



# Understanding the structure of school staff advice relations: An inferential social network perspective



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## ABSTRACT

Understanding the structure of staff advice relationships and the factors that facilitate (and hinder) the flow of resources within schools is key to school improvement. Our study examines school staff advice networks for supporting vulnerable learners using Exponential Random Graph Models (ERGMs). We investigate the individual and structural mechanisms that shape these networks in six secondary schools and find evidence for the importance of mutuality, clustering and individual similarities. Educators tend to ask for advice from those in formal leadership or support positions, although informal hierarchies are also present. The study contributes with a novel application of an inferential social network approach to study patterns of advice relations among teachers, support staff and formal leaders in schools.

## 1. Introduction

Supporting the learning and wellbeing of students who are at risk of academic failure is an important yet challenging part of educators' work. When school staff provide advice to each other, they can mobilize and exchange information, tacit knowledge, and resources (Goddard, Goddard, & Tschannen-Moran, 2007). Information diffusion and knowledge transference can, in turn, help them to improve their practice, overcome difficulties, and achieve their instructional goals (Bedward & Daniels, 2005; Chapman & Aspin, 2003; Vescio, Ross, & Adams, 2008). It follows that personal interactions that support teacher professional development and capacity building in schools around the issue of promoting the learning and wellbeing of vulnerable learners should play an important role in improving student outcomes and tackling educational inequality. Thus, understanding the mechanisms of these relational structures is of critical importance.

Yet, several reviewers of the literature on teacher advice relationships have noted that research has focused on the effects of teacher collaboration rather than on gaining insight into the phenomenon of teacher advice relationships itself, this is, the structure and antecedents of school staff advice networks and the conditions under which advice relations are most likely to occur (Siciliano, 2015; Spillane, Kim, & Frank, 2012; Vangrieken, Dochy, Raes, & Kyndt, 2015). Also, most previous studies have used general conceptualizations of professional advice network taking place in schools (this is, advice regarding all aspects involved in teaching), despite the fact that individuals are embedded in multiple, more specific and overlapping advice relations (Bridwell-Mitchell & Lant, 2014; Phelps, Heidl, & Wadhwa, 2012; Siciliano, 2017). To date, there is little empirical understanding of the patterns of practitioners' advice-seeking practices around the issue of supporting vulnerable learners. An in-depth investigation of these advice interactions may uncover important characteristics of the social structures that facilitate or impede efforts to support students.

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This study examines school professionals' advice-seeking patterns around the issue of supporting the learning and wellbeing of vulnerable learners in six English secondary schools, with a focus on the role of actor attributes (i.e. gender, teaching experience, formal role and subject taught similarity) and structural processes (i.e. reciprocity, clustering and hierarchy) on school staff advice tie formation. Vulnerable learners were defined as those students who fail to meet their attainment targets. This definition was proposed by the participant schools and is meaningful for the English context, where the school accountability system, at the time the study was conducted, was based on measures of students' expected academic progress. Moreover, unlike most previous studies on advice relations that focus either on teachers (e.g. [Bridwell-Mitchell & Cooc, 2016](#)) or on administrative staff (e.g. [Bridwell-Mitchell & Lant, 2014](#)), our definition of school staff integrates teaching staff and non-faculty members working with students in an educational role (e.g. pastoral support workers, the Headteacher and leadership team, Special Educational Needs Coordinators (SENCOs), etc.).

We used statistical network models known as exponential random graph models (ERGMs) ([Lusher, Koskinen, & Robins, 2013](#)), a method that, despite its potential for evaluating complex social structures in organizations, has been seldom applied in educational research ([Marion & Schreiber, 2016](#)). Thus, the study's contribution is twofold: Methodologically, we demonstrate a novel application of this inferential social network technique that expands recent research on practitioners' advice networks. Substantively, we provide new evidence on the antecedents of interpersonal advice and knowledge sharing, which can help schools deal with the critical challenge of ensuring that expertise and information travels from those within the school who possess it to those who need it. This is done by exploring an understudied type of advice tie (i.e., advice with regard to supporting vulnerable learners) and from a perspective that includes the relations among all school staff working in an educational role.

## 2. Conceptual framework

### 2.1. The importance and potential of educators working together

Research on the social organization of schooling can be traced back to the 1970's (e.g. [Meyer & Rowan, 1977](#); [Tyack, 1974](#)). This literature suggests that development of a collaborative structure can strengthen social capital in schools, change teacher practices and improve student performance (e.g. [Creese, Daniels & Norwich, 1997](#); [DuFour & Eaker, 1998](#); [Leana & Pil, 2006](#); [Louis & Marks, 1998](#); [Pil & Leana, 2009](#); [Sweet, 2019](#); [Yasumoto, Uekawa, & Bidwell, 2001](#)). Indeed, by improving individual collective efficacy in professional learning communities, school advice networks can enhance the quality of teaching ([Lomos, Hofman, & Bosker, 2011](#)), affecting student engagement, and, ultimately, student learning ([Moolenaar, Slegers, & Daly, 2012](#)), especially with regard to vulnerable children ([Leana, 2011](#)). Research has also shown that teacher collaboration and advice-seeking patterns can be modified when subject to intervention ([Coburn, Choi, & Mata, 2010](#); [Sun, Penuel, Frank, Gallagher, & Youngs, 2013](#); [Sweet, Thomas, & Junker, 2013](#); [Woodland & Mazur, 2018](#)). More specifically, previous studies have shown that interventions that involve teachers taking a collective responsibility for students' wellbeing and attainment, through collaboration that is focused on their students' learning, are effective in supporting the progress of vulnerable learners (e.g. [Bolam, McMahon, Stoll, Thomas, & Wallace, 2005](#); [Goddard et al., 2007](#); [Tourse & Sulick, 1999](#)).

As mentioned above, the literature has mainly paid attention to the consequences of teacher advice relationships. However, the patterns of advice networks in schools have been less systematically explored.

### 2.2. Researching school staff collaboration using Social Network Analysis (SNA)

Previous research has found that educators rely on peers to provide the resources and information needed to complete work tasks and implement policy ([Coburn, 2001](#); [Daly, 2010](#)) and that these relationships scale up to form intra-organizational knowledge sharing and advice networks ([Borgatti & Foster, 2003](#); [Lazega, Mounier, Snijders, & Tubaro, 2012](#)). Advice networks are, thus, the observable structure through which knowledge transfer and development occur ([Siciliano, 2017](#)).

Over the last two decades, research on school staff learning processes has turned to the analysis of informal collaborative practices and how these interactions can bring upon new knowledge, information, and resources to school communities. As noted by [Moolenaar \(2012\)](#), this trend has been supported by the development of Social Network Analysis (SNA), a technique used to quantify and analyse the ties and overall structures of relationships and interactions in organizations. This perspective goes beyond schools' formal roles and structures as it identifies and focuses on informal interactions between professionals, as shown in previous research on teacher support networks within schools and districts (e.g. [Daly, Moolenaar, Bolivar, & Burke, 2010](#); [Moolenaar, Daly, & Slegers, 2011](#); [Penuel, Riel, Krause, & Frank, 2009](#)).

This body of research suggests that schools can differ considerably in relation to their internal social network structures ([Bakkenes, De Brabander, & Imants, 1999](#); [Dorner, Spillane, & Pustejovsky, 2011](#)) and, more specifically, in the frequency of teacher interactions and their centralization around influential leaders ([Moolenaar, Daly, & Slegers, 2010](#); [Ortega, Thompson & Daniels, in press](#)). For example, [Daly et al. \(2010\)](#) found significant variance in teachers' social networks, both between and within schools. This is particularly important as access to resources, such as knowledge, expertise, information and support for effective teaching, has been found to be unevenly distributed within teacher networks ([Finnigan, 2010](#); [Kelchtermans, 2006](#)). Thus, the structure of teacher network relations can serve both to support and constrain opportunities for resources flow and creation.

