**Evaluating the Value of Flipped Teaching in Developing Communities of Practice among UoM Postgraduates**

**CHERIL Project – Final Report**

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**Abstract**

Clinical Genomics is a rapidly expanding area in the NHS, as evidenced by the creation of ‘Genomics England’ by the Department of Health to oversee the sequencing and analysis of the genomes of 100,000 patients. In order to translate these data into real patient benefit and deliver a personalised medicine approach, they need to be analysed by trained clinical bioinformaticians who have undergone / are undergoing study on the new Bioinformatics MSc at the University of Manchester. As bioinformatics is a new profession to the NHS and many of the clinical bioinformaticians are physically isolated, building strong networks or communities of practice (CoP) to provide support to one another is considered critical. Flipped teaching which focuses on group-focussed problem-based learning has been pioneered within the new Bioinformatics MSc at Manchester to facilitate the formation of CoP. In a cross-disciplinary study involving Manchester Institute of Education and the Schools of Computer Science and FBMH at the University of Manchester, postgraduate students from the MSc programme were interviewed about their experiences of the new teaching strategy and it was found that it did contribute to the development of CoP while the students were studying on the programme.

1. **Introduction**

The FBMH at the University of Manchester are contracted by Health Education England to deliver the masters programme in Clinical Bioinformatics and the third cohort completed their studies in July 2016. Although the students work together in university, for their training in host hospitals students may find themselves scattered across the UK and, in addition, the ‘clinical bioinformatician’ is very much a developing profession with few practitioners. Therefore many of the students are physically very isolated, thus building strong networks and communication links with their peers, or CoPs to provide support to one another is seen as very significant in enabling them to perform their role. Wenger (1998) also views CoPs as important in supporting and enhancing the delivery and support of effective healthcare. However, there remains a limited understanding of how to develop effective CoPs in healthcare. Therefore this Centre for Higher Education Research, Innovation and Learning (CHERIL)-funded project aimed to add new insights into this area by focusing specifically on whether aspects of clinical scientist training can be used to create and nurture CoPs in clinical science in the NHS (Wenger, 1998; Ranmuthugala et al. 2011).

The leaders of the new Clinical Bioinformatics Masters Programme have pioneered the use of an innovative style of ‘flipped teaching’ for clinical genomics for a cohort of post graduate taught (PGT) students who come from hospitals across the UK. Additional content and reading material were provided on Blackboard in advance of the taught sessions, which included traditional lectures. This face-to-face taught time also provided the opportunity for problem-based learning where the cohort were divided into groups and provided with clinical genomic case studies thereby enabling the students to engage in authentic bioinformatics-related activities. This meant that over the course of five afternoons, the students were able to undertake a series of group-based activities centred on these cases with each activity aligning closely with the learning outcomes for the curriculum. This approach has now been adopted with five different modules: two introductory and three more advanced.

To understand how pedagogical style might influence the development of CoPs required a unique collaboration between the Schools of Computer Science and FBMH and the Manchester Institute of Education (MIE). As the researchers from MIE were not members of the bioinformatics team, they were impartial to the outcome of the research and were able to work in an unbiased and value-free way. These measures enabled a study to be established to explore how successful the flipped teaching had been for clinical bioinformatics and whether it contributed to the development of CoPs in the first three cohorts from the course.

1. **Review of the Literature**
	1. **‘Interdisciplinary study’ and bioinformatics**

Since bioinformatics combines genomics with computer science, an appropriate way of thinking about the subject might be as ‘interdisciplinary study’ where two academic disciplines are combined into a single activity which crosses boundaries and the more traditional lines of thought (refer to Figure 1).



