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Student Learning Networks on Residential Field Courses: Does Size Matter?

A Mark Langan[1], W Rod Cullen[2] and David M Shuker[3].

[1]*Department of Environmental & Geographical Sciences, Manchester Metropolitan University*
[2]*Centre for Learning and Teaching, Manchester Metropolitan University*
[3]*School of Biological Sciences, Edinburgh University*

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Abstract

This article describes learner and tutor reports of a learning network that formed during the completion of investigative projects on a residential field course. Staff and students recorded project-related interactions, who they were with and how long they lasted over four phases during the field course. An enquiry based learning format challenged individuals to complete investigative bioscience projects utilising peers (n = 20) and tutors (n = 14) as resources. The residential nature of the course ensured full participation of tutors and learners at all stages of the study. Overall, students interacted for 'academic purposes' with about 40% of their peers and over 50% of the tutors in their potential network, although there were some differences between students and tutors in their perceptions of the interactions. In addition, patterns of networking activity differed between project stages. Tutors and learners were most interactive at the start of the course, although the data collection/analysis stages were also busy in terms of tutor support. Learners reported that they valued their interactions, but larger networks did not lead to higher marks as high attainment students were found to have worked in smaller networks. The findings provide insights into how individuals are used as resources in learning networks and the dynamics of learning networks during a residential case study.

Keywords: Learning community, learning styles, Enquiry Based Learning (EBL)

Introduction

Learning has a social basis and many learners naturally interact and form learning networks through collegial and personal relationships. This leads to a sharing of ideas, skills and information; a practice that may be useful preparation for professional careers (Wenger, 1998). This type of approach is complementary to the shift in Higher Education away from 'teaching' and towards 'learning' as we move away from direct instruction (transmissional processes) to the facilitation of learning. Socio-cognitive learning is consistent with constructivism as an educational philosophy and with collaborative enquiry used by practitioners (e.g. 'communities of practice'; Lave and Wenger, 1991). However, the concept and value of learning networks may be more apparent than real (a form of "institutional utopianism"; Frankham, 2006) Learning networks are therefore not necessarily an "educational magic bullet" and their functionality needs validating in a variety of contexts.

One context where learner networking and learning circles have been explored for some time is in *e*-communication (Levin, 1995). This has tended to focus on asynchronous communications between online distance learners, where electronic audit trails can be used to determine connectivity (Aviv *et al*, 2003). In addition, networks have been explored at a large scale to study social inter-relationships over long periods of time (Degenne and Lebeaux, 2005). For decades before virtual communities, Social Network Analysis (SNA) provided a mechanism

to explore and describe complex relationships between indidividuals at all scales, from interpersonal to international (Knoke and Kuklinski, 1982). This approach places less emphasis on the attributes of individuals and more on their relationships and ties with other 'actors' (= individuals) within networks. This means two main types of variable are utilised: structural (different ties between individuals; e.g. friendship and trust) and compositional (the attributes of the individual; e.g. position in organisation) (Martino and Spoto, 2006). As a consequence of the variety of contexts in which networking has been examined the terminology used to describe learning networks, their functioning and how they are contextualised in different fields is complex. For further discussions see Frankham (2006) and Wubbels (2007).

In learning communities there may be a great deal of both explicit and tacit knowledge discussed, explained and shared within an academic setting. However, there is little information about the nature of network interactions and the perceived quality of the information they generate or how they are valued by students. Enquiry based learning (EBL) courses, where learners can have a great deal of independence in how they work, and choice in whom they work with, therefore provide an interesting system to explore network dynamics. Here we consider how similar approaches can be applied to the examination of shorter term, more confined learner communities. Networks of learners can form and be encouraged in face-to-face, synchronous teaching, for example through EBL which has been considered to be an educational manifestation of social constructivism (e.g. Kahn and O'Rourke, 2004). This puts the learner at the centre of the learning activity and facilitates their creation and completion of learning goals. Monitoring learner networking behaviour provides an opportunity to explore how learners interact, make decisions and complete academic goals.

