Mapping Changes in Support: A Longitudinal Analysis of Networks of Preservice Mathematics and Science Teachers

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In England teachers of secondary school mathematics and science are in short supply and it is important to understand how pre-service teachers develop and maintain networks of support during their training year and the impact these networks can have on their training outcomes. The purpose of this study is to examine how changes to the size and composition of these support networks during the training year are associated with programme outcomes. The paper draws on social network theory to examine the nature of the support networks that develop around each pre-service teacher, and examines how supportive ties were initiated, maintained and broken over the course of the training year. A survey design was utilized to collect data at four time points across the 2014-15 academic year from a total cohort of more than 75 pre-service teachers. At all four time points, participants were asked to nominate those peers and others to whom they had turned during the previous month for different aspects of support. Results showed that the size and composition of support networks changed over time with significant differences in the development of the networks between pre-service teachers on school-led and university-led programs.

Keywords: teacher training; peer networks; self-efficacy; STEM

# Introduction

Recent policies towards more school-based training have significantly changed the Initial Teacher Education (ITE) landscape. With an emphasis of trainees spending more time in school, rather than at universities, this might mean that networks of support, for example through peers, university mentors or school mentors change as well. As previous research indicates (e.g. Hodgson, 2014; McCormack, Gore, & Thomas, 2006), networks can play an important role in the development of trainee teachers. We set out, therefore, to investigate how trainees’ networks developed throughout the Academic Year 2014-2015. We focus here on mathematics and science trainees as shortages in maths and science trainees have made it important to study the way trainees form relationships in more detail. It is our expectation that this might provide valuable insights in the way we might (re-)organise ITE provision. Hence, this paper reports on a project which involved researching the support relationships of trainee (student) teachers on initial teacher education programmes, and the impact of these networks on trainees’ perceived progress through their programme of study. The paper will first set out the relevant literature and policy background, then describe how a longitudinal network methodology was used to analyse appropriate research questions, and then presents findings and conclusions.

# Background

To sketch the scene of our research focus we first describe the literature background of the two main themes underpinning the study: the role of networks in teacher trainee development and recent changes in the provision of ITE in England. Working from the premise that these networks are a relevant object of study, we are interested in studying the role support networks play in the development of trainee teachers, and whether these networks might develop differently in a more university- or school-based setting.

## The role of networks on teacher trainee support and development

Darling-Hammond and Sclan (1996) once described the experience of novice teachers as “sink or swim” indicating the sparsity of good quality support for early career teachers which can result in early departures from the profession. A number of articles on pre-service and early-career teacher education and development point to the importance of social elements of support that can contribute to teachers’ survival through early stages as novice teachers as well as providing resources to support their professional learning and the development of core teacher competences (e.g. Hudson, 2012; Le Cornu & Ewing, 2008; McCormack, Gore, & Thomas, 2006). In this article we focus on those other actors to whom pre-service teachers turn for support during their period of training. We can conceptualise the ties resulting from support-seeking activity as a network of social relationships between pre-service teachers (referred to as “egos” in network terms) and a group of “supporting actors” (known as “alters”). In our case we view support as a resource that can flow through the social networks of trainee teachers. Structural features of these support networks, such as the density of relational ties, and also attributes of the both ego and alters can all influence the way in which any resource flows through the relational network, to the benefit of the trainee teacher who is the ego at the centre of the network (Borgatti & Halgin, 2011).

One particular network property of interest is extent to which pre-service teachers turn to their peers on the course for support as opposed to turning to supporting actors occupying other roles (such as mentors, fellow teaching colleagues, family members etc.) The balance of peer-support to input from other supporting actors can be measured by a feature known as *network homophily* (Lazarsfeld & Merton, 1954) which is a concept derived from social theory, often colloquially referred to as the principle that “birds of a feather flock together”. We are particularly interested to determine how, over the duration of the course, the balance of supporters to which the trainee teachers turn shifts between their peer-group and the group of all other supporting actors available to them.

McCormack et al (2006) in a study of a group of early career teacher in the first year of teaching emphasise the shock experienced on entering their full time posts as trained teachers. The researchers indicate the importance of peer support as a means by which early career teachers develop strategies to progress beyond the initial feeling of being overwhelmed by the transition to first teaching posts. This is particularly linked to the need to develop classroom and behaviour management strategies in order to emerge from “survival mode” and establish an effective foundation for teaching their classes. McCormack et al.’s (2016) research participants point especially to the importance of maintaining support relationships with their network of former peers from their training course, in order to benefit form a strong sense of empathy derived from a shared experience and common language between fellow early career teachers. Developmental issues like this resemble different stages of (student) development, not unlike those described by Furlong and Maynard (1995). Insights from educational effectiveness research (EER) also point out the importance of teacher professional development (Muijs, Kyriakides, Van der Werf, Creemers, Timerpley & Earl, 2014).

Hudson’s (2012) study reports novice teachers referring to a range of key actors in in their support networks, from senior and more experienced colleagues in their school, assigned experienced mentors through to understanding spouses, friends and family members cooking dinner while the teacher works on their preparation at home. A key source of support is described as the “teacher next door” (p. 76), which suggests a sense of both physical and social proximity that may be derived from an empathetic and understanding peer. Alongside an emphasis on the role that school based and university mentors play in the development of pre-service teachers, Le Cornu and Ewing (2008) also provide evidence for the importance of relationships between peers as a source of mutual support that is beneficial to both professional learning and personal well-being. Reciprocal relationships within peer support networks were viewed as particularly empowering because the pre-service teachers were on an equal footing with one another and less likely to judge one another. Such relationships also offer a strong source of emotional support (Nieto, 2003) which help to foster greater resilience in pre-service and novice teachers (Gu & Day, 2007), leading Le Cornu (2009) to conclude that student teachers do not simply need to be alerted to the importance of developing strong peer support networks but rather “need to *experience* peer support” (p.721, emphasis in original).