While abundant research on teachers' advice-seeking networks has been carried out, particularly in the United States and the Netherlands, little is known about the English context where, to our knowledge, only one study has applied SNA to quantify teachers' professional relationships (i.e. [Brown, Daly, & Liou, 2016](#)). This previous study focused on general expertise-seeking behaviours of primary school teachers. To date, there is no research on staff collaboration at the secondary school level using SNA in England,

where the issue of supporting vulnerable learners is of particular relevance as failure to make expected progress is the primary point of school accountability (Leckie & Goldstein, 2017).

Furthermore, internationally, collaboration networks for supporting vulnerable learners, a key aspect of educators' work, have not been studied. As stressed by several authors (e.g. Phelps et al., 2012; Siciliano, 2017), there is value in the effort of disaggregating general conceptualizations of information and advice seeking into knowledge specific networks, such as advice networks with regard to supporting the learning and wellbeing of vulnerable learners.

Finally, to the best of our knowledge, only one previous study has explored of advice networks in schools using ERGMs (i.e. Siciliano, 2015), although that study considered only advice ties among teachers. Indeed, while previous research has addressed the role of school staff leadership, much of it took a "decoupling" perspective on social structures in schools between teaching and leadership. This study presents an integrated perspective.

### 2.3. The antecedents of school-staff advice relations

Robins and Lusher (2013) highlight two broad types of effects that have been shown to drive the structures observed in social networks. A first group of effects relate to the attributes of the individuals who compose the network. These variables capture the tendency for individuals with certain characteristics to be more likely to ask or to be asked for advice. A second type of effects, that can also influence the propensity for tie formation, is known as endogenous network effects or structural effects. These effects account for the fact that the likelihood of an advice tie forming between two particular individuals also depends on the social structure surrounding them. In this study, we explored both types of patterns, attribute-based and structural effects, on the likelihood of formation of advice-ties regarding support to vulnerable learners among school staff. The specific effects tested, and the hypotheses related to them, are presented below.

#### 2.3.1. Actor attribute effects

Advice-based social networks arise when individuals decide to look for help from their peers (Nebus, 2006). This decision may not solely be driven by a rational demand for information but can be influenced by certain traits of the available peers (Siciliano, 2015). In this study, we explore the effect of gender, experience, formal role, subject taught, and similarity on these characteristics, both as individual and dyadic factors that can influence advice tie formation.

**2.3.1.1. Gender.** As most research on teacher networks as been carried out in primary school settings, where the large majority of educators are females, the effect of gender has not been thoroughly studied. The studies that have included this effect suggest that female teachers are more likely to seek out others to discuss their work than male teachers (Moolenaar, 2010). Thus, we expect to find a similar trend in our data.

**Hypothesis 1 (H1).** Female educators are more likely to seek advice on supporting the learning and wellbeing of vulnerable learners than their male peers.

**2.3.1.2. Experience.** It seems logical to infer that, when teachers need advice, they turn to those in the organization with the most relevant experience, as those individuals are the most likely to solve their problem. Indeed, in schools, status signals may be driven by one's tenure in the organization and experienced educators are, thus, seem to be more popular when it comes to being asked for advice (Lazega et al., 2012; Nebus, 2006). However, not all previous studies support this claim. For example, Siciliano (2015) and Siciliano, Moolenaar, Daly, and Liou (2017) tested the effect of teacher experience and did not find effect for receivers of advice ties, indicating that teachers do not necessarily seek out more tenured co-workers for advice.

With regard to the experience of the teacher who seeks advice, there are opposing findings on how likely or unlikely experienced teachers are to seek information and knowledge from others. Moolenaar (2010) and Spillane et al. (2012) suggest that more experienced teachers are found to look for advice to a lesser extent than their less experienced colleagues. However, Siciliano (2015) finds a positive effect of teachers' years working in the district for senders, suggesting that teachers with more experience are more inclined to seek advice. While the literature in this area is inconclusive, we hypothesize that individual experience will have a positive effect on being sought for advice and a negative effect on seeking advice.

**Hypothesis 2 (H2).** School staff are more likely to seek advice on supporting the learning and wellbeing of vulnerable learners from peers who are more experienced in working in schools.

**Hypothesis 3 (H3).** School staff who are themselves more experienced, are less likely to seek advice on supporting the learning and wellbeing of vulnerable learners.

**2.3.1.3. Formal role.** It has been proposed that a school's pattern of interactions among staff is influenced by the way in which the school is formally organized (Penuel et al., 2010; Spillane, Hopkins, & Sweet, 2015). The formal organization of arrangements for peer support and leadership in schools can facilitate and provide the structure for staff to engage in collaborative work. In this line of research, studies have found that holding a formal leadership or peer support position, especially within a subject department, is associated with giving advice within schools (Berebitsky & Andrews-Larson, 2017; Spillane & Kim, 2012; Spillane et al., 2012, 2015). Therefore, we expect an overall tendency for school staff in high-status/leadership positions to be asked for advice regarding

vulnerable learners to a greater extent than their peers non-formally appointed as leaders.

**Hypothesis 4 (H4).** Individuals are more likely to seek advice from peers with high-status (leadership) or peer support positions rather than from those in instructional roles only.

**2.3.1.4. Homophily.** Advice seeking ties within schools may also take place as a result of the principle of homophily, which states that individuals tend to form relationships based on how similar they are (McPherson, Lovin, & Cook, 2001). The preference for similar others is due to basic psychological processes, and it is often accompanied with the perception that these others have positive characteristics (Tajfel, 1974). In terms of advice seeking, this may mean that similar others are perceived as more competent, reliable, or friendly and, thus, people are more likely to approach them.

Moreover, homophily in advice seeking can also be due to friendship or other personal ties being more likely due to similarity (in other words, friendship could act as mediator between similarity and advice-seeking behaviour). Evidence for homophily within educator networks has been found, for instance, with regard to age, gender, educational level, experience, ethnicity, grade level, subject matter, shared job duties and beliefs about teaching (e.g. Coburn et al., 2010; Daly et al., 2010; Penuel et al., 2009; Siciliano, 2015; Reagans, 2011; Spillane et al., 2012; 2015). Based on this literature, we hypothesize that educators will be more likely to form advice and ties with alike colleagues, in terms of relevant variables available in our data.<sup>1</sup>

**Hypothesis 5 (H5).** School staff are more likely to seek advice from peers with whom they share similar characteristics: those with the same gender (H5a), similar work experience (H5b), same formal role (H5c), or same subject group taught (H5d)

### 2.3.2. Structural effects

While individual teacher characteristics have an impact on advice seeking, studies find that many features of social network structure cannot be explained by such exogenous variables (Robins & Lusher, 2013). This is due to dependencies in social networks: ties form and dissolve partially based on other ties in the network. This creates specific arrangements of ties in which some configurations are more likely than others. This study looked at several common structural features found in advice networks in organizations. In particular, we look at indicators of reciprocity, clustering, and informal hierarchy.

**2.3.2.1. Reciprocity.** Advice-seeking ties are directional with a given actor  $i$  seeking advice from another actor  $j$ . Reciprocity expresses the tendency for advice seeking ties to be mutual: if  $i$  seeks advice from  $j$ ,  $j$  will also be likely to seek advice from  $i$ , independent of their individual characteristics. This is almost always found in social networks (Robins & Lusher, 2013). Reciprocity can be explained by social exchange theory (Emerson, 1976), which argues that social interactions and relations, such as giving advice, can be understood as investments, which are costly, and for which one expects rewards. Repeated advice may indeed require time, effort or psychological investment from the advice giver. When people are not satisfied with the balance between costs and returns, they may break up the relationship. Returns do not have to appear in the same form of the cost, but giving advice “back” is a straightforward way to reciprocate the favour – therefore, we can expect that many of the advice seeking ties will be reciprocal. In this regard, Agneessens and Wittek (2012) finds positive reciprocity effects in advice networks and Siciliano (2017) corroborates this structural effect in the case of teacher advice networks.