Building on previous studies (Langan *et al*, 2005, 2007), this study describes a Bioscience field course in an EBL format, documenting interactions that comprise the emergent network of learners and tutors as students completed their investigative projects. We recorded project related interactions, who they were with, how long they lasted and how important the information was perceived to be over four key stages in the development of a student-led investigative project. One aspect, the size of an individual's learning network, is explored further to examine how it related to student attainment. Thus, we asked four questions: (1) how large were the learning networks?; (2) are learning networks dynamic?; (3) how were interactions perceived by learners and tutors?; (4) were learning networks associated with attainment?

Methods

This opportunistic study explored a 16 day residential field course to Southern Spain. Second year undergraduate learners were studying for biological or environmental degrees at two Manchester universities (n_{uni1} = 15, n_{uni2} = 5). Tutors (n = 14; 1 arriving part-way through the course) represented three Universities and all had experience of teaching and assessing field biology. A research technician was included as a 'tutor' in this study as they provided technical and methodological advice. A range of field and laboratory equipment (and literature) was available but there was no internet access (either at the field centre or the nearest village). Living conditions were basic with individuals living 'communally'. Peers and tutors were considered to be the primary resource for learners during their academic investigations. Full, voluntary participation in the study was provided by all tutors and learners and all participants willingly volunteered personal information.

Course Design

The course format has been described previously and is summarized in Table 1. (Langan *et al*, 2005).

Table 1 *Overview of the field course design, during which students devise and complete investigative research projects. Stages are used to deliver project elements (for example risk assessment documentation). For further details see Langan et al, (2005).*

Introduction to the field course	Familiarisation with the location Introduction to the course and its learner centered enquiry based learning format. Initial consideration of risks and ethics associated with project ideas.
Stage 1	Formulation of research questions (with a scheduled discussion group).
Stage 2	Methods development (including submission of ethics and health & safety documentation). Learners develop their own methods and, if possible their own field and laboratory equipment (even if some 'kit' is only crude in its accuracy).
Stage 3	Data collection and collation (with spreadsheets and proposed analyses checked by a tutor).
Stage 4	Statistical analyses (including graphical outputs and oral presentation preparation).
Write-up and presentations	Submission of written project in the form of a scientific paper (assessed on return to the UK). On the final day, learners are challenged to synthesise their intensive project experiences into five minute oral presentations which are self, peer and tutor assessed.

At the end of stages 1 to 4, meetings were held to discuss progress and problems with peers and a tutor. Individuals were encouraged to run pilot studies in advance of their main study, working with a 'buddy' in field locations.

Assessments of oral presentations were based on three criteria for which descriptors of 'threshold pass' and 'excellence' were provided; clarity', content' and 'comprehension'. Thematic sessions were chaired by a student and the speakers complete a self-assessment proforma and the audience of peers returned (identical) peer-assessment proformas. Tutors also assessed presentations using these criteria. Therefore, each presentation was assessed by all tutors, a subset of peers (not those presenting or chairing the session) and the presenter themselves. Only tutor grades have been used in the current analysis. For an exploration of the assessment process, see Langan *et al*, (2005).

Networking Questionnaires

Completion of each of the (four) stages of the project was used to time the delivery of networking questionnaires (coded to be anonymous). These explored who was interacted with in order to complete each stage of the project, how long the interaction lasted, and an opinion describing the nature of these interactions using a seven point scale. For interactions with tutors, learners were asked to grade their contribution on a scale from 1 ('The tutor(s) provided me with a complete prescription/solution that I have followed exactly') to 7 ('The tutor(s) confirmed that I should progress with my own ideas/methods/solutions'). Tutors were asked to grade student interactions on the same scale, but from their perspective. For full descriptors see Appendix 1.

There are many ways of describing and exploring networks. Unlike in ecological networks, we have not measured the passage of a measurable entity (for example this might be energy in ecological networks, and knowledge in learning networks). For this study we focus on describing the points of interaction between individuals that make-up the learning network. We have explored the learning network from two contexts: learner:learner interactions and learner:tutor interactions. Learner:tutor interactions were further classified depending on whether they were tutor- or learner-initiated. We used these data to construct the "learning networks" that formed during the course. We have not considered tutor:tutor interactions in this study.

At the end of the course we also carried out an 'exit' questionnaire to gather qualitative information about opinions of the whole course. This included questions about how much help was needed overall and who they interacted with most (tutor and student) and the person considered to be the most useful at each stage, and overall during the field course.