Liou, Forbes, Hsuao, Moolenaar, and Daly (2013; Liou et al, 2016) employed survey and social network analysis (SNA) techniques in order to examine how the social capital of pre-service teachers was related to their professional development. They found that interpersonal trust and perceived self-efficacy were positively associated with pre-service teachers’ performance on an assessment of mathematics teaching competence. The social network position of pre-service teachers within their peer group was also related to their performance on the assessment. They conclude that support relationships within the peer network provide an important source of resilience in a pressured environment. Liou et al (2016) measured perceived *self-efficacy* in terms of three dimensions: developing student motivation, managing student behaviour and developing instructional skills, based on the Teacher Efficacy Scale developed by Tschannen-Moran & Hoy (2001). These are core classroom-craft skills that are often a major concern to pre-service and teachers making the transition to the early-career stage (Meister & Melnick, 2003). It seems reasonable to consider that pre-service teachers are likely to turn to others for support in developing such skills and that development of *self-efficacy* is a suitable outcome to measure across the duration of the programme of training. The emphasis placed on support networks by researchers studying pre-service teacher education also led us to consider whether the attributes of individual trainee teachers such as self-reported *peer trust* (Liou et al, 2016), and the extent to which they proactively seek to develop their networks (their *network intentionality,* Moolenaar et al, 2014), are also related to the development of their networks. By conducting a longitudinal social network study of trainee teachers’ relational ties to various supporting actors, we hope to determine how the various university and school-based phases during the year long course contribute to changes in the nature and extent of support networks between trainee teachers and their peers, mentors, colleagues, friends and family members, and whether related attributes such as *peer-trust* and *network intentionality* are static (trait-like) characteristics, or if these are developmental characteristics in the way we expect *self-efficacy* to be. We also aim to examine how recent developments in the provision of predominantly school-based initial teacher education in England may serve to influence the nature and development of such support networks during the training period.

## ITE and school-based training

Initial Teacher Education[[1]](#footnote-1) (ITE) in England has been subject to major changes ever since the 2010 Schools White Paper (Department for Education, 2010) in which the incoming Secretary of State for Education described a transformation of ITE. According to new policies, teacher training needed a shift of control away from universities and into schools (ibid.). Part of this ‘school led focus was the introduction of the School Direct programme. There are two major routes into teaching. The first is ‘University Led’ (UL), in which “universities and colleges offer teacher training courses for both graduates and undergraduates.” (Get into teaching website[[2]](#footnote-2)). University-led courses run full-time over one year or part-time over two years, except for undergraduate courses. Training involves spending time at a university or college, working with other trainees and being taught by university colleagues. A minimum of 24 weeks is spent at placement schools, helping in the development of practical teaching skills and ability to manage and plan classes. School-led training is described as being “for graduates who want hands-on training in a school.” On the same Get into Teaching website this option is described as “On a school-led training course, you’ll get the chance to learn on the job in at least two schools, learning from experienced colleagues and putting your new skills into practice from day one. School-led courses generally last a year and result in the award of qualified teacher status (QTS). Most courses include a postgraduate qualification, which is likely to carry with it Master’s-level credits.”[[3]](#footnote-3). School-led courses are referred to as the SCITT (school-centred initial teacher training) programme and School Direct (SD) training programme. SD courses are designed by groups of schools – with a university or a SCITT – based on skills these schools are looking for in a newly qualified teacher (NQT). The schools recruit trainees onto their SD course with specific subject vacancies for staffing in mind. SD courses generally last a year, and trainees spend time in at least two schools. Candidates who already work at or have an existing relationship with a school, could be offered a ‘salaried’ SD position. According to the official government website “School Direct courses all result in qualified teacher status (QTS). Most also award you a postgraduate certificate in education (PGCE) and/or Master’s-level credits”. SD trainees become part of a teaching team from the start, and receive support from teachers and mentors. SD can be said to favour “an apprenticeship model of teacher training that can be located entirely in the workplace” (McNamara & Murray, 2013). Several sources like the Good Teacher Training Guide (Smithers & Robinson, 2013), the 2014 NQT survey (National College for Teaching & Leadership, 2014) and a report by the Institute for Fiscal Studies (Allen et al., 2014) suggest that the move towards school-led ITT has had benefits, while others take a more critical stance towards the wider policy implications (e.g. Parker, 2015; Whitty, 2014; Childs, 2013). This paper, however, follows the more pragmatic approach expressed in the Carter Review of Initial Teacher Training (Carter, 2015) with a focus on ‘partnership’, but also an increasingly school led system. Hodgson (2014) suggests that ‘networks’ play a role in this, for example that University-based tutors have better networks (p.17), and also how one student teacher reports that their university encourages students to create a network with each other, a peer network, which provides invaluable resources and support. This emphasis on networks is an aspect also included in Teachers’ Standards “develop effective professional relationships with colleagues, knowing how and when to draw on advice and specialist support.” (Department for Education, 2011).

It should be noted that the presence of UL and SD systems is not black-and-white: it might be best to refer to providers as more or less university or school involvement rather than either/or. In addition, UL and SD programmes are organised in various different ways across the country, and therefore it will be important to be cautious when generalising. Nevertheless, the formal nature of university or school involvement can be seen as different. Given the distinctly different nature of the two routes into teaching, it might be expected that the networks trainees develop will vary between the routes.

