impact of the multiplex network, neither of these studies distinguish the different formal networks that might exist based around different activities. Shipilov et al (2014) argue that a strategic multiplicity perspective needs to be taken in developing networks and relationships across activities and groups. This paper considers the different activity-based formal networks and the multiplex networks that arise from combining activities but remaining

within the formal constraints of the organisation. Of particular interest are the complexities of the different combinations of layers within the multiplex network of the formal organisation.

This paper explores the relationship between different network structures at group level: formal networks, informal network and multiplex on performance. It argues that where there are networks built across tasks, inter-relationships develop that lead to greater group performance. The authors consider group level because this is the operational unit within academic structures. It is the first formal level of semi-permanent aggregation of individuals within the academic organisation around delineated tasks for which the group is held responsible and accountable.

Leadership in groups

The effect of leaders on team performance has been well-considered in organisational theory. Leaders influence others in what work should be done, and how to do it. They facilitate the accomplishment of shared objectives (Yukl, 2010). Bennett et al (2003) describe distributed leadership as "a group activity that works through and within relationships, rather than individual action" (p.3). Increasingly, leadership is less seen as about command-and-control and more of a shared and distributed phenomenon where a network encompasses both formally and informally emerging leaders (White et al, 2016). Within this view multiple leaders exert a more 'naturally occurring' influence through formal and informal networks (Denis, et al. 2012). Carson et al (2007) argue that there are positive effects of shared leadership on team performance. Although Oh et al. (2006) found the optimum group to be one which had moderate closure, with both formal and informal leadership roles fulfilled by the same person. In reality however, this is achieved when leadership is distributed across a

number of different individuals, especially where those teams are responsible for multiple tasks (Ancona et al., 2015, 2019).

Mehra et al (2006) defined three types of leadership structure: leader-centred, where all leadership rests with a single formal leader and all members defer to that individual; distributed – coordinated, where the formal leader recognises an emergent leader and the tie between them bridges two sub-groups; and distributed – fragmented, where there is both a formal and one or more emergent leaders but there is no effective co-ordination of leadership between the formal and emergent leaders. They found that distributed – coordinated leadership structures are associated with higher team performance than both leader-centred and distributed – fragmented leadership structures.

Gosling et al (2009) found leadership of academic groups to be a complex relationship between academic positions, seniority and relevant subject expertise. In many HE departments in the UK, the leader of an academic group is commonly appointed to the role by the senior management of the school and has both seniority and subject expertise; it is common practice for the formal leader to deputise in particular task areas or for other individuals to emerge from the group as the 'go to' person for other members of the group for advice/support/guidance in certain task areas and is consensually accepted as a leader in those areas.

This study addresses the research gap raised by White et al (2016:281) regarding "our knowledge of pluralized leadership surrounding the influence of leadership on the network relations that connect people and vice-versa" and considers the differences in leadership position within the network structures of the nominal leaders and actual leaders at group level and their relationship to group performance.

Methodology

Design and data collection

The analysis is based on the rich data from an academic school within a UK Higher Education Institution. The school chosen had definable formal organisational networks, which are easily identifiable. All groups within the school were engaged in similar tasks, so ostensibly are organised to achieve similar outcomes. The school was sub-divided into five subject groups, each managed and led by a senior academic, designated the 'head of group'. While the groups represent five different research and teaching subject interests, they are all within the same wider discipline. Therefore the expectations for publication quantity and quality are equal.

This study adopts a social networks perspective to identify the social networks that co-exist within formal groups, to examine the different network characteristics of groups and to identify the roles of leaders within groups. Social network analysis is useful in showing the different networks that may exist within groups and how connected they are (c.f. Gallardo-Gallardo et al, 2017). The analysis also explores the distribution of leadership roles within groups, identifying group structures associated with better performance. The authors adopt a mixed method explanatory sequential design approach (Bryman, 2006); the first step identifying the network structure and ties using questionnaire data. Secondly, using interview data to enrich and explain our findings.

Network Analysis:

Whole network information is required for Social Network Analysis and due to the tightly bounded nature of the units of analysis, a roster method was used with a socio-metric questionnaire (Valente, 2010) where each respondent is asked to tick categories against a

provided list of names. The questions asked respondents to identify with whom they had meaningful contact in the previous seven days. Meaningful contact was defined as either (a) a face to face or telephone conversation which lasted over one minute, or (b) an email correspondence which included at least three emails over a determined week. In order to create multiplex layers in our analysis, respondents were asked to categorise their interactions by activity: research related, teaching related, social or administrative[iii]. This approach is consistent with socio-metric work on network interactions (Balkundi and Harrison, 2006). This study focused on the two primary tasks of research and teaching. Administrative tasks were excluded because these tended to be distributed at an organisational level and not restricted to academic groups.

Matrices were constructed to represent how each actor was connected to every other actor in the network. This began by constructing single layer network diagrams for each group on the basis of task (a research network, a teaching network and a social network). Next, to examine the simultaneous overlap of each of these networks, three duplex networks were created made up of ties which exist in two of the single layer networks: the duplex formal network combined data from teaching and research networks; and two formal/informal networks combined task and social data (research/social and teaching/social). Finally, a multiplex network was created, referred to here as the Triplex network, made up of ties that exist in *all three* of the task networks (research, teaching and social). The analysis below (see figures 1-4) present these superimposed over a 'Master' network for each group, which shows *any* tie between two nodes regardless of the task with which it is associated.

Key organisational performance measures:

Performance measurement in HE is measured at school, group and individual levels. Here we focus on group performance.

Publications: In most Higher Education Institutions in the UK, quantities of articles publishing research findings in academic journals are a primary measure of research output and are used as the main criteria for comparisons across individuals, groups, schools, faculties and universities and is therefore a sector-wide accepted measure.

The University holds a repository of research publications produced by its employees. It is compulsory for all employees to add new publications to the repository within three months of their acceptance to an academic journal. Through this repository, a full list of publications for all members of the school was collated. This data was used to compile a frequency count of publications for each employee for five years following our network analysis data collection (2011-2016). As this study was interested in group level performance rather than individual performance publications for all group members were combined, and then averaged by the number of group members (excluding any staff who were on teaching only contracts), providing a per-member publications frequency for each year.