**Hypothesis 6 (H6).** Advice-seeking ties of school staff will tend to be reciprocated.

**2.3.2.2. Clustering.** Teachers’ relationships have been shown to be structured in subgroups within the overall pattern of teacher relationships in schools (Daly, 2010; Penuel et al., 2009). Indeed, closed triads are often found in similar social networks in educational contexts, such as teacher knowledge sharing (Siciliano, 2017), school student help (van Rijsewijk, Dijkstra, Pattiselanno, Steglich, & Veenstra, 2016) and graduate student advice (Snijders, Lomi, & Torló, 2013) networks. As a result of the formation of multiple overlapping triads, subgroups or cliques take place.

**Hypothesis 7 (H7).** Advice-seeking ties of school staff will tend to show clustering that cannot be explained by individual similarities.

**2.3.2.3. Hierarchy.** In social networks, certain individuals are typically more central than others. In advice-seeking networks, a large part of this can be explained by exogenous characteristics, such as formal roles or teaching experience. However, beyond such factors, schools may develop an informal hierarchy, when popularity of some actors does not necessarily come from their roles in the formal hierarchy. Indeed, previous research also suggests that schools’ formal hierarchical structures are not completely replicated in their informal (social network) structure. This is, the patterns of interactions among school staff are not necessarily aligned with the way in which the roles of Headteachers, support staff, and teachers are officially structured (Penuel et al., 2010; Spillane, Healey, & Kim, 2010).

<sup>1</sup> A related effect that has been shown to be important in school social network processes is that of propinquity (e.g., Spillane, Shirrell, & Sweet, 2017; Reagans, 2011). However, in this study physical proximity information was not collected and, thus, the role of propinquity could not be directly explored.

Beyond exogenously given characteristics, structural processes also contribute to the development of hierarchical differences in social networks. In certain cases, “giving advice” may become an informal role itself: educators who are especially sought after for advice may keep on attracting more advice seekers over time (Rivera, Soderstrom, & Uzzi, 2010). For instance, one teacher giving advice to a few others might signal to their peers that the individual is the best source of information or knowledge. This process, where popular individuals in a network continue to grow in popularity, is known as preferential attachment or the Matthew effect (Merton, 1986). Empirical evidence regarding tendency toward centralized teacher advice networks has been inconclusive, with studies in primary school settings finding non-significant centralization effects (e.g. Siciliano, 2015, 2017). We expect secondary schools, which are generally larger and more complex organizations, to have a more hierarchical and specialized distribution of expertise that would lead to higher in-degree centralization.

**Hypothesis 8 (H8).** Advice-seeking ties of school staff will tend to form hierarchical structures that cannot be explained by formal roles.

In the following section, we describe the methods used to investigate the nature of school staff advice-seeking relationships.

### 3. Methods

#### 3.1. Sample

Data collection was conducted in the academic year 2014-15 in six state secondary schools located at an ethnically mixed small city in the South-East region of England with wide disparities between areas of wealth and poverty. The participant schools, recruited via convenience sampling, reflected the local diversity as they differed in terms of overall levels of academic performance and served communities with different deprivation levels.

Table 1 provides demographic data, such as size, attainment, attendance and deprivation indicators, for the sample schools, according to official statistics from the UK Department for Education. As shown in the table, there is clear variation within the sample, with schools deviating from the county average in both directions for most of the indicators.

#### 3.2. Measures

The study examined advice-seeking patterns among school staff, in relation to addressing the needs of vulnerable learners, using a social network approach to data gathering and analysis, which provides a valuable detailed picture of the structure of their advice-seeking interactions.

Quantitative survey data were collected to portray school advice networks. To this end, an on-line questionnaire was administered to 484 professionals working in the six participant schools. A very satisfactory average response rate of 90 %, with a range of 81–98%, was obtained, although the response rates for network items were lower, ranging from 67 to 92 %. As it is explained below, this issue was addressed by using data reconstruction techniques. Table 2 provides the overall school staff demographics, which are somewhat consistent across schools.

##### 3.2.1. Advice-seeking interactions regarding vulnerable learners

We examined whole school staff networks using a roster method. Network boundaries were defined to include all members of staff who worked with students in an educational role. This included teachers but also pastoral support workers, the Headteacher and leadership team, Special Educational Needs Coordinators (SENCOs), etc.

Participants were asked to identify the colleagues that they had turned to for advice or information on supporting vulnerable learners in their learning or wellbeing over the last school year. Respondents were able to nominate from none to up to five colleagues.<sup>2</sup> The inverse question, that is, “who had turned to them for advice or information on supporting vulnerable learners”, was also asked in order to symmetrize and reconstruct data.<sup>3</sup>

Vulnerable learners were defined, in the questionnaire, as those students who fail to meet their attainment targets. This definition was proposed by the participant schools and is meaningful for the English context, where the school accountability system, at the time the study was conducted, was based on measures of student expected academic progress.

Indeed, during the period under study, and since 2011, the UK Government school accountability system had, as its headline indicator of school performance in England, the Expected Progress (EP) score. The Department for Education (DfE) reported EP separately for English language and mathematics, and the indicator was calculated as the percentage of pupils in each school who ‘make the progress expected of them’ during secondary schooling, defined for all pupils as three (or more) national curriculum levels.<sup>4</sup> Nationally, 72 % of pupils made EP in English in 2014, while 66 % made EP in mathematics (DfE [Department for Education],

<sup>2</sup> 23% of the participants nominated 5 colleagues, the maximum number of colleagues that was possible to nominate in the survey.

<sup>3</sup> The former technique consists of calculating a summary statistic (the mean in this case) when answers from pairs of respondents were discordant, and the latter is used to impute missing values if only one of the two sides of the relationship responded (Borgatti, Everett, & Johnson, 2013). Traditional techniques available to correct for survey non-response in standard sampling designs are not appropriate for network data and, thus, the specialized literature favours data reconstruction (Kossinets, 2006; Stork & Richards, 1992).

<sup>4</sup> In 2016, EP was replaced by the Progress 8 indicator. See Leckie and Goldstein (2017) for more details on the evolution of, and debate around,

**Table 1**  
Demographics of the sample schools.  
Source: The National School Census, Department for Education (DfE), UK Government, 2014 (DfE [Department for Education], 2015).

School	Total number of children	Percentage of students with Special Educational Need statement or on School Action Plus	Percentage of students with English not as first language	Percentage of students eligible for Free School Meals (FSM) at any time during the past 6 years up to 2014	Percentage achieving 5+ A*-C GCSEs <sup>a</sup> (or equivalent) including English and maths GCSEs	Percentage of students making Expected Progress in English language	Percentage of students making Expected Progress in mathematics	Persistent absence (around 15% +)	Ratio of students to teachers	Index of Multiple Deprivation (IMD) Rank 2015 <sup>b</sup>
A	1 071	7.8	9.2	15.1	73	85	87	7.0	17.4	32 264
B	1 257	9.5	41.8	32.1	47	69	55	10.8	14.7	8 387
C	1 387	11.2	31.9	35.0	59	73	74	7.8	12.1	19 331
D	1 003	14.4	4.5	22.9	46	48	76	7.9	16.1	22 895
E	739	11.1	52.2	46.6	58	80	65	4.2	16.5	12 109
F	1 867	7.9	22.4	20.2	72	86	84	5.8	16.0	29 663
Sample average	1 220.7	10.3	27.0	28.7	59.2	73.5	73.5	7.3	15.5	20 775
County average <sup>c</sup>	934.7	15.4	10.2	20.9	59.5	72.0	66.0	7.0	14.9	23 664

<sup>a</sup> General Certificates of Secondary Education (GCSE), national examinations normally sat at age 16.