Figure 1: The clinical bioinformatician within the National Health Service

Although writing about interdisciplinary research rather than interdisciplinary study, Tait and Lyall (2007) offer suggestions about the problems that may occur and the personal skills needed to solve them, all of which seems appropriate here especially as the context for their research is genomics. Tait and Lyle (2007, p.1) define interdisciplinary research as 'occurring where the contributions of the various disciplines are integrated to provide holistic or systemic outcomes' and they further suggest that the crossing of boundaries lends itself to new problems which may be pertinent to bioinformatics due to the nature of the subject (p.3):

* Issues with language and communication
* Issues with different institutional structures and/or procedures
* Issues with divergence in worldviews/research approaches across disciplines

Tait and Lyall (2007, p.3) also provide a list of the various skills required to mediate or resolve these problems where individuals need to be:

* Flexible, adaptable and creative
* Curious about other disciplines and also willing to learn from other subject areas
* Open-minded to ideas originating from other disciplines and experiences
* High tolerance for ambiguity, thereby not prematurely reducing a problem to a limited set of dimensions
* Good communicators with good listening skills
* Able to bridge the gap between theory and practice
* Good team workers

Since these skills are crucial to both the learning of bioinformatics and the practice of bioinformatics in the workplace, it seems appropriate that the teaching of the discipline should not take the form of traditional lectures so that the necessary skills can be practiced and developed in a nurturing environment.

* 1. **Flipped Teaching**

When the lecturer ‘delivers’ information to his or her students in a transmissionist manner i.e. the teacher is the conduit of information that is provided to the students (Cobb, 1988; Aspinwall & Miller, 1997) and it could be described as lecture-style teaching i.e. what might be expected in a traditional university setting. However, moving away from the transmissionist method may better serve students’ diverse needs, not least because lecturers’ hour-long monologues are not what undergraduate students were used to in school (Harris & Pampaka, 2016). This lecture-style of teaching should now be unnecessary. Significant developments and improvements in technology have made it possible for tablet computers to reduce (or eliminate) the need for handwritten session notes, lecturers’ presentations can be made available for download before the session and Skype, chat rooms and forum posts have made it possible for students and lecturers to ‘meet’ without the need of being face-to-face (Brazas & Ouellette, 2013). In a further development, YouTube and other video sharing sites have also made it possible for lecturers to ‘flip’ their teaching (Bergmann & Sams, 2012) which means that the acquisition of new information can be completed away from the teaching/learning environment at the university; the precious face-to-face time can be spent on problem-based activities, exploring applications and synthesis of this new knowledge. That said, Brazas & Ouellette (2013, p.557) are concerned that bioinformatics training programmes need to stay current and advise that they should ‘integrate these advances and realities’ into their teaching. Bioinformaticians will therefore need to:

… stay aware of new developments in the online learning space in bioinformatics and continuously update its programming accordingly, as from experience, needs will change as the learning landscape changes. What exactly such future programs will look like though, remains an exciting predictive problem in a rapidly changing landscape (Brazas & Ouellette, 2013 p.561).

* 1. **Communities of Practice**

The purpose of this research project was to discover whether the student bioinformaticians formed a community or communities of practice when non-traditional lecture-style teaching was replaced by flipped teaching. In order to ascertain whether one or more CoPs were formed, Wenger’s 1998 key themes that characterize CoPs were investigated in the data: (i) mutual engagement of participants; (ii) concepts of the joint enterprise and (iii) shared repertoire.

In considering the ‘mutual engagement of participants’, Wenger proposes that the content and form of the practice is in constant negotiation by the people who are involved in the activities that form the practice. Moreover, the individuals who perform these negotiated activities develop close relationships amongst themselves and, at the same time, form and develop their community. Wenger asserts that the overriding issue here is ‘what makes mutual engagement possible’ (1998, p.74). Interaction is key here. A sense of belonging leads individuals into a form of engagement which, in turn, intensifies these feelings still further. At first the bonds between individuals may be quite tenuous but, with time, a transformation can occur such that the community becomes (and is seen to become) a CoP. Further, Wenger (1998) describes the individuals within the CoP as having unique characteristics, different temperaments, disparate attitudes and who therefore do not form a homogenous group. The collection of skills, knowledge (and not knowing), personal preferences and attitudes require each member of the community to ‘connect meaningfully… to the contributions and knowledge of others’ (ibid, p.76). By sharing both the common things of their life practice and the specialities of their work practice, their interpersonal relationships have the opportunity to develop and grow. However, the CoP members do not have to agree because 'what makes engagement in practice possible and productive is as much matter of diversity as it is of homogeneity’ (ibid, p.75) and this feature makes CoPs especially pertinent to intercultural groups.