Academics may write a number of different types of publication, for example, books, conference articles, blog posts. Peer reviewed academic journal articles are considered to be the most crucial of these (Thomson Reuters, 2010). The institution expected employees to prioritise high quality journal articles as their primary outlet and any other type of publication was deemed to be at the discretion of the individual academic. For simplicity, therefore this study considers publications in peer-reviewed journals only. Due to the variety of journals available to publish in and controversy over the inappropriateness of various journal ranking lists (Willmott, 2011), it was not feasible to take account of the *quality* of individual publications. However, this institution insisted that employees only published in high quality academic journals and therefore this analysis makes the assumption that a majority (if not all) of the publications counted represent a high quality of work.

In the world of academic publishing, the time lapse between the submission of articles and their eventual publication in a high quality academic journal can be anything from nine months to two years (excluding data collection and writing) (Björk and Solomon, 2013) with considerable variation between discipline (e.g. . business/economics journals on average had double the delay than chemistry). Therefore it was important to capture the publications output for the period following our analysis of the group structure therefore ensuring that the performance captured could be attributed to group dynamics in the years preceding the eventual publication. Publications data for the following five years from the network study (2011-2016) is therefore used. This approach, however, reveals an added complication of how to count year on year publications where the membership of the group changes. Groups contain a fairly small number of members and over the six year time frame various members have joined and left each group. Employees who were present at the time of the network data collection but subsequently left the organisation within the few years that followed may well have been influenced by the group dynamic even after leaving the institution. Therefore, the authors decided to continue to count their publications for three years after they left the case study institution to allow for work produced at the time of data collection to come to fruition[iv]. For new group members it is difficult to determine whether any publications within the first few years of their employment were produced within the group dynamic that we measured in the network analysis. Therefore, it was necessary to make several assumptions in order to apply a consistent measure. Firstly, this study makes an assumption that the group dynamic measured at the time of the network analysis did not significantly change in the years that followed. In most groups where the head of group changed, the new head of group almost always came from within the existing group membership. Through continued contact with a number of our interviewees they have indicated that their comments still stand. Secondly, the assumption that even if research work might have initially begun at

another institution, the writing up of this research and later stages of the publications process will have been influenced by the group dynamic at our case study institution (to a greater or lesser extent). All new staff at the institution are assigned a mentor for the first months of their time at the institution. The authors therefore decided to be as inclusive as possible in counting publications of new employees and therefore count publications from one year after their arrival date.

The authors acknowledge that publication counting alone is a much contested performance measure for academics (Mingers and Yang, 2017; Willmott, 2011). It does not take full account of the holistic role of the employees within the organisation. Academic staff make other contributions to the institution by performing substantial tasks such as teaching, administrative/managerial roles, as well as bringing in grant funding and being a good citizen of their research consortium (or group) (Spurling, 2015). These multiple aspects of the role are difficult to measure in any objective way. However, in attempting to capture some of this behaviour, additional data, including the number of promotions and staff turnover in the group, were collected.

Promotions: Promotions are defined as a movement upward, and typically would progress from lecturer to senior lecturer to reader to professor, and are based around a set criteria broadly encompassing excellence in practice/activity (teaching excellence, academic merit such as quality and quantity of research, leadership and impact). What promotions are capturing is a broader measure of performance, which also includes citizenship and collaborations. Considering the promotions within the group, provides an indication of the group's effectiveness in working together to share workload and resources (i.e., in developing the social capital of the group).

Promotions are granted in an annual review of staff, therefore any eligible member of staff has one opportunity per year to be promoted. Not every employee will be put forward for promotion every year, and it is normal for employees to remain at the same grade level for a number of years between promotions. Nevertheless the proportion of employees being promoted on average within a group each year should be comparable. Employees who are already at a professorial level were not eligible for promotion and therefore were not included in this analysis. For each year, the authors counted a percentage of promotions amongst eligible staff members. New staff were deemed eligible from the year after their appointment.

Turnover: For each year the authors counted the number of group members who left and joined the organisation. This included both those who retired and those who left to work at other organisations, however, it is qualitatively recorded which of these options applied to each employee and this was applied to the interpretation.

Interviews

Interviews were conducted with appointed group leaders and other key informants within the group to understand the different roles that individuals play in facilitating research in an academic school. 14 interviews were conducted, each lasting approximately one hour. Interviewees were purposely sampled based on the social network analysis (e.g. emergent leaders) as well as those formally designated as 'heads of group'. Interviews were in depth and semi structured around a set of themes and the initial SNA findings. These themes included: the individual's role, leadership styles of group leaders, their interpretation of group performance and challenges they faced. Interviews were recorded and transcribed. Interview transcripts were deductively analysed using a predetermined set of themes. Firstly, the researchers analysed descriptions of formal and emergent leaders within each group from the perspectives of the leaders themselves, other leaders within the group, and group members.

From this analysis each group was categorised by leadership structure according to Mehra et al's (2016) theory (see table 1). Secondly, extracts of interviews which referenced attitudes to the group's performance and relationship between group members for each group were analysed. For this part the researchers adopted a more open approach to coding statements which reflected the group norms and culture, categorising them together where themes emerged. These themes were used to contextualise and explain the SNA, allowing the authors to investigate the complex phenomena surrounding each group's dynamics and interactions.

TABLE 1 HERE

Selection of case studies

There are five academic groups within the data set. The authors chose to exclude group 5 in our analysis due to a range of anomalies in their circumstance. These included having a large number of contract researchers at the time of survey and a series of location changes during the period of analysis. Summary dashboards were created for the remaining four groups (see figures 1-4). The dashboards are derived from the full range of data (interviews and network analysis) and include network diagrams of the triplex, duplex and single layer networks superimposed on the undifferentiated master network, and were a helpful tool in seeing a holistic picture of each group.

Table 1 shows the performance measures for each group. It can be seen that group 4 outperforms all other groups on both performance measures (publications and promotions).

TABLE 2 HERE

Findings

Group 1

FIGURE 1 HERE

Figure 1 shows the network diagrams for group 1. The star denotes the formal leader (#82). On the simple basis of interaction, it is a well-connected group, with all members of the group connected to at least one other member of the group in at least one category.

Whilst the group 1 master network here indicates that this is a well-connected group, the triplex network is relatively simple in comparison. We do not see the same consistent shape across the different levels of multiplex, which suggests that there are a variety of relationships between individuals. The formal leader (#82) is not connected to the majority of the group. At the single network level, this group appears to have some very well-connected individuals (#23, #56, #90 and #41) and there is a distributed-coordinated leadership between #82 (the formal leader), and #41 and #77 within the teaching and research single layer networks. Many of the well-connected individuals are not connected to the formal leader. However, #82, did not formally delegate leadership tasks to others in the group. Instead #23 describes how he reluctantly assumed some of the leadership roles. #23 is well-connected within the group and was referred to as the 'go to' person for many issues by some, due to his long standing membership. However, #23 did not see himself as a recognised leader.