<sup>b</sup> The Index of Multiple Deprivation (IMD) combines a number of indicators, chosen to cover a range of economic, social and housing issues, into a single deprivation score for each small area in England. This allows areas to be ranked relative to one another according to their level of deprivation, where 1 is most deprived.

<sup>c</sup> County average for maintained and academy secondary schools (including free schools) 2014. Figures exclude independent and special schools.

**Table 2**

Demographics of the sample school staff.

Source: On-line questionnaire,  $n = 484$ .

School	Number of participants	Percentage female	Years at the school	Years working in schools	Percentage working full-time in school
A	66	70.0	6.9	12.7	80.3
B	84	64.0	5.9	10.5	84.3
C	92	59.3	4.6	8.7	81.3
D	61	60.0	5.5	11.0	77.0
E	58	55.9	7.8	12.9	75.9
F	123	66.9	7.1	11.4	74.4
Sample average	81	63.2	6.3	11.0	78.8

2015). Table 1 shows the EP made for each participant school in 2014. The EP made in English by the schools in our sample ranged from 48 to 86 %, and in mathematics ranged from 55 to 87 %, showing a wide range of performances. Schools and teachers received official data on the progress made by each student and, therefore, it is reasonable to assume that they were able to consistently identify vulnerable learners (i.e., students not meeting their expected progress) when prompted in the questionnaire.

This broad definition of vulnerable learners was intentional, as it allows us to capture the populations identified as vulnerable in each school, regardless of their specific background. For example, in the UK, male pupils, older pupils, pupils with FSM eligibility, pupils in care, pupils with a special educational needs (SEN) statement, mobile pupils and pupils living in deprived neighbourhoods all show lower achievement than their otherwise equal peers (DfE [Department for Education], 2015). Thus, by defining vulnerable learners flexibly, according to an outcome (i.e. not meeting expected progress) we are able to obtain a measure that is sensible to each school's reality.

### 3.3. Social network data analysis

Analysing social networks within communities raises a number of methodological challenges. Most importantly, standard statistical techniques including linear or logistic regression models assume that observations are independent. This assumption does not hold for social networks; therefore, using standard techniques would lead to biased results. Hypothesis testing with network data requires an approach that takes potential types of network dependencies such as reciprocation of directed ties, homophily, transitivity, degree differentials and local hierarchies (Robins, Pattison, Kalish, L, & usher, 2007).

In this study, inferential analysis was conducted by applying Exponential Random Graph Models (ERGMs) to depict the structure of school staff advice networks and the individual characteristics that shape these networks. ERGMs are a family of statistical models for analysing cross-sectional social network data (Lusher et al., 2013). The dependent variable in ERGMs is a binary tie variable, i.e., the presence or absence of a tie from actor  $i$  to actor  $j$ . Presence of a tie is denoted by  $i \rightarrow j$ , and the tie variable takes the value 1 or 0, respectively. The network is constituted by the tie variables, represented by an  $n \times n$  adjacency matrix, where  $n$  stands for the total number of actors. Under this approach we estimate the probability that a tie exists, and this probability is a function of structural network parameters (e.g. reciprocity), actor attributes (e.g. gender) or dyadic attributes (e.g. same gender).

In the first step, analyses were run separately for each school with the aim of finding a common model specification for the 6 schools to allow us to answer our research questions and capture the networks' structure. We followed this approach as, for testing and developing explanatory theories about social networks, it is desirable to use data about several networks (Snijders, 2011). Step-by-step model building was performed, informed by goodness of fit (GOF) indicators.

Once we obtained a converged and well-fitting model for each school, in the next step we applied meta-analysis: we analysed the school-level results together to study the general tendencies. The statistical assumption of the meta-analysis is that individual networks are sampled from a common population. Using the method proposed by Snijders and Baerveldt (2003), we used estimated parameters and standard errors of the school-level models and tested whether the values for a given parameter, averaged over the population, differed significantly from 0. This way, we tested whether the results indicated some general tendency. We conducted the meta-analysis for each parameter separately, estimating and testing both the mean and the variance of the parameters in the population. For the meta-analysis, the R-package 'metafor' (Viechtbauer, 2010) was used.

#### 3.3.1. Staff characteristics effects

The online questionnaire administered to the schools asked participants about their gender (coded 0 if male, and 1 if female), the number of years working in schools, their roles in the school (which were grouped into the categories Leadership and other managerial roles, Instructional/Wellbeing support staff, and Classroom teacher only)<sup>5</sup> and the main subject that they taught (which were grouped into the categories Arts, English, IT, Mathematics, Physical education, Sciences, Social Sciences, and Does not teach/Subject

(footnote continued)

'school league tables' in England.

<sup>5</sup> Some examples of positions in the "Leadership and other managerial roles" are Headteachers, Deputy Heads, Assistant Heads and Examination Coordinators. Examples of positions in the "Instructional/Wellbeing support staff" are Department Heads or Leaders, Special Educational Needs Coordinators, Heads of House and Heads of Year/Key Stage.

**Table 3**  
Structural network parameters included in the advice-seeking model.

	Parameter Name	Name in Tables	Description	Illustration
(1)	Arc (Intercept)	<i>arc</i>	Occurrence of nominations	
(16)	Reciprocity	<i>reciprocity</i>	Occurrence of mutual ties	
(17)	Reciprocity within same role	<i>interaction- reciprocity: role</i>	Occurrence of mutual ties when sharing role	
(18)	Reciprocation by leaders	<i>activity-reciprocity: leader</i>	Occurrence of mutual ties received by leaders	
(19)	Reciprocation by support staff	<i>activity-reciprocity: support</i>	Occurrence of mutual ties received by support	
(20)	Reciprocity within subject group	<i>interaction-reciprocity: subject</i>	Occurrence of mutual ties when sharing subject	
(21)	Transitivity (path closure)	<i>AT-T</i>	Transitive closure of two-paths	
(22)	Cyclicity (cyclic closure)	<i>AT-C</i>	Cyclic closure of two-paths	
(23)	Two-path (simple connectivity)	<i>2-path</i>	Occurrence of paths connecting three actors	
(24)	Popularity spread (in-degree distribution)	<i>A-in-S</i>	Dispersion of in-ties distribution	
(25)	No ties received (in-isolates)	<i>Source</i>	Occurrence of actors with zero in-degree	
(26)	Two-instar	<i>In2star</i>	Occurrence of two actors nominating the same third actor	
(27)	Activity spread (out-degree distribution)	<i>A-out-S</i>	Dispersion of out-ties distribution	
(28)	No ties sent (out-isolates)	<i>Sink</i>	Occurrence of actors with zero out-degree	

not specified).

For gender and years working in schools, effects based on self-declared attribute were used: (2) gender of the sender, (3) gender of the receiver, (4) gender interaction, (5) years working in schools of the sender, (6) years working in schools of the receiver, and (7) absolute difference in years working in schools. Gender and number of years working in schools effects were included as non-centered node covariate effects in the models.

For role in the school, the following effects based on three categories (teachers only was used as reference category) were included: (8) sender in leadership category, (9) receiver in leadership category, (10) sender in support category, (11) receiver in support category, (12) same role, (13) same role: additional effect for leaders, (14) same role: additional effect for support staff.