The second key theme is ‘joint enterprise’ which is a collective response by community members to their common situation (ibid, p.73). The enterprise is created in full knowledge of any opposing forces and influences where the individuals’ personal aims, hopes and fears have to be offered, discussed and possibly put-aside as the emerging common enterprise is designed and created. For the members of the CoP, this negotiation is a ‘response to their situation and thus belongs to them in a profound sense, in spite of all the forces and influences that are beyond their control’ (ibid, p.77). Nevertheless, as a joint undertaking, it is expected that all participants will contribute to the CoP regardless of any disagreements and this will also involve negotiating how individuals are accountable to others in the community. CoPs can emerge even under particularly constraining circumstances with necessarily greater compromise amongst the community members.

The third theme is the ‘shared repertoire’ which is a product of the joint development of approaches, procedures, forms of speech and activities which are created through joint interaction over time (Wenger, 1998). The shared repertoire, however, is not a static phenomenon because it is influenced by group members’ personal repertoires as well as the (possibly idiosyncratic) activities carried out by the CoP such that its members are creating and reinforcing new repertoires (Somekh & Pearson, 2002). In his ‘structuration theory’, Giddens (1986) recognized a comparable system which advocates that there is a relationship between human agency and social structure such that the repetition of the acts of the individuals reproduces the structure. Furthermore, Giddens and Pierson (1998, p.77) argue that, 'society only has form, and that form only has effects on people, in so far as structure is produced and reproduced in what people do'.

A further issue is reification where the shared experiences of the CoP around which members organize their participation are forms of reification and may include both physical and conceptual artefacts. Wenger (1998, p.58-59) used the concept of reification,

. . . very generally to refer to the process of giving form to our experience by producing objects that congeal this experience into ‘‘thingness’’ . . . With the term reification, I mean to cover a wide range of processes that include making, designing, representing, naming, encoding and describing as well as perceiving, interpreting, using, reusing, decoding and recasting.

Reification involves articulating successes, failures and emerging limitations of joint resources. In this way, reification can make an abstract and concise representation of what is active involvement within the CoP and, in so doing, quite complex (and even messy) practices can be made easier to share.

Wenger, McDermott, and Snyder (2002, p.4) define CoPs as ‘groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their understanding of this area by interacting on an ongoing basis’. That is not to say that members of the CoPs necessarily work together every day but, when they do, they find value in their interactions.

* 1. **Application of Communities of Practice in Bioinformatics**

As already explained, bioinformatics is an emergent discipline, currently with few practitioners. Therefore the formation of a bioinformaticians' community (or communities) of practice seems a sensible way forward since the practitioners are very often working in isolation in hospitals etc., designing and developing and maintaining new analysis pipelines to deal with the huge quantities of genomic data being generated. A CoP would be comprised of bioinformaticians who could share knowledge, ideas and strategies, determine solutions, develop innovations and finally contribute to and develop the community with their diversity of experiences.

Having identified the need for bioinformatics communities, Budd et al. (2015) have set out some general principles for creating effective communities which are fuelled by higher Internet speeds, big data production and more open-source projects which are then accessible to an international audience and lead to international projects. They highlight the significance of openness and communication in establishing a bioinformatics community but also the need for these features for the effective functioning of the group. Budd et al. (2015, p.8) also stress that their most significant finding was that scientific communities are ‘at the heart of many fulfilling bioinformatics-related careers’ which in turn underlines the importance for scientists of ‘finding and participating in communities that align with their interests, goals, and values’.

1. **The Research Methodology**

The aim of this study was to explore postgraduates’ views and arguments concerning the teaching on the new Bioinformatics MSc at the University of Manchester. With funding from the Centre for Higher Education Research, Innovation and Learning (CHERIL), data were collected in the form of semi-structured interviews which is a well understood methodology evolving mainly from sociology-based approaches and entails a scheduled prolonged conversation (Cresswell, 2007). Unlike the direct measurement of participant performance which would be normal in more formal laboratory settings, the interviews produced qualitative data which occurred as part of the one-to-one process. This type of interview encourages the interviewee to answer at length and in detail, and includes a responsive interview style where the researcher may follow the interviewee’s direction (Rubin & Rubin, 2011).