> *..Because there was no clear structure of the way that I networked, it was very much when I was in I would get involved with as many networks as I could, be on certain committees etc., when I wasn't then it was obviously left to other people to do that.(#23)*

#23's leadership is centred on a small cluster between #23, #83, #57 and #56 which appears rich, permeating the levels to the triplex.

While #82, the formal leader, took a perfunctory approach to leading the group in any of the formal activities (teaching, research), it was expected that these could only take place via the formal leader's authority. This had a de-laminating effect on the multiplex network, leading to a group which, although superficially appearing well-connected, does not have a consistency of connections.

Considering the single-themed networks, there are far fewer connections in the research network than either the teaching or the social networks, and significantly not all those who were research active were connected. For example, #90 is research active but is not in the group's research network. #90 describes the different philosophy to research within this group:

> *I feel more resonance with X who is from a different group but our research interests are more complementary. So I do my research with X. I've been in this group for many years and I've tried to find commonalities with my colleagues but I've not been successful. The group head has also not helped to drive our research as a group* (#90)

Within the duplex networks, the number of ties diminishes and the formal leader is only connected in one duplex network (research/teaching). However #23, is connected in all duplex networks although, as we will see, to a lesser extent compared with the emergent leader in group 4 (#43).

At the triplex network level, there are even fewer connections with more members not connected than connected. It is barely a network. Despite a fairly promising network reach at the single-themed level, its poor multiplex suggests it is unlikely to perform well (Aalbers et al, 2014). It is apparent here that the formal/informal dichotomy is not sufficient to explain performance. This study argues that there is a need to understand formal activity multiplicity to explain performance differences.

In summary, group 1 connects socially; however with little structure and centrality of a leader. There is also little evidence of systemic distribution of leadership therefore little reach throughout the group, extending out to the peripheral individuals.

Group 2:

Figure 2 shows the network diagrams for group 2. The star denotes the formal leader (#54). Unlike group 1 not all members of the group connected to other members of the group and the scarcity of research ties is of particular note.

FIGURE 2 HERE

The formal leader (#54) plays no role in the research network and is not the most significantly connected in other networks. Instead leadership is somewhat distributed amongst a number of others (#12, #59 and #32) but each of these nodes have a relatively low number of connections (max. 4, compared with 7-9 for informal leaders in groups 1 and 4).

> *…there are not many whole group meetings with the Head of Group. Discussions tend to be between people who teach in the same subject area. People come and talk to me when they need specific advice or general advice based on my experience [of school roles]. (#12)*

It should be noted that the formal leader at the time of network data collection also had responsibility for leading the whole school. Whilst this might explain the leader's relative absence within the group, it does not account for the fragmented leadership in their absence.

In the duplex and triplex networks, we observe a stronger diminishing of the number of ties than in group 1 which suggests very little connection across networks. Like group 1, it appears that this group's performance is hindered by the lack of multiplex, in particular there have been very few promotions within the group over the study period.

In summary, group 2 connects primarily on individual issues with little interaction between networks. Arguably, the group suffers from a lack of leadership with no key individual presenting themselves as an emergent leader.

Group 3:

Figure 3 shows the network diagrams for group 3. The star denotes the formal leader (#21). At the time of data collection one third of group members were professionally qualified practitioners and the group was responsible for one of the highest recruiting (and one of few externally accredited) undergraduate degree programmes which was of significant strategic value to the school. On the simple basis of interaction, this group had the highest total number of connections; all but one member of the group is connected to at least one other member of the group. Notably the teaching-only single layer network was by far the densest. In contrast the triplex network consists of only one tie. Research active staff are in the minority within this group and of those, only 50% noted research-related interactions.

FIGURE 3 HERE

The formal leader (#21) is one of only a few group members with connections in all three networks and is directly connected to two thirds of group members. The only group member better connected (in terms of having more ties) is #34 but this individual is not often connected to those to whom the leader is not. Of the four groups this one has the most traditional leader-centric structure but we see equally poor performance in terms of publications and promotions. Whilst they appear to be a high functioning group within the teaching network, this does not translate to a multiplex which covers the diverse range of activity required of most group members.

Group 4

Figure 4 shows the network diagrams for group 4. The star denotes the formal leader (#63). On the simple basis of interaction, it appears to be as similarly well-connected as the other groups with only one person not connecting with at least one other member of the group. However, in contrast to other groups, the lagged publications data shows that the average number of publications per person was higher, and the group was more successful in terms of promotions (see table 1 and figure 5).

FIGURES 4 and 5 HERE

Group 4 exhibits a similar pattern of connections in each of its single theme networks and also in duplex networks. It has a denser triplex network which follows the same shape as other layers.

The formal leader (#63) is present in all three single-theme networks and there is evidence of a distributed-coordinated leadership with two other significant individuals (#65 in the teaching and social networks, and #43 across all single theme networks). They spread the reach of the formal leader and engage with the colleagues who are on the periphery. #43 takes the central role in the social theme network whereas there is a more equal distribution between #43 and #63 in the research network, reaching out to half the research active group each (note that #15 and #91 are not research active).

At the duplex network level there is a variation of this story. Within the networks that involve the social theme, the leadership role seems to be taken by the emergent leader (#43). However, in the research and teaching network, the leadership adopts the distributed-coordinated pattern shared between #63 and #43. When compared with the emergent leader in group 1 (#23) the emergent leader in group 4 is connected in all duplex networks to a greater extent.

Social activities are centralised around #43 who is also one of the leaders in the group's research. With the two leaders working together, the formal leader (#63) is more focused on the formal leadership tasks, and the emergent leader (#43) takes on other roles:

> *#43 is very much central to this group as [they are] a good communicator and also organises the teaching for us* (#63)

It is this arrangement that has resulted in a stronger multiplex network. In contrast to other groups, there is a consistency of connections across the layers within their network. In the interviews group members described how having the same leaders in all three networks allowed mentoring and sponsoring of group members. They were keen to emphasise the importance of these relationships and the formal leader's influence on facilitating this atmosphere as he explains himself also:

> *..Sometimes it's good to come (together) informally. I think that is more successful because you do it because you want to do it, not because you think you have to help someone because they said as Head of Group, you have to do it. It's good that the Head of Group feels more or less like working together without even thinking about working together – that's very important really, without having some, say, rules, or guidelines or some targets. So it's more that you have that idea of feeling comfortable with them so everyone will do it without knowing that they are doing it. (#63)*

It is clear that group 4's leader viewed research as a group-driven activity, which helped build the networks within that group and drove research outputs as a collaborative group outcome.