For subject taught, the effect of (15) teaching the same subject was added. As control variables, we included a sender and a receiver effect for each subject group in order to capture that educators who teach certain subjects may be more popular or more active in the advice-seeking network. In total, this means the inclusion of 16 subject dummies for 8 subjects (SD1-SD16).

### 3.3.2. Structural effects

The structural effects included in the model are summarized in Table 3. The majority of the effects are standard network effects expressing our hypotheses 6–8, or reflecting well-known structural tendencies (Lusher et al., 2013). Some additional effects were added based on GOF statistics showing that some aspects of the network were not properly captured by our original model specification. First, the model captured the in-degree distribution relatively poorly. Therefore, following the suggestions of Lusher et al. (2013), we added an additional effect that captures the in-degree distribution (25) accounting for this. This effect, however, caused divergence in one school, therefore, it was removed from the final model for that school. Further, reciprocity appears to have a different importance when crossing boundaries of subjects taught and formal roles. Thus, we added four interaction effects (16–19) to capture this. Finally, homophily in subject taught seemed to be different for some subjects in some schools. For the respective schools, we added further variables to capture this: this did not change the estimates for the rest of the parameters, therefore, these variables are not included in the final (common) model specification.

For this article, we first calculate a series of network measures and draw sociograms using the R ‘igraph’ package (Csardi & Nepusz, 2006). Then, we estimate ERGMs using MPNet (Wang, Robins, Pattison, & Koskinen, 2014) with the single-level (or one-mode network) option.

## 4. Results

### 4.1. Descriptive results

First, we provide descriptive statistics about the six schools, each of which was treated as one network. The number of staff members per school ranged from 59 to 136. The density coefficients, shown in Table 4, suggest that the six networks are quite sparse. The average density of the networks in the participant schools was .05, indicating that, on average, staff were connected to only 5 % of their colleagues with respect to seeking advice on supporting vulnerable learners. If we look at the number of colleagues nominated



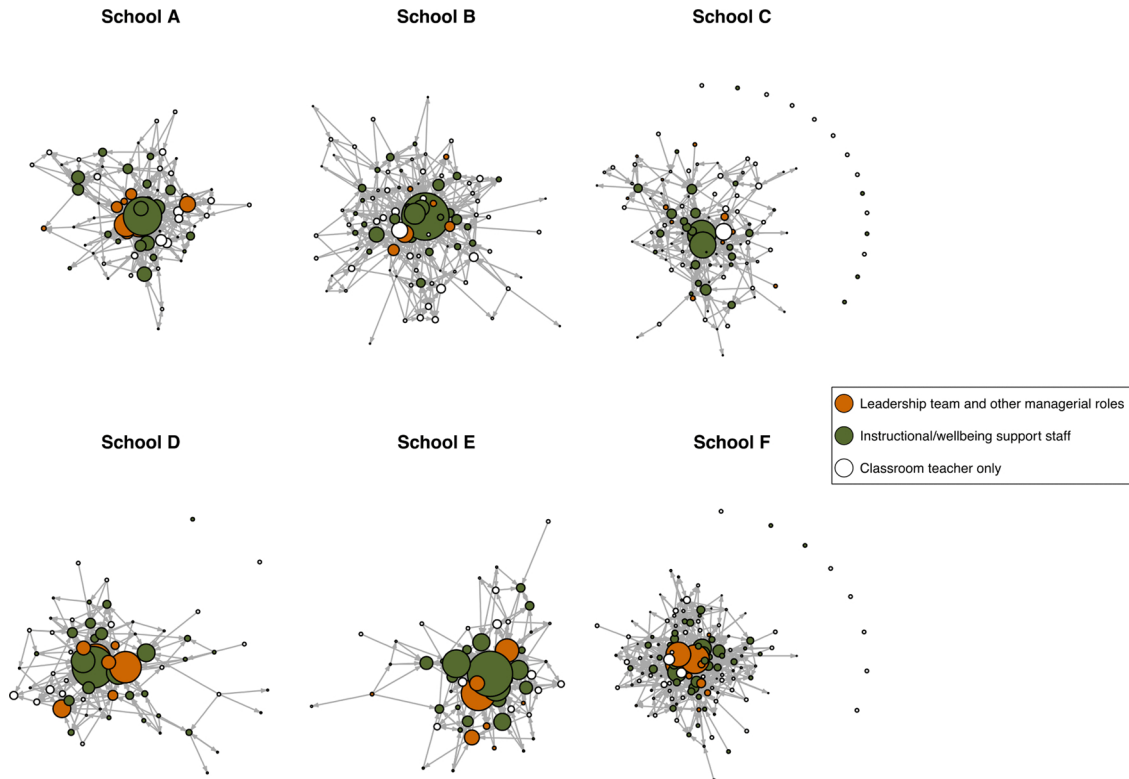
**Table 4**  
Summary of network statistics.

School	Network Size	General Response Rate	Network Items Response Rate	Average Number of Nominated Colleagues	Density	Reciprocity	Centralization	Clustering
A	70	0.94	0.91	3.50	0.06	0.31	0.28	0.25
B	100	0.84	0.81	3.33	0.04	0.25	0.34	0.22
C	114	0.81	0.67	2.25	0.02	0.24	0.19	0.19
D	65	0.94	0.89	2.61	0.05	0.20	0.28	0.24
E	59	0.98	0.92	2.95	0.07	0.35	0.29	0.23
F	136	0.90	0.80	3.13	0.03	0.26	0.18	0.18
Sample average	91	0.90	0.83	2.96	0.05	0.27	0.26	0.22

by the participants, we can see that, on average, participants nominated 2.96 colleagues. Using the Kruskal-Wallis test we found that the participant schools differed significantly in relation to the number of colleagues they went to for advice on supporting the learning and wellbeing of vulnerable learners ( $H(5) = 30.30, p < .001$ ). As shown in Table 4, the networks also seem to differ somewhat in relation to reciprocity, centralization, and clustering of interactions. Some of these features are also evident in the visual inspection of the sociograms shown in Fig. 1.

Table 5 shows descriptive statistics on advice-seeking ties by actors' gender, years working in schools, role group and subject taught. There was little difference between the average incoming nominations of male and female staff, although female staff received slightly more ties and nominated more. Also, more experienced teachers sent somewhat less nominations, but received substantively more nominations, than their less experienced peers. With regard to role groups, the descriptive analysis suggests that staff that are classroom teachers are similar to leadership and support staff in terms of activity (nominating) but less popular (receiving less ties) than staff in support roles. Staff in leadership positions, in turn, seem to be more popular than teachers and staff in support roles. There were also some marked differences with regard to activity and popularity by group of subject taught, with the groups of staff teaching English, Social Sciences and not teaching receiving more ties than staff teaching ICT, mathematics and Modern Foreign Languages. The groups of staff teaching English, Mathematics and Social Sciences, were sending more ties staff teaching ICT, Physical Education and not teaching.

The findings regarding in-degree centrality by role group are represented graphically in Fig. 1. Here, node size is weighted by in-



**Fig. 1.** Advice-seeking networks in participant schools (node size weighted by in-degree centrality of the actor and node colour represents the actor's role in the school).

**Table 5**  
Average degrees by actor attributes.

In-degree		Out-degree	
<b>Gender</b>			
Male	Female	Male	Female
4.62	4.80	3.61	3.79
<b>Years teaching in schools</b>			
< 10	> = 10	< 10	> = 10
3.66	5.59	3.81	3.65
<b>Role groups</b>			
Classroom teacher only	Support staff	Classroom teacher only	Support staff
2.67	5.68	3.62	3.85
<b>Subject taught groups</b>			
Arts	English	Arts	English
4.00	6.35	3.62	4.01
ICT	Mathematics	ICT	Mathematics
3.11	3.46	2.77	4.00
PE	MFL	PE	MFL
4.84	3.60	3.20	3.67
Sciences	Sciences	Sciences	Sciences
3.89	5.12	4.26	4.26
Does not teach/Subject not specified	Leadership staff	Does not teach/Subject not specified	Leadership staff
6.28	8.18	2.78	3.73

Notes: ICT = Information and Communication Technology; MFL = Modern Foreign Languages; PE = Physical Education.