Statistical Analysis

We used a mixed methods approach to analysis with quantitative and qualitative analyses for data exploration and synthesis, an approach that has proved useful for explorations of this type (Martinez *et al*, 2003). Statistical analyses were carried out using S-Plus version 7.0 (Insightful Corporation, Seattle, USA). Where appropriate, mixed-effects linear models were used, taking into account that the same student/tutor contributed multiple observations, with individual ID fitted as a random effect. Qualitative information was drawn from open questionnaire questions and discussions with learners and peers.

Results

How large were the learning networks?

In total, learners reported 251 learner-tutor interactions and tutors reported 250. There was a high level of consistency in the number of interactions reported by tutors and learners. Scrutiny of the raw data confirmed that reports were, to a very large degree, recollections of the same individual interactions and not a coincidentally similar total. There was an uneven sex ratio in our network: learners nmales = 8, nfemales = 12; tutors nmales = 10, nfemales = 4 and although our first impressions were that there were not obvious gender effects on who was chosen to interact with (using network diagrams; see Langan *et al,* 2007), subsequent analysis indicated that males were associated with larger networks (mixed-effects model: Likelihood ratio test LR = 3.87; P = 0.05). It is notable that there were no significant differences between male and female attainment (t18 = 0.883, P = 0.389: means ±se; male = 67.7% ±2.1, female = 70.7% ±2.3).

Are learning networks dynamic?

Networks reported during this study were dynamic over the lifecycle of the projects. Table 1 indicates that most interactions occurred during the 'flurry of activity' when learners were deciding upon the project they would perform. At this stage the learners from the two universities were developing social relationships with each other and the tutors, often based on discussions of potential projects. The percentage of potential people interacted with was highest at this stage (about a third of all tutors and almost a quarter of all peers). Learners were less reliant on peers during their data collection phase and analysis, although after a dip in the methods development, the numbers of tutors consulted increased in the latter stages.

***Table 2**. The learning network in terms of the number of peer-interactions and student-tutor interactions across the four stages of the field course. Percentages denote realisation of all the possible connections in terms of the potential network at each stage and are given in parentheses (*final percentages are for the potential network for the whole study period). Although total values are coincidentally the same values, they are part of networks that have different potential sizes. Total potential networks (all potential people interacted with) were: student-student = 380; student-tutor[1] = 260.*

Interaction	Stage 1 'Questions'	Stage 2 'Methods'	Stage 3 'Data'	Stage 4 'Analysis'	Total
Student-student	80 (21.1%)	76 (20.0%)	63 (16.6%)	67 (17.6%)	147 (38.7%*)
Student-tutor	78 (30.0%)	49 (18.8%)	63 (24.2%)	61 (23.5%)	147 (56.5%*)

Table 3 provides a breakdown of quantitative measurements over the project lifetime, initially confirming the activity patterns seen in Table 1.

***Table 3** Questionnaire responses for student (n = 20) and tutor (n = 14) perceptions of their interactions during the four stages of the investigative projects. Means (±se) are presented in all cases other than for ranked data for which medians (±IQR) are displayed. To show basic patterns for each variable, bold highlights the highest value recorded and italics the lowest for the four project stages.*