In summary, the richness of network ties in combination with clear formal and emergent leadership roles is effective in achieving high performance. Six years on, the average number of publications per person in group 4 is over three times that of the other groups. This is

reflected in the higher proportion of successful promotions among eligible staff in the years following the collection of the network data.

Discussion

This article examined the role of network ties and leadership within formal groups in an academic school of a UK Higher Education Institution. This paper makes two key theoretical contributions. Firstly it further explains the role of complex ties in groups with multiple tasks (Balkundi and Harrison, 2006; Shipilov et al, 2014) by considering the coupling of formal ties. Secondly it builds on the insights of pluralized leadership scholars (e.g. Ancona et al (2019); White et al. 2016), by examining multiplex networks. It identifies two dimensions which the authors argue influence group effectiveness: multiplex networks and distributed-coordinated leadership.

Groups work! -- Multiplex Matters

This research suggests that dense configurations of informal ties alone are insufficient; they must be coupled with strong ties around formal activity. This study found that where a consistent pattern of network ties, replicated across all formal and informal activities existed, this was related to higher performance in terms of narrower measures (e.g. quantity of publications) and broader measures (e.g. promotion opportunities). It also resulted in lower employee turnover. Previous studies of multiplex networks have concentrated on the overlapping formal and informal network interactions (Aalbers et al, 2014, Soda and Zaheer, 2012). However, this study finds further explanatory value by understanding the richness of ties within the formal group activities. Often groups may be tasked with achieving multiple outcomes. This requires a balancing of resources and skills across the group (Ng and Pemberton, 2013).

Oh et al (2004) and Oh et al. (2006) proposed that *group social capital* is dependent on the configuration of its group activities by enhancing the transfer of innovative knowledge in organisations (Aalbers et al. 2014). This research extends this by arguing that where group members are active across all formal group tasks, and also informally, this further increases the opportunity for knowledge sharing. When this is similarly experienced by a majority of group members, there is positive reinforcement, resulting in greater group effectiveness. In a higher education context, this contradicts the view that the most successful institutions are those made up of academics who focus on publications supported by a cast of colleagues who engage in citizenship and teaching. Rather, this study would suggest that an organisation can benefit from groups in which individuals are well-connected across all areas of their work within group. By creating more resilient and stable groups it promotes the development of long term social capital (Tasic et al, 2019; Shipilov et al, 2014).

Balkundi and Harrison (2006) claim that the pattern of ties was of more importance than their content in affecting performance. This paper argues that pattern, strength and content of ties are all important for high performing networks. The more variety of connections, the better performing the group will be where performance is judged across multiple areas. For example, if individuals say they discuss research 10 times a week, this is better than talking about research once a week. However, if individuals discuss research three times a week, teaching three times a week, and socialise over a coffee break, knowledge transfer will be richer and opportunities to affect performance positively will be increased. This research is important because it suggests that this should not mean dividing members of the group, but instead, that it is important to build formal work activity interactions into a multiplex network.

Distributed-coordinated leadership and multiplex networks

Oh et al (2006) and Mehra et al (2006) found that moderately closed groups where recognition between formal and informal leaders exists is co-ordinated leads to higher team performance. This study supports this finding (group 4). However, there is more to this story than distributed-coordinated leadership alone.

This study extends distributed leadership research by examining the impact of having different distributed leaderships at different task levels. Distributed-coordinated leadership not only extends the reach within that network, but within a multiplex network it also ties different layers of activities together. Such a leadership structure provides strong structural support for the group, reduces pockets of disconnection and encourages development and growth amongst the group members. It discourages silos and permits development of additional activities whilst maintaining the strength of the ties. This paper argues that such a juxtaposition allows for creativity and growth within a stable and yet dynamic structure. This same argument would also apply in other knowledge-intensive settings such as other professional service organisations, where multiple tasks are interconnected. Where this is the case a clearer picture of the capacity for social capital generation can be understood by deconstructing the group network into its duplex and triplex components. Creating complex networks between group members across multiple tasks can help to create a dense hive of interconnectivity in order to harvest performance potential.

Limitations and future research

As with all research, this study is not without limitations. First, this study focused on quantity of publications and not the quality. Across the many disciplines that made up this case study,

there was not much agreement as to what denotes quality and if anything, plenty of critique as to the singular approach to measuring journals rankings (Willmott 2011, Mingers and Yang, 2017). With such disagreement and critique of the methodology of judging quality of publications, it was felt that for the purposes of this study, it was best to have a simple measure of number over quality.

The second limitation of the study is that the researchers were unable to obtain an isolated measure of teaching performance at a group level. Where the focus of the group is primarily on one task (e.g. teaching in group 3), the multiplex may seem less important and therefore the leader-centric focus could allow the group to perform well on performance criteria more aligned with their focus. Future research could look at the difference between single-focused and multiple-focused group priorities. However, the development of HE in recent years and the increased multi-faceted scrutiny and external pressures would suggest the ability of a group to focus on a single type of task is becoming less common (Moran and Powell, 2018).

Conclusions

This article explored the role of multiplex networks and distributed leaderships in enhancing group performance within an academic school in a UK Higher Education institution. It finds that the presence of a multiplex network does have a positive effect on performance in terms of research output and promotions. It also demonstrates an enhanced effect when situating a stable distributed coordinated leadership within a multiplex network. By encouraging the overlap of the social networks in an organisation and specifically in an academic school, greater innovative activity can be facilitated. Where networks are built across tasks, inter-relationships develop that lead to greater group performance, suggesting that dense

configurations of informal ties are insufficient; they must be coupled with strong ties around formal activity and demonstrative leadership.