This background gives rise to the following research questions we want to answer:

RQ1: Are certain network characteristics (such as network homophily, network intentionality, peer trust and views on support) significantly associated with the growth in perceived self-efficacy of one cohort of maths and science pre-service teachers?

RQ2: How do the support networks of a cohort of maths and science pre-service teachers vary between University Led (UL) and School Direct (SD) programmes?

To answer these questions we will utilise a longitudinal analysis of network data, as we have emphasised the developmental nature of networks.

# Methodology

## Research design

The study employs a longitudinal survey design. The first phase is a longitudinal survey of both the peer support and wider networks of pre-service teachers. The peer network data is full network data in that respondents indicated peer relations between themselves and all other trainees in the group. In our operationalisation we will refer to this as the *internal* network. In addition, wider network data, like that of family, friends could only be collected in the form of egocentric networks (Crossley, Bellotti, Edwards, Everett, Koskinen, & Tranmer, 2015). In our operationalisation we will refer to this as the *external* network. In the external network it is unknown whether ties exist between different alters. As we were interested in networks involving both sets of actors (internal and external) we mapped networks that were centred on an individual (*ego*). The people that an individual interacts with in his/her personal network are called *alters*, and the relationship between ego and alter is referred to as a *tie*. The survey also collected data on background factors such as self-reports of organisational and interpersonal trust and self-efficacy as a teacher.

## Instrument and variables

The survey instrument collected several variables at four different waves throughout 2014-2015. The dependent variable was self-perception of personal development as a teacher (a measure self-efficacy that we refer to as DEVELOPMENT). This was collected using a scale developed by Tschannen-Moran and Hoy (2001) consisting of a set of twelve items, each employing a 9 point Likert-type scale (1=not at all, 9=always). This scale has been used in several previous studies (Daly, Der-Martirosian, Ong-Dean, Park, & Wishard, 2011; Daly, Liou, Tran, Cornelissen, & Park, 2013). Previous principal component analyses (PCA) have indicated that three scales could be calculated from them, namely classroom management, student motivation, and instructional skills. In this study we used the mean of all items as metric for self-perceived self-efficacy/development. We observed that the internal consistency of the scale was high (Cronbach α= .96, calculated over all waves).

As described in the literature, several concepts were used as independent variables. Data on our core focus of network development was captured by using by asking trainees to indicate those actors to whom they have turned for support during the previous month. This was done on two levels. Firstly, trainees were presented with names from their peer-group (distinguishing maths and science as different groups), and asked whether they had any communication with this trainee during the last month. This enabled us to establish the *peer* *network* for each subject group (maths and science) and to evaluate the number of *internal* ties for each individual trainee, referred to as “I”. Secondly, we asked about the *wider network*. Trainees were also asked to indicate whether they had turned to any wider groups/types of actors for support during the previous month. This enabled us to establish the presence of network links to family members, friends, school colleagues, school mentors, university tutors/mentors, online contacts and other acquaintances. We refer to this data as data pertaining to their *wider* *network* and call this number of *external* ties “E”. This means that the total outward connections (the *out degree*) is the sum of I, the internal ties, and E, the external ties. This can be perceived as the size of their total *ego network*. With E and I we calculated Krackhardt and Stern’s (1988) External–Internal (EI) index:

The resulting index ranges from −1 (all ties are only with own group members, so-called *homophily*) to +1 (all ties are to students outside the group, so-called *heterophily*). According to Hernández-Nanclares, García-Muñiz and Rienties (2016, p.5) the “values of the EI index highlight if a group develops strong and cohesive learning links within a group (values near to −1) or present strong knowledge spill overs outside the group (values near to +1)”. To demonstrate the nature of the collected network data, Figure 1 highlights the egocentric network of trainee ‘25’. The nodes in the immediate vicinity of ‘25’ are fellow trainees, immediate internal peers. The smaller circles are part of the external network. Trainee ‘25’ has a relatively high number of nodes in the internal network, and few in the external network, resulting in relatively high homophily measured by the EI index.

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**Figure 1 Sociogram highlighting the support ego-network for a trainee mathematics teacher (participant 25) at wave 3. This teacher has a network relatively high network homophily indicated by the high number of ties to peers (fellow trainee teachers) in the support network, compared to ties to external alters (smaller circles as external ties).**

Further independent variables on trust, views on support and network intentionality were collected:

* A peer trust scale (TRUST), after applying PCA, consisted of six items explaining 74% of the variance. This scale was modified from previous work by Daly and Chrispeels (2008) and Hoy and Tschannen-Moran (2003).  The items were scored on a 9-point Likert-type response scale (1 =very strongly disagree, 9 = very strongly agree). In this study we used the mean of all items as the metric for peer trust, yielding a scale with values that could range from 1 to 9. We found that internal consistency of the scale was high (α= .95, calculated over all waves).
* Views on support (SUPPORT). This scale consisted of thirteen items concerning the extent to which respondents are open to asking for support, for example by asking for help from friends. The items have been used in previous studies but no published references are available as yet. The items are therefore tabulated in appendix A. Each item was scored on a 6-point Likert response scale (1 =strongly disagree, 6 =strongly agree). In this study we used the mean of all items as the metric for views on support, yielding a scale with values that could range from 1 to 6. Internal consistency of the scale was relatively low (α= .61, calculated over all waves) but we felt it was acceptable in the context of the study.
* Network intentionality (NETWORK). This scale consisted of twenty-two items concerning the extent in which respondents are pro-active about developing their network(s), such as “I attempt to connect to people who are prominent or central in the course/at school” or “I periodically evaluate the nature of my connections and networks within the course/at school”. Some items are reversed. The items have been used in previous studies but no references are available. The items are also tabulated in appendix A. Each item was scored on a 5-point Likert response scale (1 =strongly disagree, 5 =strongly agree). In this study we used the mean of all items as the metric for network intentionality, yielding a scale with values that could range from 1 to 5. Internal consistency of the scale was high (α= .81, calculated over all waves).