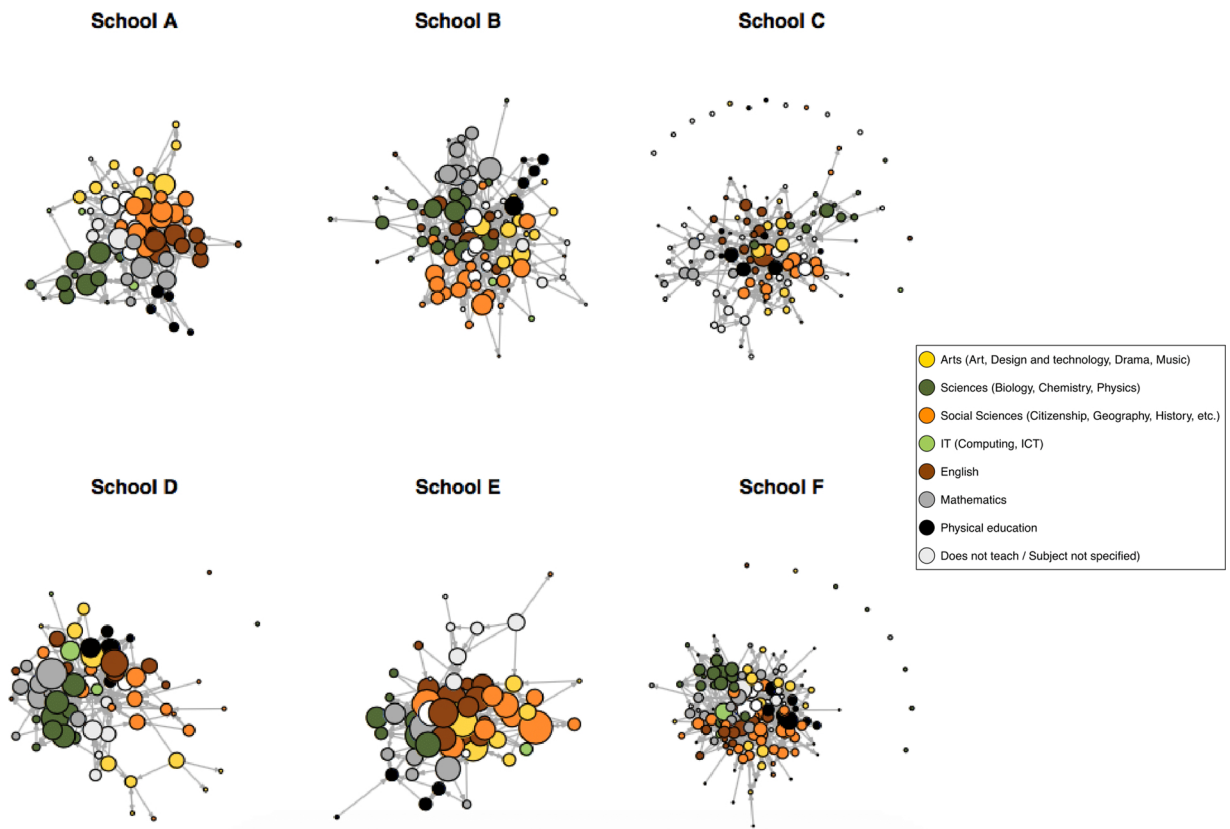


Fig. 2. Advice-seeking networks in participant schools (node size weighted by out-degree centrality of the actor node and colour represents subject taught grouping).

degree centrality of the actor and node colour represents the actor's role group. From visual inspection, it is possible to observe that those members of staff that show higher in-degree centrality are usually part of the leadership team (e.g. head teachers) or are support staff (e.g. Special Educational Needs Coordinators, SENCOs). With some exceptions, formally appointed support staff seem to play the intended central advisory function and are usually situated in a central position in their schools' advice network.

In addition, Fig. 2 depicts the advice-seeking networks with node size weighted by out-degree centrality of the actor node colour representing the actor's subject taught group. These sociograms confirm that some subject groups are more active in seeking advice and that teachers tend to look within their department for advice and information on supporting vulnerable learners.

#### 4.2. ERGM results

After having described the six networks, this section focuses on the results of the exponential random graph models, which jointly model the effect of network dependencies and node-level characteristics. Table 6 presents the results of the meta-analysis of the six school-level models. The estimates shown can be interpreted similarly to conditional log odds ratios in logistic regression models. We also indicate whether the parameter is similar across schools by presenting results of Q-tests for heterogeneity: + means that school-level results show significant differences, while - means no significant differences along the given parameter. This is important; while the *p*-value from the meta-analysis shows whether or not a given parameter is significant in our whole sample, the Q-test shows whether it is the same parameter value that best describes each network. More information on the results, including those on the subject sender and receiver dummies, is presented in the Appendix (Table A1). In Table A1, we also present the number of individual schools for which the given parameter was significant: this is yet another attribute to look at when assessing homogeneity or heterogeneity of processes.

We sorted the variables into three categories: background characteristics, formal roles and endogenous structural effects. The variables set in *italic* are interaction effects that should be interpreted in addition to their main effect.

The first hypothesis (H1) proposed that female educators are more likely to seek advice than their male peers. This is directly modelled by the Sender female effect, which is negative and not significant. Therefore, we find no support for the first hypothesis. According to the second and third hypotheses, we expected that those with more experience are asked for advice more (H2) and ask for advice less (H3) than those with less experience. These tendencies are modelled by the receiver's and sender's work experience variables, respectively. The receiver's experience variable is positive and significant, while the sender's experience is negative and

**Table 6**  
Summary of ERGM results for advice ties.

		Estimate	SE	Sig.	Heterogeneity
1	Arc (Intercept)	-6.152	0.743	***	+
<b>Background characteristics</b>					
2	Sender is female	-0.133	0.102		-
3	Receiver is female	-0.199	0.075	**	-
4	Both are female (interaction)	0.223	0.153		+
5	Sender's work experience	-0.012	0.006	*	-
6	Receiver's work experience	0.013	0.006	*	+
7	Difference in work experience	-0.005	0.004		-
<b>Formal roles</b>					
8	Sender: leader	-0.023	0.190		-
9	Receiver: leader	1.436	0.156	***	-
10	Sender: support	1.052	0.173	***	-
11	Receiver: support	2.154	0.170	***	-
12	Same role	1.634	0.186	***	-
13	Same role: leader	-0.189	0.440		+
14	Same role: support	-2.661	0.267	***	-
15	Same subject group	1.987	0.113	***	+
<b>Endogenous structural effects</b>					
16	Reciprocity	5.039	0.555	***	+
17	Reciprocity within same role	-1.518	0.350	***	-
18	Reciprocation by leaders	-1.264	0.390	**	+
19	Reciprocation by support	-1.511	0.370	***	-
20	Reciprocity within subject group	-1.954	0.197	***	-
21	Transitivity	0.616	0.093	***	+
22	Cyclicity	-0.118	0.060	*	+
23	Two-path	-0.029	0.007	***	-
24	Popularity spread	0.687	0.249	**	+
25	No ties received	-0.779	0.485		+
26	Two-instar	0.048	0.008	***	+
27	Activity spread	-0.562	0.245	*	+
28	No ties sent	1.484	0.645	*	+

Note: Estimated parameters; estimated standard errors; *p*-values for statistical significance based on estimates and standard errors (\*\*\* < 0.001 < \*\* < 0.01 < \* < 0.05); heterogeneity of parameter among schools based on Q-test (+ : significant heterogeneity, - : no significant heterogeneity).

significant, confirming both H2 and H3. Of these, the parameter for the receiver's work experience shows a significant variation between groups, while that for the senders' work experience does not.