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Table 1 – Data categorisation examples for leadership structure

Table 1 – Data categorisation for leadership structure		
Group	**Example quotation**	**Categorisation***
1	"..I think there should be more interaction in terms of people actually being able to come together and discuss an issue, whereas I think at the moment we've got forums which are driven very much by somebody doing a presentation and then the expected output is that you ask a question, or that there's not time for questions. So it's not a structure in which it allows people to express opinions, to critique things that are going on, to suggest new ways of doing things"	Distributed Fragmented
2	"I'm trying for a very participatory management style because in many ways I know other people know more about particular things than I do... but (Participative style of management in research) is not at all effective I think"]	No leadership
3	"a big part of what I'm trying to do is to generate a culture where we care for each other, where we provide a professional manner in which we deliver what we do and I think if we do that then we can look after our students, look after each other"	Leader-centric
4	'..it's good that the Heads of Group feels like working together without even thinking about working together – that's very important really, without having some rules, or guidelines or some targets. So it's more that you have that idea of feeling comfortable with them so everyone will do it without knowing that they are doing it'	Distributed Co-ordinated
category names adapted from Mehra et al (2014)		

TABLE 2 – Performance data

TABLE 2 – Performance data						
PUBLICATIONS	2011	2012	2013	2014	2015	2016
Group 1						
Total publications for the group	12	17	20	14	17	19
No. of active researchers	10	11	12	11	12	13
Average no. publications per person	**1.20**	**1.55**	**1.67**	**1.27**	**1.42**	**1.46**
Group 2						
Total publications for the group	7	8	13	15	23	14
No. of active researchers	6	10	13	14	17	19
Average no. publications per person	**1.17**	**0.80**	**1.00**	**1.07**	**1.35**	**0.74**
Group 3						
Total publications for the group	8	9	11	14	20	26
No. of active researchers	9	10	13	15	15	15
Average no. publications per person	**0.89**	**0.90**	**0.85**	**0.93**	**1.33**	**1.73**
Group 4						
Total publications for the group	27	19	26	33	37	53
No. of active researchers	12	12	12	13	14	15
Average no. publications per person	**2.25**	**1.58**	**2.17**	**2.54**	**2.64**	**3.53**
PROMOTIONS	2011	2012	2013	2014	2015	2016
Group 1						
Total no. eligible for promotion in the group	8	9	9	7	7	8
No. of promotions granted	1	1	1	1	0	1
Proportion promoted of those eligible	**0.13**	**0.11**	**0.11**	**0.14**	**0.00**	**0.13**
Group 2						
Total no. eligible for promotion in the group	6	11	12	11	13	14
No. of promotions granted	1	1	0	1	1	1
Proportion promoted of those eligible	**0.17**	**0.09**	**0.00**	**0.09**	**0.08**	**0.07**
Group 3						

Total no. eligible for promotion in the group	13	16	20	20	17	17
No. of promotions granted	0	1	1	1	1	1
Proportion promoted of those eligible	**0.00**	**0.06**	**0.05**	**0.05**	**0.06**	**0.06**
Group 4						
Total no. eligible for promotion in the group	8	7	7	9	10	10
No. of promotions granted	1	0	2	2	1	2
Proportion promoted of those eligible	**0.13**	**0.00**	**0.29**	**0.22**	**0.10**	**0.20**
TURNOVER	2011	2012	2013	2014	2015	2016
Group 1						
Size of group	9	10	10	10	10	8
No. who left or retired	2	0	1	2	1	2
No. who joined	2	1	0	2	1	1
Group 2						
Size of group	13	15	15	16	18	21
No. who left or retired	3	0	1	1	0	2
No. who joined	5	2	1	3	2	4
Group 3						
Size of group	18	21	23	22	21	27
No. who left or retired	1	1	0	1	2	0
No. who joined	2	4	2	0	1	7
Group 4						
Size of group	12	11	12	13	15	15
No. who left or retired	0	1	1	0	0	1
No. who joined	**0**	**0**	**2**	**1**	**2**	**1**

FIGURE 1: Dashboard Group 1

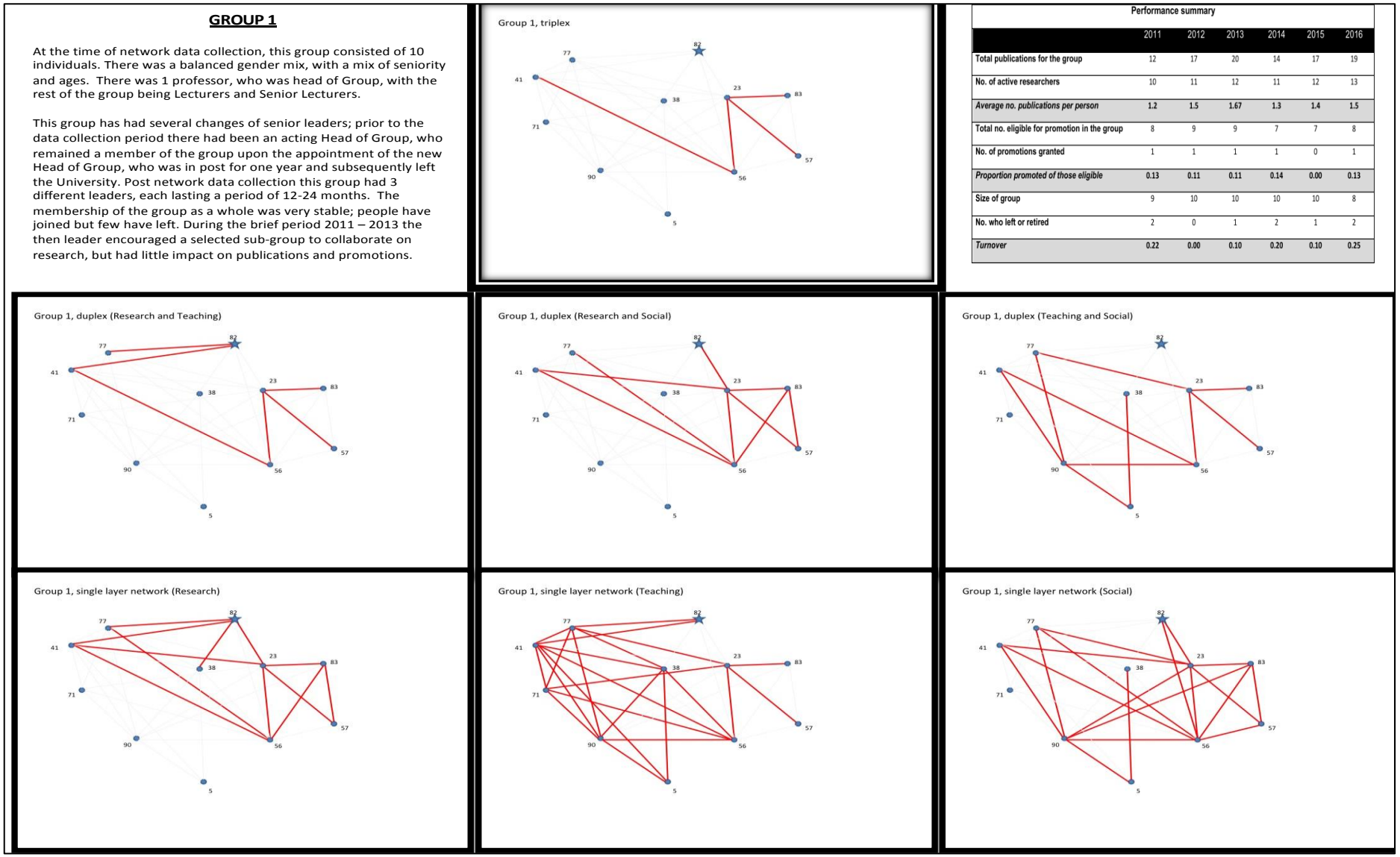
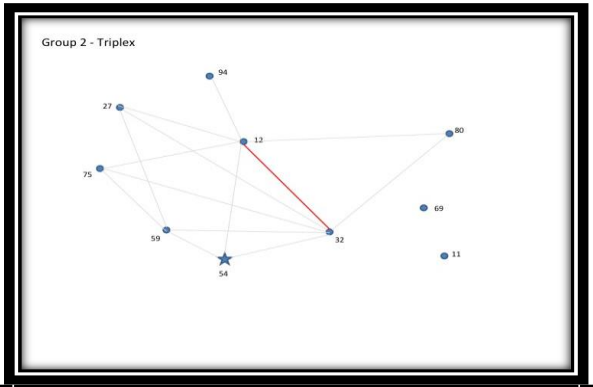