	Means (±SE) or Medians (IQR)	Stage 1 'Questions'	Stage 2 'Methods'	Stage 3 'Data'	Stage 4 'Analysis'
Tutor Questionnaires	**Number of students interacted with**	7.31 ± 0.75	5.69 ± 0.61	**8.00 ± 0.83**	5.21 ± 0.52
	Number of student interactions	17.7 ± 2.39	11.5 ± 2.24	**19.2 ± 3.26**	9.57 ± 1.44
	Total duration of student interactions (min)	280.0 ± 66.1	176.1 ± 30.2	**306.2 ± 39.8**	198.4 ± 48.4
	Staff perceptions of student contributions to student progress (rank 1-7)	3.00 (1.00-3.00)	3.00 (2.00-4.00)	3.00 (2.00-4.00)	3.00 (2.00-4.00)
Student Questionnaires	**Number of peers interacted with**	**4.00 ± 0.45**	3.80 ± 0.58	3.15 ± 0.65	3.35 ± 0.48
	Number of tutors interacted with	**3.90 ± 0.44**	2.45 ± 0.38	3.15 ± 0.29	3.05 ± 0.32
	Number of interactions with most useful tutor	**4.50 ± 0.69**	3.90 ± 0.72	2.85 ± 0.34	3.05 ± 0.34
	Duration of interactions with most useful tutor (min)	78.75 ± 29.24	64.00 ± 16.34	**90.00 ± 14.42**	73.00 ± 13.24
	Number of interactions with most useful peer (min)	**5.65 ± 1.47**	3.35 ± 0.62	2.50 ± 0.55	2.50 ± 0.58
	Duration of interactions with most useful peer	**65.75 ± 17.65**	33.25 ± 8.92	19.00 ± 6.18	23.30 ± 5.57
	Student perceptions of student contributions to student progress (rank 1-7)	4.00 (3.00-4.00)	5.00 (4.00-5.00)	4.00 (3.00-5.00)	4.00 (3.00-5.00)

Changes in activity were detectable not only in terms of the number of interactions, but also in the number of people interacted with (students and staff) and the total duration of interactions (represented as a mean of the total each individual encountered). Thus, tutors interacted with more students, more frequently and for longer during stages 1 (project initiation) and stage 3 (data collection).

At each stage there were a total of 380 possible 'peer-peer' links between students. With between 63 and 80 of these links realised, there was an average of about 20% of possible interactions realised during any particular stage. Overall, 39% (147 links) were realised if interactions across the whole study period are used for the calculation. A slightly different pattern was observed with tutor-student links (with a maximum of 260 potential links across the network). In total, over half (57%) of the potential student-tutor links occurred and most of these links were student-initiated. There was an average of about a quarter (24%) of the potential links made with tutors at each stage (i.e. about four interacted with at each stage). Therefore, students interacted on an academic basis at least once with an average of almost half (47%) of the learning community. The size of peer networks varied across the field course (Likelihood ratio test: LR = 10.49, P = 0.001) with a decrease in an individual's network size as the course progressed.

How were interactions perceived by learners and tutors?

There was slight disparity between learners and tutors in how they perceived their contributions to the projects as a whole. Using the descriptors provided (Appendix 1) to describe the nature of interactions with students, tutors reported that they ' …provided strong guidance that helped the student to progress with their own ideas/methods/solutions which were initially unstructured and not well formulated'. However, learners reported a higher level of independence from the tutors, with a score of one ranking lower; the ranking increasing with increasing perceptions of help from the tutors. Thus learners' perceptions were ranked 4, closer to the score descriptor ranking of 3 which indicated that '…tutor(s) helped me to resolve some minor problems/ misunderstandings in my own ideas/methods/solutions which I then progressed with'.

Were learning networks associated with attainment?

The relationship between network size and learner attainment (based on their oral presentation marks awarded by tutors) provided an interesting finding. The peer network size of individuals (calculated as an average of reports from the four stages) was negatively correlated with their grade (r18 = -0.46, *P* = 0.04; Figure 1a).

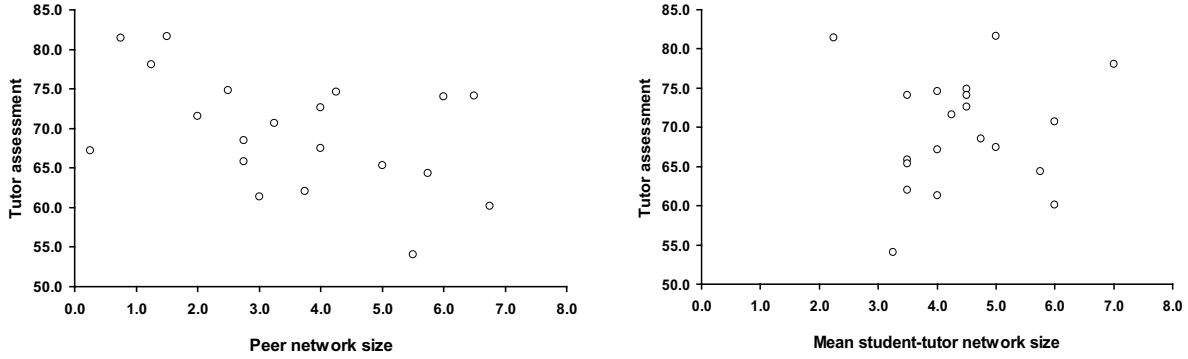

Figure 1 *(a) Tutor assessments (%) of oral presentations were negatively correlated with the peer network size during project development of the student presenters. (b) No relationship was detected between the number of tutors interacted with and student attainment.*