Ethics approval for this research was obtained from The School of Computer Science prior to any of the interviews being arranged. During September/October 2015 the interview questions were refined and volunteers were recruited to the study. Eight postgraduate students from the three year groups in the programme volunteered to be interviewed by a qualified researcher from Manchester Institute of Education who had not been involved in teaching the course and who was not known by the students. These interviews took place during November and December 2015 while the students were on campus. The information sought from the students is detailed in the table in Appendix 1. The majority of the interviews took place face-to-face at a suitable venue within the School but there were also two that were conducted by phone. Each interview was planned to last for a maximum of an hour during which time no more than ten questions would be asked. The interviews revealed the students’ experiences of and their engagement with the new Bioinformatics MSc at the University of Manchester and how this shaped their interaction with the other postgraduates on the programme. The student interviews were audio-recorded were then formally transcribed ensuring that due care was taken in anonymizing the participant information as well as any comments or notes which could lead to the participants’ identification being deduced by third-parties.

A narrative is any text or discourse and these naturally occurring language data can be analysed using narrative analysis (Cresswell, 2007 p.55). The characteristic that makes narrative analysis different from any other qualitative research (except perhaps case study work) is the focus on storytelling to describe situations and account for events (Riessman, 2008 p.12). In this project, although the interviews were of a semi-structured format, the narratives were ‘strategic, functional, and purposeful’ (ibid, p.8) and therefore a narrative analysis of the interview transcripts could be undertaken. According to Riessman (2008) these narrative stories could be analysed in a variety of ways i.e. by what was said (thematically), the nature of the telling of the story (structurally) or the way in which the story was told (dialogically/performance). In qualitative research, narratives can be used using a thematic approach. Thematic analysis was identified as the most suitable approach because of its flexibility which allows for rich, detailed and complex description of the research data. Initially two of the anonymised interviews were analysed independently by the two researchers from MIE and, although there was general agreement about the emergent themes, they were discussed at length to ensure that they were relevant to identifying whether there was evidence supporting the existence of a community of practice. The remaining six interviews were then analysed using the identified themes.

Ten emergent themes were identified from the data. The eight substantial interviews (over 500,000 words in total) were coded according to these themes:

* *Communities of Practice –* shared repertoire (bioinformatics) of new practice
* *New career* – the specialism has no history and so depends on negotiation with potential employers
* *Isolation in practice –* students talk about being ‘the only one’ in the hospital
* *Accountability* – the practice is not established
* *Teaching/Learning*
	+ *Group work*
	+ *Traditional lectures*
	+ *Flipped teaching*
* *Ownership of the course –* student feedback has influenced subsequent presentations of the course
* *Joint enterprise* – nothing decided by the institutions/professional body so ‘joint enterprise’ is the decision, responsibility of the group.
* *Talk about group and dynamics –* not during studies but social aspects and holidays*.*

The rationale for this research project was to explore and reflect on the postgraduates’ experiences of the Bioinformatics MSc at the University of Manchester and the ways in which it encouraged engagement with others, collaborative working and the development of CoP. The report will therefore address the following research questions:

1. To what extent do CoP exist within the clinical bioinformatics cohort?
2. To what extent has the pedagogic methodology helped to create and nurture this community?

The quotations and short extracts included in this report focus on the postgraduates’ learning experiences and also serve to provide insights into the way in which the students engaged with one another and also the formation of communities of practice during their time in university and also during their placements in hospitals spread across the UK.

1. **Findings**

In the following discussion, the postgraduate students are: Sarah (1st year); Heather, Louise and Gemma (2nd year); and Emma, Chloé, Peter and Ryan (3rd year). Short extracts from the interview transcripts are provided.

1. ***To what extent do CoPs exist within the clinical bioinformatics cohort?***

Although clinical bioinformatics is a shared endeavour for the postgraduates, their responses suggest that their interaction in/across different contexts varies and so the findings for this research question will be reported under the following headings:

* 1. Within each year group
	2. Across the three year groups currently studying at the University of Manchester
	3. On placement

The themes that were identified in the narrative interviews generally fall under one of these sub-headings but CoP is relevant to all three.