Finally, contextual variables were collected: gender (0=male, 1=female), age (numeric but also split into 5-year ordinal categories across the range from 20 to 59 years old), subject (0=maths, 1=science) and programme type (0=University Led, 1=School Direct).

## Procedure

The participants were drawn from a single cohort of maths and science pre-service trainees of the secondary Initial Teacher Education (ITE) programme associated with a university in the south of England (N=77). Both University Led (UL) and non-salaried School Direct (SD) courses were involved. For this university, contrary to the UL group, the SD group went into school at the beginning of the school year and stayed on until the end, and had fewer days, roughly half of 40, at the university. All participants were briefed about the nature of the study and were invited to give their consent at the beginning of the survey on each data collection occasion. The survey required participants to complete a 20 minute (approximate) online questionnaire on four occasions during their year of initial teacher education time span of the project. A summary of the survey instrument is provided in appendix A.

The metrics were collected on four occasions (waves), spaced across the Academic Year 2014-2015. As not all variables and scales were collected at all time points, Table 1 shows which metrics were collected in each wave. Time points were partly determined by programmatic ‘ideal moments’ for both UL and SD courses, with an aim to have at least two months between waves. The first wave was in October 2014, the second wave December 2014, the third wave March 2015 and the fourth and last wave begin May 2015.

**Table 1 overview of data collection points**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Wave | **Network** | | **Related factors** | | | |
| **Peer (I)** | **Wider (E)** | **Trust** | **Network intent** | **Support views** | **Self-efficacy** |
| **1** | ✓ | ✓ | ✓ |  |  | ✓ |
| **2** | ✓ | ✓ |  | ✓ | ✓ | ✓ |
| **3** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **4** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Response rates are indicated in Table 2. Note that attrition of participants resulted from trainees withdrawing from the programme before completion, as well as non-response.

**Table 2 response rate over waves**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Subject** | **1** | **2** | **3** | **4** |
| **Maths (37)** | 35 (95%) | 28 (81%) | 29 (94%) | 29 (90%) |
| **Science (40)** | 38 (95%) | 33 (83%) | 32 (86%) | 31 (83%) |
| **Total** | 73 | 61 | 61 | 60 |

We used SPSS version 22 to generate descriptive statistics, cross-tabulations and graphs. We further examined the longitudinal development by using a repeated measure ANOVA. Finally, we fitted a simple OLS regression for the final time point (wave 4) variables with perceived self-efficacy (DEVELOPMENT) as the dependent variable. In the regression model we used two additional independent variables capturing change in the size and nature of the trainees’ support networks. The first was the network growth which helped us adjust for changes to the size of the trainees’ support networks over the duration of the programme of study, evaluated as the gain in total network ties (I+E) from wave 1 to wave 4 (NETWORKGAIN). The second was the change in EI index, capturing the change in the degree of homophily (balance of ties to peers compared with other external actors) in the trainees’ support networks, evaluated as the difference in EI index between wave 1 and wave 4 (EIGAIN).

# Results

In the results section, we report the descriptive statistics, graphs of key variables for UL and SD courses and regression models respectively. SD trainees tended to be older than their peers on the UL programme (57% of SD trainees were aged 30 or over as opposed to just 7% of UL trainees).

Table 3 descriptive statistics for key variables

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Wave** | | **1** | | **2** | | **3** | | **4** | |
|  | | **Frequencies** | | | | | | | |
| **Age category** | 20-24 | 38 | | 34 | | 30 | | 30 | |
| 25-29 | 18 | | 16 | | 19 | | 19 | |
| 30-34 | 6 | | 4 | | 4 | | 4 | |
| 35-39 | 3 | | 3 | | 4 | | 4 | |
| 40-44 | 5 | | 4 | | 4 | | 2 | |
| 45-49 | 1 | | 0 | | 0 | | 1 | |
| Total | 1 | | 0 | | 0 | | 0 | |
|  | | **M** | **StD** | **M** | **StD** | **M** | **StD** | **M** | **StD** |
| **Proportion female** | | 0.49 | 0.50 | 0.49 | 0.50 | 0.54 | 0.50 | 0.55 | 0.50 |
| **Proportion science** | | 0.52 | 0.50 | 0.54 | 0.50 | 0.52 | 0.50 | 0.52 | 0.50 |
| **Proportion School Direct** | | 0.29 | 0.46 | 0.21 | 0.41 | 0.25 | 0.43 | 0.23 | 0.43 |
| **SUPPORT (range 1-6)** | |  |  | 4.77 | 0.45 | 4.68 | 0.39 | 4.66 | 0.45 |
| **NETWORK (range 1-5)** | |  |  | 3.39 | 0.34 | 3.46 | 0.36 | 3.43 | 0.33 |
| **DEVELOPMENT (range 1-9)** | | 4.87 | 1.48 | 5.74 | 1.05 | 6.48 | 0.79 | 6.84 | 0.87 |
| **TRUST (range 1-9)** | | 6.69 | 1.61 |  |  | 7.13 | 1.54 | 7.19 | 1.85 |
| **E (no. of ties to  external actors)** | | 5.42 | 3.65 | 6.00 | 3.74 | 5.90 | 3.73 | 5.40 | 3.42 |
| **I (no. of ties  to peers)** | | 10.86 | 7.09 | 11.28 | 7.46 | 7.59 | 5.36 | 5.33 | 4.65 |
| **EI-index** | | -0.25 | 0.46 | -0.24 | 0.41 | -0.05 | 0.44 | 0.08 | 0.49 |