This implies the more gregarious students (in terms of learning communities) received lower marks. However, there was no relationship with attainment and the number of tutors interacted with for either all interactions (r18 = 0.08, *P* = 0.73: Figure 1b) or just for student initiated interactions (r18 = -0.25, *P* = 0.28).

Discussion

We have described a residential Bioscience course run in an EBL, learner-centred format and anecdotal discussions suggest that the students enjoyed the experience of setting and completing their own learning goals. Feedback gathered at the end of the field course indicated that students enjoyed the social aspects of the course (using terms such as 'great fun') as well as benefiting from the learning aspects ('excellent preparation for my final year project'). All students met the learning outcomes and passed the course. It is of note that these learners worked in a 'closed' environment during our residential course, with limited access to information resources (published literature) and no internet. Their main information resources were peers and tutors. We capitalised on an unusually high staff:student ratio and the 'closed' learning environment to explore what learners do if given a lot of choice in their interactions of people associated with the course itself. How far findings can be generalised (e.g. to campus University-based study) is a matter of debate and future study. However we believe that the insights we have gained into the networking strategies that students have adopted are valuable in researching learner behaviour, particularly when so many options were available to learners in terms of tutors, peers, project choice, working times etc.

The high number of links between individuals, changes in networking frequencies at different stages and anecdotal feedback on the benefits of academic exchanges throughout the field course lead us to believe that learners interacted dynamically as a network. We were surprised at the number of interactions and the dynamic nature of how people interacted. Extensive use of the potential learning network was realised in the duration of the study (Table 2), despite participants originating from different degree programmes and universities. We had anticipated smaller, closed groups of friends and a reliance on specific tutors; this was clearly not the case. This drives us to believe that the networks were in some sense "real" and also dynamic in nature.

This concept is furthered by previously presented network diagrams based on interactions with the 'most useful' tutor and 'most useful' peer (Langan *et al*, 2007). These provide evidence of a good dispersion of interactions across the network, with over 90% of the individuals reported as 'most important' by someone at (at least) one stage. This further supports the notion of a dynamic learning network. However, questionnaire responses indicated that the most critical interaction for learners, over the whole project, was always provided by a tutor. This is not surprising, and the value of interactions requires greater depth of exploration in future studies. The dynamics of the interactions that we observed were consistent with tutor experiences; with times of greatest activity among peers in the early formative stages. Pressure for tutors to interact was greatest when peers did not have the knowledge or skills base (i.e. problem during data collection and statistical analyses). Learners tended to interact with multiple individuals at each stage and on only one occasion did a student report the same individual as being the most important to them throughout the field course (Langan *et al*,2007).

Interestingly, learners with larger peer networks received lower summative marks for their oral presentations. Put simply, engaging in more interactions did not lead to high attainment. There are a number of potential reasons for this. For example, high attainment students may have been more selective in their networking, focusing their attention on small networks of other high attaining students and the nature of these types of interactions are currently being scrutinised. Alternatively, high attainers may be demonstrating higher levels of autonomy and proficiency in

engagement with the task, or perhaps they only seriously conversed with smaller groups as this was time efficient. This doesn't imply that the networking they do is not important, rather that they were adopting networking strategies that met their own learning needs. This further highlights the need to explore in more detail the student's perceptions of the quality of interactions and the value that is placed on different interactions. For example, we identified slight disparities in viewpoints about the extent to which tutors influenced the student progression (Table 3) with tutors indicating that they helped slightly more than the students reported. We are currently exploring further the importance of the quality of interactions in the context of adoption of strategic approaches to networking, and how these factors are associated with attainment. Clearly, any measures put in place by educators to facilitate networking need to consider their role in learner attainment, and benefits to all students, especially in small groups such as the one studied here, should not be assumed.