FIGURE 2: Dashboard Group 2:

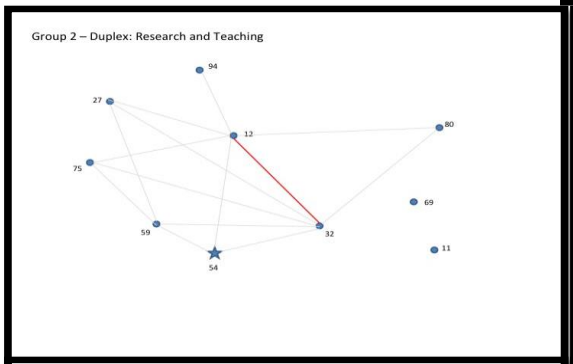
GROUP 2

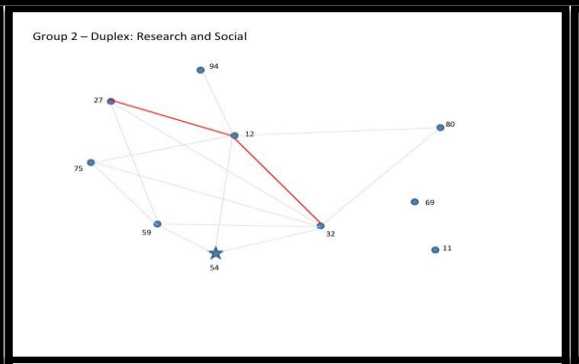
At the time of network data collection, this group consisted of 10 individuals. There was a balanced gender mix, and a mix of ages. The Head of Group was the only professor, with the rest of the group consisting of Lecturers and two Senior Lecturers.

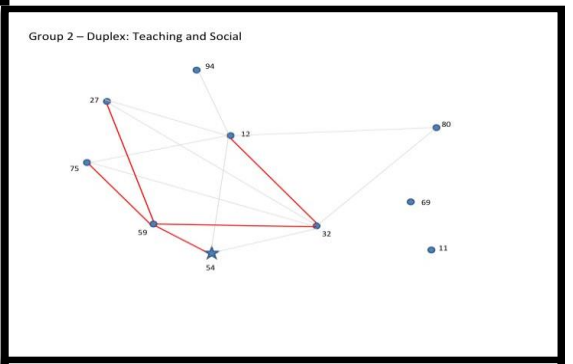
This group has had relatively stable leadership. During the network data collection period the Head of Group was also the Head of School. Post network data collection this group had 1 new leader, who was in post for 5 years. There has been significant turnover in the membership of the group, such that half of those in the network data collection have left, but the overall size of the group has nearly tripled. There are two main sub-groups within the group.

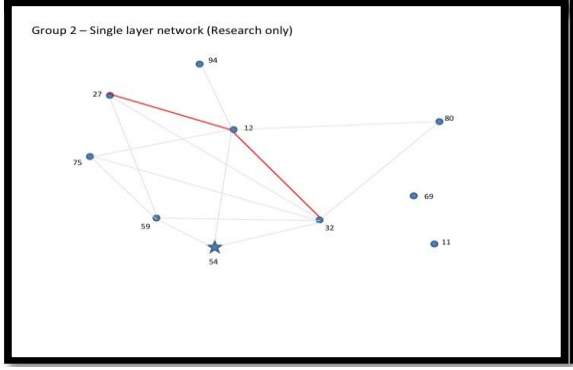


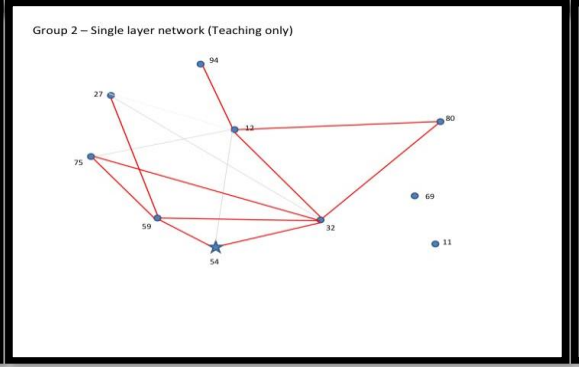
Performance summary						
	2011	2012	2013	2014	2015	2016
Total publications for the group	7	8	13	15	23	14
No. of active researchers	6	10	13	14	17	19
Average no. publications per person	1.17	0.80	1.00	1.07	1.35	0.74
Total no. eligible for promotion in the group	6	11	12	11	13	14
No. of promotions granted	1	1	0	1	1	1
Proportion promoted of those eligible	0.17	0.09	0.00	0.09	0.08	0.07
Size of group	13	15	15	16	18	21
No. who left or retired	3	0	1	1	0	2
Turnover	0.23	0.00	0.07	0.06	0.00	0.10