M=Mean, StD=Standard Deviation

Descriptive statistics are presented in Table 3. The first four lines refer to contextual variables and are presented in proportions. The measure of trainees’ views on support (SUPPORT) appears to be relatively consistent over the three relevant waves (0.11 difference between min and max for the mean values), suggesting that SUPPORT is quite trait-like. With a difference of 0.07 between minimum and maximum for in means of the variable NETWORK, the same can be said about the measure of trainees’ network intentionality, namely the extent to which they are proactive in establishing and developing their network of contacts to peers and wider actors.

*RQ1: Are certain network characteristics (such as network homophily, network intentionality, peer trust and views on support) significantly associated with the growth in perceived self-efficacy of one cohort of maths and science pre-service teachers?*

As the mean values from the scales TRUST, NETWORK and SUPPORT seem relatively consistent over time, a repeated measures ANOVA was used to examine the growth in perceived self-efficacy (DEVELOPMENT), external ties (E), internal (peer) ties (I) and the measure of network homophily (EI index). Variables were visually inspected and seemed to roughly be normally distributed. As ANOVA is quite robust regarding possible violations of assumptions, we proceeded with the repeated measures ANOVA (Glass, Peckham & Sanders, 1972). Figure 2 presents the longitudinal growth of the trainees’ mean perceived self-efficacy (DEVELOPMENT).

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**Figure 2 Development of perception of self-efficacy (DEVELOPMENT)**

Mauchly's Test of Sphericity indicated that the assumption of sphericity had been violated, χ2(5) = 40.493, p < 0.001, and therefore, a Greenhouse-Geisser correction was used. A repeated measures ANOVA with a Greenhouse-Geisser correction determined that DEVELOPMENT differed significantly between the four time points (F(1.900, 95.019) = 77.925, *p*<0.001). Post hoc tests, using the Bonferroni correction for multiple tests of difference, revealed that DEVELOPMENT increased significantly between each of the waves. Figure 3 presents the mean growth of the ego-networks of trainees in three ways. Firstly the mean internal support network size among peers (I), then the mean size of wider support networks involving other external actors (E), and finally the mean support network homophily in terms of the balance of peers to external supporters (EI index).

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**Figure 3 Development of I (panel a), E (panel b) and EI-index (panel c)**

Analysis for the network measures showed that none of them met Mauchly's Test of Sphericity, hence a Greenhouse-Geisser correction was used for each ANOVA. Changes in the mean size of the trainees’ wider support ego-networks (E), did not yield significant difference, F(2.351, 119.884)=.908, *p*=.419, whereas changes in the mean peer-support ego-network size (I) and the network homophily (EI index) were significant across all the waves (F(2.521, 128.578)=22.238, *p*<.001 and F(2.389, 119.467)=17.589, *p*<.001. Post hoc tests of difference between waves using the Bonferroni correction showed that both for the size of the peer-support networks (I) and the network homophily (EI index) only the change in means from wave 1 to wave 2 was non-significant. In sum, trainees’ self-perceived development increased over all four waves. External ties stayed relatively constant, but after wave 2 the internal ties decreased, resulting in a higher EI-index ie. less homophily.

*RQ2: How do the support networks of a cohort of maths and science pre-service teachers vary between University Led (UL) and School Direct (SD) programmes?*

Having sketched the general picture of the complete sample we can focus on the differences between University Led (UL) and School Direct (SD). We will first do this by presenting graphs of key variables over the four waves. By including 95% confidence intervals around each mean we can also see whether there are significant differences between both groups. In all cases it is good to remember that the SD group is smaller than the UL group and experienced greater attrition over the course of the study (see Table 2). Figure 4 shows how perceived self-efficacy (DEVELOPMENT) grew over time. Again, 95% CI bars are included. It can be seen that the trainee groups on the different programme types, UL and SD, start off quite different, with SD trainees having a higher perception of their self-efficacy. By wave 2 the self-efficacy of both groups has increased, but the difference in means now becomes non-significant because the perceived self-efficacy of the trainees on the UL programme grows more quickly between wave 1 and 2, only for the difference in to become significant again in wave 3, before the mean self-efficacy of trainees on both programme types to rise to a similar level by wave 4. We have not included similar figures for the growth of trainees’ views on support (SUPPORT), network intentionality (NETWORK), and interpersonal trust (TRUST), as for trainees on both the UL and SD programmes they showed a relatively consistent, almost trait-like behaviour.

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**Figure 4 Development of self-perceived efficacy for University Led and School Direct programmes.**

Figure 5 shows the growth over time of the peer-support ego networks of all trainees (I), the wider support ego-networks (E) and the mean network hompohily (EI index) respectively, for trainees on the University Led programme in blue and the School Direct programme in green. It can be seen that the mean total number of peer (internal) network ties starts off significantly higher for trainees on the UL programme compared to SD, which eventually decreases to a non-significant difference by wave 4. The mean total number of ties to external actors in the trainees’ wider support networks are more equal with SD decreasing throughout the waves and UL first increasing, to being significantly different from SD in wave 3, and then decreasing again. As the measure of network homophily (EI index) is calculated from I and E its development could be predicted: it starts negative for trainees on the UL programme, indicating that their networks are more homophilous due to being predominantly made up of peers rather than wider supporters, but it then increases steadily, while trainees on the SD programme start with significantly less homophilous support networks which show no significant change over time. By wave 4 trainees on the SD and UL programmes have no significant difference in terms of their network homophily (EI index).