In terms of formal positions, the fourth hypothesis posited that those in leadership or support positions will be more likely to be asked for advice by their colleagues. These are expressed by the receiver: leader and receiver: support variables. These are both positive and significant; therefore, we find evidence for H4. The parameters show homogeneity across groups.

H5, which included sub-hypotheses 5a to 5d, predicted homophily: individuals are more likely to turn for advice to those who are similar to them in terms of gender, work experience, subject taught and formal role than to those who are different in these regards. For gender homophily, male-male nomination is the reference category: the sender and receiver female variables show that female-male and male-female nominations are both less likely. However, the interaction effect was positive; the sum of the three effects ( $\beta = -0.133 - 0.199 + 0.223 = -0.109$ ), expressing female-female nominations, shows that these are still less likely than the male-male case, but are more likely than nominations between genders. This is evidence for gender homophily, and confirms H5a. In terms of work experience, the negative parameter shows that difference between two individuals leads to lower likelihoods for advice; but this is not significant. There is no evidence for homophily in work experience and, therefore, H5b is not supported. In terms of formal roles, individuals having the same role also had a strong and significant effect. This effect, however, was lower for leaders ( $\beta = 1.634 - 0.189 = 1.445$ ), and was negative for members of the support staff ( $\beta = 1.634 - 2.661 = -1.027$ ). Therefore, as expressed in H5c, we found support for homophily among those who are teachers only (the reference category here) and a slightly weaker homophily among leaders, but heterophily for members of the support staff. Further, the parameter for teaching the same subject was positive and significant, confirming homophily in subject taught, as expressed in H5d. All in all, we found evidence for Hypothesis 5 along all dimensions examined, except for formal role homophily among support staff and work experience homophily. The significant homophily interaction parameters seem to be homogeneous across groups.

In terms of network structure, we had three additional hypotheses. H6 proposed that advice-seeking relations are reciprocated rather than one-sided. Indeed, the reciprocity parameter was strong, positive and significant, confirming H6. There are cases, however, when weaker tendencies of reciprocity were observed, as shown by the interaction effects 17-20. Between those with the same role or those teaching the same subject, in general, less reciprocity was present.<sup>6</sup> Interestingly, the main reciprocity parameter

<sup>6</sup> At the same time, both leaders and members of the support team were found to reciprocate their advice ties less than teachers. This may be partly

itself shows significant variation across groups.

Based on H7, we expected advice-seeking relationships to show clustering which cannot be explained by individual similarities discussed above. This is shown by the transitivity parameter: if  $i$  asks  $j$  for advice and  $j$  asks  $h$ ,  $i$  will also ask  $h$ . This was again positive and significant, providing evidence for this hypothesis. The cyclicity variable, however, showed a negative tendency for a different type of closure: if  $i$  asks  $j$  for advice, and  $j$  asks  $h$ , it is unlikely that  $h$  will turn to  $i$ . This can be interpreted as a tie from  $i$  to  $h$ , found as likely by the transitivity effect, would be nominating “up”, and one from  $h$  to  $i$ , found as unlikely by the cyclicity effect, as nominating “down”, providing evidence for hierarchy beyond the evidence for clustering (predicted by H8). Both the transitivity and the cyclicity parameters show significant variation across groups.

Besides cyclic closure, other variables may also be interpreted in terms of hierarchy and are therefore relevant to test H8, which posited that advice-seeking happens embedded in relations of informal hierarchy. The two-path variable was negative and significant (and homogenous across groups), which means that those who were more popular sources of advice were less likely to seek advice from others. Moreover, actors have varying levels of popularity. The popularity spread distribution variable was positive and significant, which means that actors showed large differences in their incoming nominations (conditional on other variables in the model). The two-instar variable, which was added to the model for goodness-of-fit improvement, expresses the distribution of actors' popularity in a slightly different way (see Table 3). This effect was also significant and positive, pointing towards the same conclusion. We also focused on network in-isolates in particular, that is, we tested whether more people than expected by chance (and other variables in the model) are asked by none of their peers for advice. However, we do not find evidence for this trend.<sup>7</sup> With the exception of the two-path variable, parameters testing the mechanisms mentioned in this paragraph all show heterogeneity between schools.

In general, we find that endogenous network variables are more likely to show variation between the six schools than the ones based on individual attributes, even when the meta-analysis shows significant associations between them and the presence of advice ties between school staff. This shows that network structure can develop many individual variations in different communities, even when the general tendencies are similar across communities.

## 5. Discussion

The main aim of this study was to explore the specific nature of school staff advice-seeking networks in relation to supporting the needs of vulnerable learners. To this end, we used an inferential social network approach that shed light on the micro-processes that drive these social interactions by examining the effect of several attribute based and structural processes on the formation of advice ties.

The findings arising from our sample of six English secondary schools suggest that both individual and structural variables shape networks of advice. In line with previous research (Siciliano, 2015, 2017), we found that individual similarities, reciprocity and clustering have an important role in educators' advice relationships. These may be related to dyadic friendships or friendship groups within schools (such networks are, unfortunately, not part of this data set). At the same time, advice is often asked from those who teach the same subject (i.e. peers within the same school department) or from those with certain formal roles in the school (leaders and members of the support staff). This suggests that the structure of the advice-seeking network matches, to some extent, the formal structures of school organization. Interestingly, reciprocity appears weaker in cases when advice seeking closely follows institutional lines: it seems as advice may stem from personal relationships, or may be asked from specific people who are more prepared to help. Besides the formal hierarchy, though, advice seeking ties seem to show tendencies of informal hierarchy: certain individuals appear as popular sources of advice, while some are asked much less, or even never, by others. This tendency is found in all schools examined, and independent of formal roles and individual characteristics.

### 5.1. Limitations

With regard to the limitations of our study, it should be noted that these conclusions cannot be generalized to all types of schools nor to all types of school staff advice relationships. Furthermore, this project was informed by literature that highlights the importance of structures of advice and collaboration between teachers in enhancing the quality of teaching in schools and outcomes for vulnerable learners; however, it was not possible to directly connect staff advice interactions to student, teachers and school outcomes. An important avenue for future research would be to investigate whether schools that present stronger advice networks have a

(footnote continued)

because of the limitations in possible nominations. As shown in Table 5, leaders and members of the support team have, on average, an in-degree that is higher than five and, since they cannot nominate more than five colleagues, it appears as if they were not reciprocating all their incoming ties.

<sup>7</sup> We also have a few other variables in the model about which we did not have hypotheses. The Arc effect serves as an intercept in the model: this shows how likely a tie is when all parameters are 0. This is strongly negative and significant, which is not surprising given that individuals were only able to name five contacts and, thus, they had dozens of colleagues they did not report. In terms of individual roles, the leader and support sender effects show respectively that leaders do not ask for significantly more or less advice than the reference category (that is, teachers), but members of the support staff ask for significantly more advice. In terms of structure, the model also takes endogenous differences in advice seeking into account. The activity spread variable is negative and significant, showing that people tend to send similar numbers of ties, everything else being equal in the model. This may be related to the fact, though, that the number of nominations was limited to 5 for everyone. The no-ties-sent variable is significant and positive, showing that controlling for this similarity, the number of people who do not ask for advice from anyone is overrepresented.

more positive impact on the learning and wellbeing of vulnerable learners.