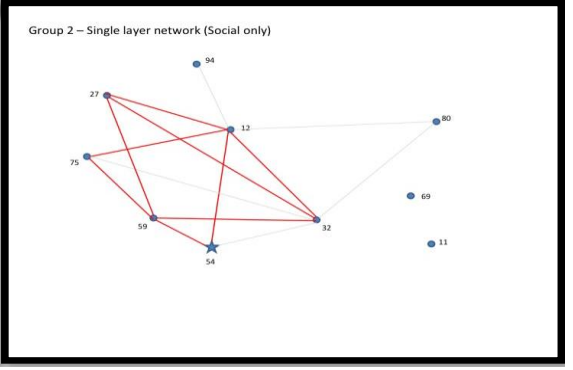


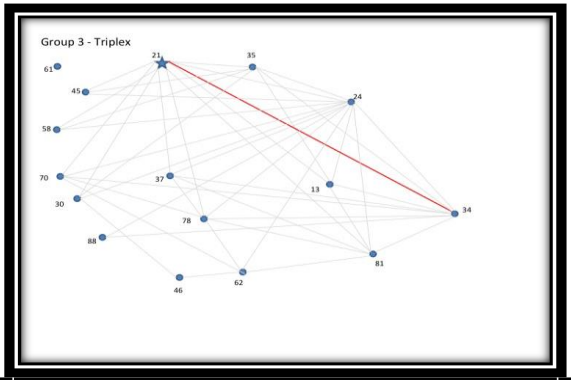
FIGURE 3: Dashboard Group 3:

GROUP 3

At the time of network data collection, this group consisted of 15 individuals. The group was male dominated, but had a mix of ages. The Head of Group was one of two professors, the other being the former Head of Group. The rest of the group consisting of Lecturers and Senior Lecturers.

This group has had stable leadership with the leader at the time of data collection remaining in post to present. In addition the membership of the group as a whole remains stable, with most people who have left having retired rather than moving to another post elsewhere.

At the time of data collection one third of staff were professionally qualified practitioners. Five years on the group has more than doubled with the acquisition of a group from another School in the last year.



Performance summary						
	2011	2012	2013	2014	2015	2016
Total publications for the group	8	9	11	14	20	26
No. of active researchers	9	10	13	15	15	15
Average no. publications per person	0.89	0.90	0.85	0.93	1.33	1.73
Total no. eligible for promotion in the group	13	16	20	20	17	17
No. of promotions granted	0	1	1	1	1	1
Proportion promoted of those eligible	0.00	0.06	0.05	0.05	0.06	0.06
Size of group	18	21	23	22	21	27
No. who left or retired	1	1	0	1	2	0
Turnover	0.06	0.05	0.00	0.05	0.10	0.00

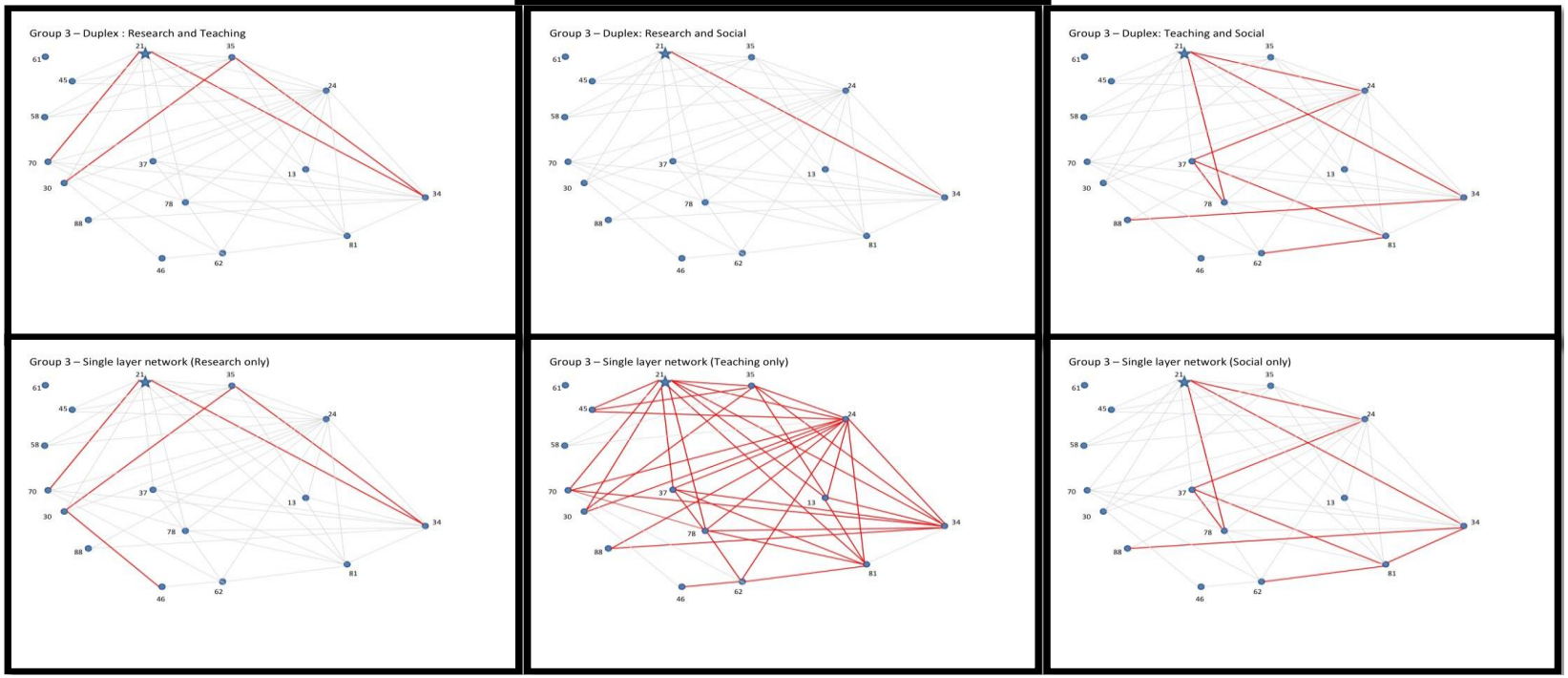


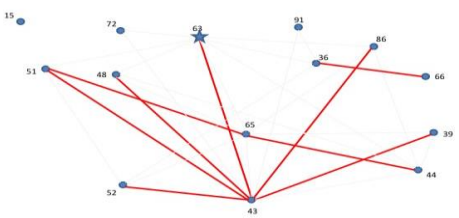
FIGURE 4: Dashboard Group 4

GROUP 4

At the time of network data collection, this group consisted of 14 individuals. The group was male dominated, with only 1 female member. There were 5 professors of which one was the Head of Group. The rest of the group consisted of Lecturers and two Senior Lecturers. Average number of publications is high, compared with the other groups; this volume of publication is not limited to the professors.