C:\Users\cb1y11\Google Drive\articles_under_construction\_S_ITT_Downey_Oxford\Figure5b.tifC:\Users\cb1y11\Google Drive\articles_under_construction\_S_ITT_Downey_Oxford\Figure5a.tifC:\Users\cb1y11\Google Drive\articles_under_construction\_S_ITT_Downey_Oxford\Figure5c.tif

**Figure 5 Development of I (panel a), E (panel b) and EI-index for UL and SD (panel c)**

Finally, we studied the influence of key independent variables on the dependent variable perceived self-efficacy (DEVELOPMENT) using a multivariate linear (OLS) regression. As we wanted to know the influence on the final perceived level of self-efficacy we chose the value of DEVELOPMENT for wave 4 as an outcome of the year of pre-service training and education. As TRUST, NETWORK and SUPPORT were fairly constant we decided to treat them as such over time by using the values at wave 4 in step 1. The size of the peer network (I) and wider network (E) changed over time, and therefore we chose to represent the network evolution as the gain in total support-network size (I+E) from wave 1 to wave 4, and the change in network homophily (EI index) from wave 1 to wave 4. These newly created variables are called NETWORKGAIN and EIGAIN respectively and were added in block 2. Finally, we added PROGRAMME in the last model.

<Table 4 around here>

The model shows that trainees’ views on support (SUPPORT) is a significant positive predictor for perceived self-efficacy (DEVELOPMENT) while an increase in the total size of the support network (NETWORKGAIN) is a significant negative predictor. Regarding the network gain, Figure 5 had already shown us that in particular the internal links, the peer network, changed considerably for UL, compared to SD. As PROGRAMME is a positive predictor for DEVELOPMENT, it seems that the reduction in network size is associated with gain in perceived self-efficacy, even after adjusting for SD who start from a lower base in terms of number of ties and so have less potential for reduction in network size.

# Conclusions and discussion

In this paper we set out to answer whether certain network characteristics might be significantly associated with the growth in perceived self-efficacy of these pre-service teachers, and whether there were differences between the support networks of trainees on University Led (UL) and School Direct (SD) training programmes. An analysis of the variables showed that for all the trainees in the study over the four waves views on support (SUPPORT), network intentionality (NETWORK) and peer trust (TRUST) were trait-like and did not change much. As one might expect from Initial Teacher Education, the perceived self-efficacy (DEVELOPMENT) increased significantly over the four waves. With regard to the development of network ties, trainees on the university led (UL) programme had similar number of external ties to wider supporters, but they did lost internal ties to peers during the year, and subsequently their networks became less homophilous as demonstrated by an increased EI index. These changes, however, did only set in after wave 2. This can partly be explained by the structure of the current ITE programmes, but we suspected there might be other differences between trainees on the UL and SD programmes. Upon exploring these differences several differences between them could be observed.

Firstly, perceived self-efficacy as represented by DEVELOPMENT between the two groups SD and UL differed: SD starts out higher, but UL trainees report greater increases from wave 1 to 4. We hypothesise that this might be caused by the fact that SD students, on average, are older than UL students, and therefore have more confidence in their competency as teachers. However, although SD students almost immediately go into the classroom, their perceived self-efficacy grows more slowly than the trainees on the UL programme which may simply be due to the fact that they start from a higher baseline. When looking at the nature of their support networks trainees on the SD programme have an EI index that starts relatively high and remains high across the year of pre-service training, indicating an initially more heterophilic support network than trainees on the UL programme. UL trainees have networks with an EI index that starts negative, indicating homophily due to the predominance of support ties with fellow trainees, but over time the E I index increases to slightly over 0. We see this as indication that UL students start off with a more homogeneous group of ties but that after starting school placements, the role of the peer network is slowly replaced by the wider network, eventually with a core of peer support ties remaining. This would make sense, if the move to periods of school placement which give the UL trainees access to this wider network resulted in an increased number of ties to external supporters. Within the change in EI index, however, it is not the number of external ties that changes significantly but rather a fall in the number of internal support ties (I) to peers. Figure 5 showed that for trainees on the UL programme that number of peer support ties started high and then decreased over time, leading eventually to a non-significant difference in ties to peers compared to trainees on the SD programme. The change in size of the number of ties to peer supporters (I), and so NETWORKGAIN, seems to be a significant predictor for this perceived self-efficacy. But the direction of the relationship is surprising if we recollect the evidence on ‘growing networks’: in our study it is the decrease in network size, a negative NETWORKGAIN, that is a significant predictor of increased self-efficacy. Here it is pertinent to think about causality, though. Given the previous evidence base, it does not seem logical to assume that reducing one’s (internal) peer network leads to improved perceived self-efficacy. Rather, the reduction in the size of the peer support network might, at least in part, go hand-in-hand with an increased perception of self-efficacy. A tentative exploration with NETWORKGAIN as the dependent variable and DEVELOPMENT in wave 4 as an independent variable seems to confirm this. This causal aspect might be explored in further research with some structural equation modelling. As trainees’ views on support (SUPPORT), a more trait-like feature, was a significant predictor of perceived self-efficacy, it might be hypothesised that changing (views on) support help UL students more with their development. This, however, is something that would need further study, especially, the temporal aspect of these changes. For instance, for every step in time, from wave to wave, the roles of peer and wider supporters as well as the type and quality of support, might influence the development of trainees. All in all, it is clear that although the two courses provide *different* peer support opportunities, although there appear to be are no differences in perceived self-efficacy as a teacher, by the end of each programme.