Another limitation of the study is that we were not able to include the effect of other relationship dimensions – in particular, friendships – on advice ties, which have been found important in previous studies (Lazega & Pattison, 1999; Siciliano, 2015). Moreover, while we considered several individual-level variables, different ways of including them in our models be desirable: for instance, ego's and alter's teaching experience may not have a diminishing effect on advice seeking, one extra year of experience counting more at the beginning of one's career than later. Future studies could investigate this. In addition, this analysis was cross-sectional, only capturing a snapshot of these school staff networks. While this cross-sectional step is very important, because it shows the likelihood of the presence of relationships among staff, it would be interesting to investigate the factors predicting relationship changes among staff for a more detailed picture.

Finally, in the analyses presented, advice ties were treated as binary (this is, either present or absent). However, recent generalizations of the ERGM framework allow the modelling of weighted edges (Krivitsky, 2012; Wilson et al., 2017). Future studies that incorporate information on valued ties representing, for example, frequency or impact of advice-seeking relations, could provide important insights and further advance our understanding of the structure of school staff advice networks.

## 6. Conclusion

The study advances the field as there are very few studies that examine the social networks of school staff in the UK and, to the best of our knowledge, none that explore teacher advice-seeking networks in relation to supporting vulnerable learners, internationally. Furthermore, most of the existent literature provides evidence on primary school settings, and very few examine school staff networks in secondary schools. Finally, while most previous research has generally focused on teachers or staff in leadership positions separately, this study includes all members of staff who worked with students in an educational role.

A substantive conclusion from this multi-school network study is that the actions of school staff are neither independent responses to the needs of vulnerable learners nor simple consequence of individual information needs, but rather are developed and shaped by specific features of the social structure in which the educators are embedded, and more specifically, they are affected by personal attributes and structural processes. This has important implications for policy makers when planning school-level interventions: not only formal managers but also informal leaders have opportunities to influence others around them.

Indeed, the results of the study highlight the importance of studying and strengthening informal advice patterns as a complementary strategy to the formal arrangements that can be put in place to support teaching and learning. The educational implications of this study are that policy makers, school leadership teams and practitioners should pay attention to providing the conditions for strengthening advice networks that involve staff at all levels in the school.

Finally, the analytical strategy in this study can be replicated to support educators' work towards vulnerable learners. A detailed analysis of patterns of collaboration within schools can inform the design and implementation of teacher support programs, with the aim of ultimately improving the educational outcomes of students who struggle to meet their expected progress. Relevant information on the social structure of a school can prove useful as these patterns of interactions can be managed in support of, for example, novice teachers or those struggling with supporting vulnerable learners.

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## Appendix A

**Table A1**  
Full ERGM results for advice ties.

		Global estimates			Heterogeneity			School-level results	
		Estimate	SE	<i>p</i>	Tau	Q	<i>p</i>	Sig. positive	Sig. negative
1	Arc (Intercept)	-6.152	0.743	0.000	2.454	24.918	0.000	0	6
<b>Background characteristics</b>									
2	Sender is female	-0.133	0.102	0.190	0.020	6.377	0.271	0	1
3	Receiver is female	-0.199	0.075	0.008	0.003	4.785	0.443	0	1
4	Both are female	0.223	0.153	0.146	0.078	11.943	0.036	1	0
5	Sender's work experience	-0.012	0.006	0.043	0.000	10.867	0.054	0	2
6	Receiver's work experience	0.013	0.006	0.018	0.000	13.209	0.021	3	0
7	Difference in work experience	-0.005	0.004	0.265	0.000	7.000	0.221	0	1
<b>Formal roles</b>									
8	Sender: leader	-0.023	0.19	0.902	0.088	9.588	0.088	0	1
9	Receiver: leader	1.436	0.156	0.000	0.030	6.342	0.274	6	0
10	Sender: support	1.052	0.173	0.000	0.071	8.476	0.132	5	0
11	Receiver: support	2.154	0.17	0.000	0.011	5.325	0.378	6	0
12	Same role	1.634	0.186	0.000	0.037	6.247	0.283	6	0
13	Same role: leader	-0.189	0.44	0.667	0.812	15.217	0.009	1	1
14	Same role: support	-2.661	0.267	0.000	0.009	6.110	0.296	0	6
15	Same subject group	1.987	0.113	0.000	0.046	13.385	0.020	6	0
<b>Endogenous structural effects</b>									
16	Reciprocity	5.039	0.555	0.000	1.041	11.550	0.041	5	0
17	Reciprocity within same role	-1.518	0.35	0.000	0.350	9.696	0.084	0	4
18	Reciprocation by leaders	-1.264	0.39	0.001	0.532	11.989	0.035	0	4
19	Reciprocation by support	-1.511	0.37	0.000	0.372	9.534	0.090	0	4
20	Reciprocity within subject group	-1.954	0.197	0.000	0.039	5.275	0.383	0	6
21	Transitivity	0.616	0.093	0.000	0.040	22.100	0.001	6	0
22	Cyclicity	-0.118	0.06	0.048	0.012	11.646	0.040	0	1
23	Two-path	-0.029	0.007	0.000	0.000	3.590	0.610	0	2
24	Indegree distribution	0.687	0.249	0.006	0.272	19.515	0.002	5	0
25	No ties received	1.484	0.645	0.021	1.401	12.567	0.028	3	0
26	Two-instar	0.048	0.008	0.000	0.000	16.539	0.002	5	0
27	Outdegree distribution	-0.562	0.245	0.022	0.226	17.461	0.004	0	4
28	No ties sent	-0.779	0.485	0.108	0.907	14.783	0.011	0	1
<b>Subject dummies</b>									
SD1	Sender: Arts	0.358	0.279	0.199	0.334	18.112	0.003	1	0
SD2	Receiver: Arts	-0.388	0.106	0.000	0.020	9.352	0.096	0	2
SD3	Sender: Sciences	0.382	0.292	0.191	0.374	18.520	0.002	2	0
SD4	Receiver: Sciences	-0.456	0.140	0.001	0.067	12.318	0.031	0	3
SD5	Sender: Social Sciences	0.209	0.402	0.603	0.833	27.012	0.000	3	1
SD6	Receiver: Social Sciences	-0.455	0.113	0.000	0.037	10.375	0.065	0	3
SD7	Sender: IT	0.108	0.415	0.795	0.530	13.142	0.022	1	0
SD8	Receiver: IT	-0.204	0.193	0.291	0.009	3.630	0.604	0	0
SD9	Sender: English	0.141	0.249	0.571	0.248	17.302	0.004	1	0
SD10	Receiver: English	-0.103	0.094	0.273	0.018	9.969	0.076	0	1
SD11	Sender: Mathematics	0.507	0.239	0.034	0.209	12.626	0.027	3	0
SD12	Receiver: Mathematics	-0.387	0.094	0.000	0.002	5.625	0.344	0	2
SD13	Sender: Modern Foreign Languages	0.453	0.239	0.058	0.189	11.136	0.049	3	0
SD14	Receiver: Modern Foreign Languages	-0.310	0.100	0.002	0.000	4.363	0.498	0	2
SD15	Sender: PE	0.238	0.273	0.384	0.287	15.132	0.010	2	0
SD16	Receiver: PE	-0.046	0.088	0.604	0.000	4.534	0.475	0	0

Note: Estimated parameters; estimated standard errors; estimated *p*-values for statistical significance; estimated between-classroom standard deviations; test-statistics and *p*-values testing whether there is a difference between parameters among classrooms; number of schools where the parameter is significant and positive; number of schools where the parameter is significant and negative.

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