This group has had stable leadership with the leader at the time of data collection remaining in post to present. In addition the membership of the group as a whole remains stable, with all those who have left having retired rather than moving to another post elsewhere. In recent years the size of the group has increased by 50%.

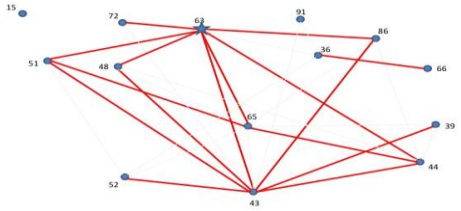
Group 4, triplex



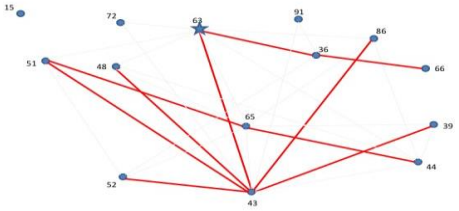
Performance summary

	2011	2012	2013	2014	2015	2016
Total publications for the group	27	19	26	33	37	53
No. of active researchers	12	12	12	13	14	15
Average no. publications per person	2.25	1.58	2.17	2.54	2.64	3.53
Total no. eligible for promotion in the group	8	7	7	9	10	10
No. of promotions granted	1	0	2	2	1	2
Proportion promoted of those eligible	0.13	0.00	0.29	0.22	0.10	0.20
Size of group	12	11	12	13	15	15
No. who left or retired	0	1	1	0	0	1
Turnover	0.00	0.09	0.08	0.00	0.00	0.07

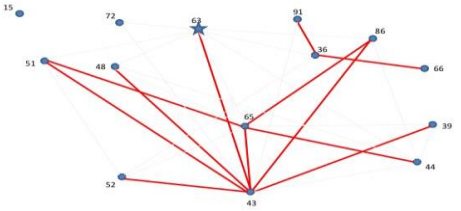
Group 4, duplex (Research and Teaching)



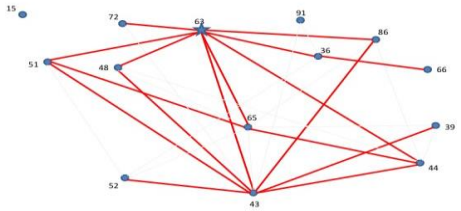
Group 4, duplex (Research and Social)



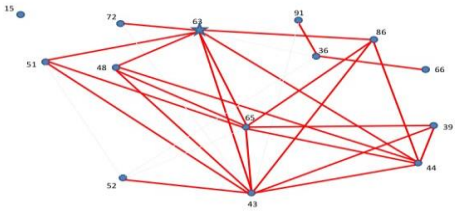
Group 4, duplex (Teaching and Social)



Group 4, Single layer network (Research)



Group 4, Single layer network (Teaching)



Group 4, Single layer network (Social)

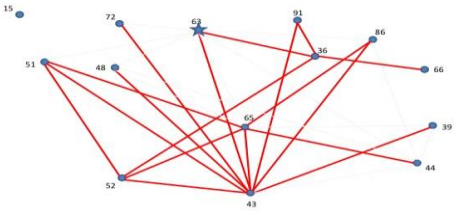
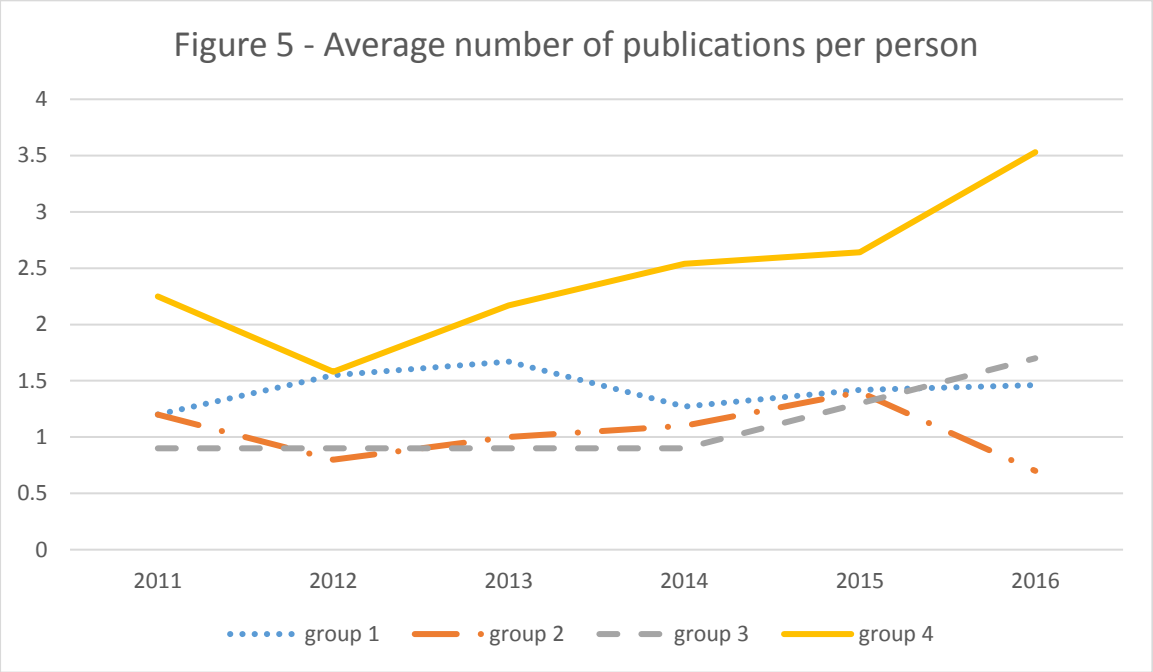


FIGURE 5: Average number of publications per person



[i] The REF is the research excellence framework which measures impact quality and quantity of publications and is a sector wide expert peer measure of performance.

[ii] The annual National Students Survey (NSS) measures student learning experiences and is a consumer measure of teaching performance

[iii] The categorisations for research and teaching followed the guidelines provided by The Transparent Approach to Costing, or TRAC, which is the method that is used for costing in UK higher education institutions.

[iv] A majority of institutions hold similar repositories of academic work. This meant that open access to the publications records of employees who had left the organisation was possible. In one instance an employee had moved to another institution where an open access repository was not available, in this case a list of relevant publications was compiled from their online social media profile (e.g. ResearchGate) and subsequently the academic was contacted to confirm this was an accurate list of publications.