We have made several assumptions in this study which can be construed as limitations. As SUPPORT, NETWORK and TRUST seemed fairly constant over the waves we have taken this to be a sign of *trait-like* characteristics. Although this might have been the case in this study, theoretically it seems probable that these characteristics also develop over time. There is likely to be a relationship between these characteristics: an increase in (positive) thoughts about support might have an influence on network intentionality, and it is not improbable that trust influences network intentionality. Correlational analyses for the scales SUPPORT, NETWORK and TRUST for wave 4, exhibit significant correlations between SUPPORT and NETWORK (*r*=.343, *p*<.01) and NETWORK and TRUST (*r*=.394, *p*<.01) but not SUPPORT and TRUST (*r*=.047, *p*=.722). We have already mentioned that the progression of many of the variables seemed to be influenced by the structure of the programs and, of course, participant characteristics. For example, trainees on the SD programme tend to commence classroom teaching more quickly than their fellow trainees on the UL programme, and it might be expected that the peer network will be less developed for SD trainees since they are likely to spend less of their time in contact with fellow trainee teachers, especially in their own subject area, thus leading to a lower number of ties to peer-supporters (I). SD programmes will vary in terms of the amount of time that trainees form the same subject area can gather across school partnerships and it’s not clear how typical the SD programmes involved in this study would be. We do know that for our participants, there were opportunities for SD trainees from the same subject area to mix with one another and also with trainees from the UL programme in their subject area. However, it’s clear that after UL trainees move into substantive periods of school placement, their number of internal support ties to peers also decreases, perhaps reducing to the ties that are perceived to have lasting value; ties through which support of greater quality or impact can flow. In our model ties were simply modelled as present or absent, but there was no measure of the quality or impact of support ties. It would be useful to check whether these findings also are applicable to differently organised UL and SD courses.

The experience of “reality shock” for trainees (Veenman, 1984) might have strong effects on the development of their network(s). These features of the programme could be a confounding factor. This also brings us to another major assumption the study: our definition of internal and external ties. We assumed ‘peers’ to only be students in the same programme, but perhaps, for UL programmes, university mentors could be seen as ‘internal’ supporters as well. After all, they form part of the organisational unit ‘University Led’. Another restriction is that we used the perceived self-efficacy as the outcome variable of focus for the training programmes. Trainees are also observed formally, and given ratings based on OFSTED criteria. These observation ratings may be seen as a more ‘objective’ measure of teaching quality than perceived self-efficacy (DEVELOPMENT). In addition, more sophisticated models might partition wave and student variance.

Finally, as *network change* seems to be a significant predictor of perceived self-efficacy it would be pertinent to study the development of network measures over time in more detail, for example by using *dynamic* Social Network Analysis (Bokhove, 2016). In future research we hope to further unpick the different support roles that internal and external actors play. For instance, support ties can be useful in providing materials and literature, while other ties might be more useful for moral or emotional support. This article has tried to shed light on the influence of the development of trainees’ networks on the perceptions of competence over four time points that span some one-year programmes of postgraduate pre-service training.

# References

Allen, R., Belfield, C., Greaves, E., Sharp, C., & Walker, M. (2014). *The costs and benefits of different Initial Teacher Training routes*. IFS report R100.

Bokhove, C. (2016). Exploring classroom interaction with dynamic social network analysis. *International Journal of Research & Method in Education*. Advance online publication. doi:10.1080/1743727X.2016.1192116

Borgatti, S. P., & Halgin, D. S. (2011). On network theory. *Organization science*, *22*(5), 1168–1181.

Carter, A. (2015). *Carter review of initial teacher training (ITT)*. Department for Education.

Childs, A. (2013) The work of teacher educators: An English policy perspective. *Journal of Education for Teaching*, *39*(3), 314-328.

Crossley, N., Bellotti, E., Edwards, G., Everett, M. G., Koskinen, J., & Tranmer, M. (2015). *Social network analysis for ego-*nets. London: SAGE Publications Ltd.

Daly, A. J., & Chrispeels, J. (2008). A question of trust: Predictive conditions for adaptive and technical leadership in educational contexts. *Leadership and Policy in Schools*, *7*(1), 30–63.

Daly, A.J., Der-Martirosian, C., Ong-Dean, C., Park, V., & Wishard-Guerra, A. (2011). Leading under sanction: Principals' perceptions of threat rigidity, efficacy, and leadership in underperforming schools. *Leadership and Policy in Schools*, *10*(2), 171-206.

Daly, A.J., Liou, Y., Tran, N., Cornelissen, F., & Park, V. (2013). The rise of the neurotics: Social networks, leadership, and efficacy in district reform. *Educational Administration Quarterly*, *50*(2), 233-278.

Darling-Hammond, L., & Sclan, E. M. (1996). Who teaches and why: Dilemmas of building a profession for twenty-first century schools, in J. Sikula, T. J. Buttery, and E. Guyton (Eds.), *Handbook of Research on Teacher Education* (2nd ed., pp. 67-101). New York: Macmillan.