Furthermore, it seems intuitive that networking behaviour should be affected by the personalities of the people involved. We are currently attempting to overlay our network data with measures of learning styles of both learners and tutors. Preliminary investigations indicate that one index of learning styles (Felder and Silverman 1988) influences some networking patterns (see Langan *et al*, 2007). However, these initial explorations have revealed a very complex picture, there was not a simple 'like attracts like' outcome. We are now exploring the use of multivariate analysis techniques to utilise simultaneously our whole range of metrics.

Overall, we have presented evidence of a dynamic, closed learning network that emerged during an Enquiry Based Learning field course with high staffing levels and no online provision. We did not account for the associated social network, but monitoring academic interactions alone revealed that a large proportion of the potential interactions between individuals occurred. Strategic approaches to using the learning community were apparent and the size of networks had an inverse relationship with attainment. Tutors were key components of course, and provided the critical advice in all cases.

The task of educators in face to face, online and blended learning scenarios is to maximise the success of the diverse populations of their learning communities. Although Van Dijk (1999) predicted that the 21st century will be an 'age of networks' and that they will become the 'nervous system of our future society', this study highlights the complex nature of networks and the need for more detailed, exploration of emergent learning networks, ideally through both quantitative and qualitative methods and in a wide variety of educational settings. The current study raises the potential for future exploration of issues such as gender in networks, staffing levels and the role and availability of resources (e.g. online) in shaping learner networks.

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Communicating Author

Dr Mark Langan, Department of Environmental & Geographical Sciences, Manchester Metropolitan University, Manchester, UK. M1 5GD.
Tel: 0161 247 1583, Email: m.langan@mmu.ac.uk

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Appendix 1
Examples of descriptors in the questionnaires completed by tutors and learners after each project stage. These are indicative of the wording of questions in the 'exit' questionnaire.

Questions for learners

1. Academically, how difficult did you find it to get to this stage?
    1. Unchallenging – I possessed the knowledge and skills to complete this stage with minimal academic input from the tutor(s).
    2.
    3. Moderately challenging – Some elements of this stage proved moderately difficult and required clarification form the tutor(s).
    4.
    5. Very challenging – Some/many elements of this stage proved very difficult and required significant input from the tutor for me to complete this stage to my satisfaction
    6.
    7. Too challenging - I was totally reliant on the tutor(s) to complete this stage.
2. Which tutors did you interact with to reach this point and who instigated the initial discussion?
3. Who did you find the most useful?
4. Estimate how much time you interacted with this person academically since the last survey (Estimate Hours, Minutes) and how many separate interactions this involved? (Put this is brackets)
5. So far, how would you assess your contribution to the project with that of the tutors you have interacted with
    1. The tutor(s) provided me with a complete prescription/solution that I have followed exactly.
    2.
    3. The tutor(s) provided strong guidance that helped me to progress with my own ideas/ methods/solutions which were initially unstructured and not well formulated.
    4.
    5. The tutor(s) helped me to resolve some minor problems/misunderstandings in my own ideas/methods/solutions which I then progressed with.
    6.
    7. The tutor(s) confirmed that I should progress with my own ideas/methods/solutions.
6. Which students did you interact with academically to reach this point? (Prompt: it may have been no one)
7. Who did you find the most useful?
8. Estimate how much time you interacted with this student academically (Estimate Hours, Minutes)?

Please don't discuss your responses with other students or tutors. Thank You!!

Questions for tutors

1. For this stage of the project, which students have you interacted with academically and who instigated the discussion?
2. How much time did you spend interacting with each student academically during this stage (Estimate Hours, Minutes) and how many separate interactions this involved? (Put the latter in brackets)
3. How would you assess your contribution to the project with that of the students you have interacted with: (Prompt How much did you give it away)

1. I provided the student with a complete prescription/solution that they have followed exactly.
2.
3. I provided strong guidance that helped the student to progress with their own ideas/ methods/solutions which were initially unstructured and not well formulated.
4.
5. I helped the student to resolve some minor problems/misunderstandings in their own ideas/methods/solutions which they could then progress with.
6.
7. I confirmed that the student should progress with their own ideas/methods/solutions.