Department for Education. (2010). *The importance of teaching: The Schools White Paper 2010*. Retrieved from [https://www.gov.uk/government/uploads/system/upload s/attachment\_data/file/175429/CM-7980.pdf](https://www.gov.uk/government/uploads/system/upload%20s/attachment_data/file/175429/CM-7980.pdf)

Department for Education. (2011). *Teachers’ Standards*. Retrieved from <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/301107/Teachers__Standards.pdf>

Furlong, J., & Maynard, T. (1995). *Mentoring student teachers: The growth of professional knowledge*. London: Routledge.

Glass, G.V., Peckham, P.D., & Sanders, J.R. (1972). Consequences of failure to meet assumptions underlying fixed effects analyses of variance and covariance. *Review of Educational Research*, *42*(3), 237-288.

Gu, Q., & Day, C. (2007). Teachers resilience: a necessary condition for effectiveness. *Teaching and Teacher Education*, *23*(8), 1302–1316.

Hernández-Nanclares, N., García-Muñiz, A. S., & Rienties, B. (2016). Making the most of “external” group members in blended and online environments. *Interactive Learning Environments*, 1–15. doi:10.1080/10494820.2016.1140656

Hodgson, J. (2014). Surveying the wreckage: The professional response to changes to initial teacher training in the UK, *English in Education*, *48*(1), 7-25.

Hoy, W. K., & Tschannen-Moran, M. (2003). The conceptualization and measurement of faculty trust in schools: The omnibus T-Scale. In W.K. Hoy & C.G. Miskel (Eds.), *Studies in leading and organizing schools*. Greenwich: Information Age Publishing.

Hudson, P. (2012). How can schools support beginning teachers? A call for timely induction and mentoring for effective teaching. *Australian Journal of Teacher Education*, *37*(7), 71-84.

Krackhardt, D., & Stern, R. (1988). Informal networks and organizational crises: An experimental simulation. *Social Psychology Quarterly*, *51*(2), 123-140

Lazarsfeld, P. E., & Merton, R. K. (1954). Freedom and control in modern society. In M. Berger, T. Abel, & C. H. Page (Eds.), *Friendship as a social process: A substantive and methodological analysis* (pp.18-66). New York: Van Nostrand.

Le Cornu, R., & Ewing, R. (2008). Reconceptualising professional experiences in pre service teacher education…reconstructing the past to embrace the future. *Teaching and Teacher Education*, *24*(7), 1799–1812.

Le Cornu, R. (2009). Building resilience in pre-service teachers. *Teaching and Teacher Education*, *25*(5), 717–723.

Liou, Y., Forbes, C. A., Hsiao, J., Moolenaar, N., & Daly, A. J. (2013). *Investing in potential: Exploring preservice teachers’ social capital and outcomes.* Paper presented at the annual meeting of the UCEA Annual Convention, Indianapolis.

Liou, Y.-H., Daly, A. J., Canrinus, E. T., Forbes, C. A., Moolenaar, N. M., Cornelissen, F., Van Lare, M., & Hsiao, J. (2016). Mapping the social side of pre-service teachers: Connecting closeness, trust, and efficacy with performance. *Teachers and Teaching: Theory and Practice*, *23*(6), 635-657.

McCormack, A., Gore, J., & Thomas, K. (2006). Early career teacher professional learning. *Asia-Pacific Journal of Teacher Education*, *34*(1), 95-113.

McNamara, O. & Murray, J. (2013). *The School Direct programme and its implications for research-informed teacher education and teacher educators*. Retrieved from <https://www.heacademy.ac.uk/system/files/resources/learningtoteach_part1_final.pdf>

Meister, D.G., & Melnick, S. A. (2003). National new teacher study: Beginning teachers' concerns. *Action in Teacher Education*, *24*(4), 87-94.

Moolenaar, N. M., Daly, A. J., Cornelissen, F., Liou, Y.-H., Caillier, S., Riordan, R., Wilson, K., & Cohen, N. A. (2014). Linked to innovation: Shaping an innovative climate through network intentionality and educators’ social network position. *Journal of Educational Change*, *15*(2), 99–123.

Muijs, D., Kyriakides, L., Van der Werf, G., Creemers, B., Timerpley, H., & Earl, L. (2014). State of the art – teacher effectiveness and professional learning. *School Effectiveness and School Improvement*, 25(2), 231-256.

National College for Teaching & Leadership. (2014). *Newly Qualified Teachers: Annual Survey 2014*. Retrieved from <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/430783/Newly-Qualified-Teachers-Annual-Survey_2014.pdf>

Nieto, S. (2003). *What keeps teachers going?* New York: Teachers College Press.

Parker, G. (2015). School Direct: A critique. *Power and Education*, *7*(1), 106-112.

Smithers, A., & Robinson, P. (2013). The Good Teacher Training Guide. Retrieved from <http://www.buckingham.ac.uk/wp-content/uploads/2014/01/GTTG2013.pdf>

Tschannen-Moran, M., & Hoy, A.W. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education*, *17*(7), 783-805.

Veenman, S. (1984). Perceived problems of beginning teachers. *Review of Educational Research*, *54*(2), 143–178.

Whitty, G. (2014). Recent developments in teacher training and their consequences for the ‘University Project’in education. *Oxford Review of Education*, *40*(4), 466-481.

1. ITE is also referred to as Initial Teacher Training (ITT). [↑](#footnote-ref-1)
2. <https://getintoteaching.education.gov.uk/> [↑](#footnote-ref-2)
3. Note that the University Led mostly leads to QTS, PGCE and Master credits but this is not mentioned on the Get Into Teaching website. [↑](#footnote-ref-3)