1. **Within each year group**
2. ***Communities of Practice – shared repertoire (bioinformatics) of new practice***

All eight postgraduates were enthusiastic about the programme and spoke about the ways they communicated with other members of the cohort. Heather was describing how the students normally communicate via email:

Heather: Yeah absolutely so if we have issues with anything from coursework to lab work or like, for example, if I wanted to, erm, do a survey with the students or find out all their opinions on something, then I have no problem doing that I can just email them or text them and say ‘right sent you an email can you send me a reply as soon as possible’ that kind of thing.

She was also asked whether they used social media at all:

Heather: Yeah email we have WhatsApp group and I think there's an NHS network group that we have as well, erm, and then obviously our Manchester email is our main method of communication with the other students.

Chloé gives a lot more detail about the benefit of the emails which enable the students to gain support from the other students in the cohort between teaching sessions:

Chloé: Yes ‘cos otherwise I think, er, there would have been a much higher attrition rate to be honest, particularly in the first year. There was a lot of, erm, emails going back and forth going, ‘what are we doing? Help!’ Not so much my case in the sense that I am not a quitter. I wouldn’t have quitted regardless but I did worry that a couple of people would fall off the wayside and towards the end of the first year, because of the good environment and the fact that everyone was helping each other out, it kind of felt like we could just push through. But that initial period I think is very stressful for people that don't have support in their labs so it’s really good to have a good network which we do.

She went on to describe the ways in which four or five students supported the others by raising appropriate questions, by responding quickly to questions and by signalling important reading materials:

Chloé: There's like four or five people that are constantly going, ‘I found a new really good resource’ erm, so there's people that give resources, there's people that put questions up which are really good questions not like, you know, silly questions but like, ‘I've been doing this like this, I think it’s right what do you guys reckon, what do you use instead?’ blah, blah, blah, then a little bit of discussion but you always get the same four or five people that respond really but when you speak to them here you know that everybody else is reading it, if that makes sense? So everyone’s getting benefit but you do get that core kind of group of people that either are always thinking of the rest of the group by always posting things that they find useful or are always trying to bring the level up by going ‘guys what do you think?’

In addition to the students supporting one another by conveying what they believe to be relevant information via email, they also support one another during the sessions. When asked if everybody was comfortable about explaining concepts that perhaps some were very familiar with while others were less certain, Peter explains:

Peter: Oh the group work, the group work lends itself very well to that one I guess, on the proviso that you get people who are good and are willing to do the explaining but there's certainly been loads, you know, loads of stuff that I have just been not very familiar with but, you know, people have done it, covered it with their PhDs or their previous jobs or whatever and have been able to explain that to other members of the group and likewise I've been able to do that for things that I'm more experienced in than others.

Interviewer: You've not minded doing that?

Peter: No like I said the, erm, certainly the people in our year group are very, I don't know how to put it, just nice normal people, you know, and nobody has a superiority complex or anything or ‘I know this therefore, you know, I am, you know, better than you or higher up than you now’ it’s very felt very much felt like, erm, collaborative rather than competitive environment.

Peter exemplifies this notion of a collaborative rather than competitive environment:

Peter: It’s like, you know, what we have in common, erm, yeah, you know, if someone has a problem, you know, there's twelve of us to help, that's normally the case… Nobody, nobody assumes that anyone should know X, Y or Z; there's a very, there's a real sense of community which is something that was pushed quite hard from various outside sources like [one of the programme leaders] and our trainers to a certain extent.

As part of the masters programme, the postgraduates spend two weeks at the University X. It proved to be a difficult experience but they supported one another through it:

Peter: The fact that we knew each other already, we were kind of able to band together and suffer, suffer together as it were, you know. In [University X] we were all based in a couple of apartment blocks, erm, so most of us were kind of living, almost living together so we spent evenings, maybe not quite going over work but, you know, being able to decompress about the day shall we say and, you know, and kind of go through stuff together to yeah just revise a few of the concepts and again just to talk it out, you know, again being able to do that with people that you know and trust. It’s amazing how quickly you can kind of build those relationships. And if, you know, the teaching had happened the other way round we it would not have, erm, coped with it as well, definitely.

More generally, Ryan spoke about the benefits of the web forum that the third year students had established:

Ryan: Yeah so we have, erm, like a web forum that we all kind of communicate through so, erm, you know, when we meet up, you know, inevitably we talk a lot about work as well, erm, but predominantly because we only meet up three times a year or maybe, you know, plus any conferences so, erm, the majority of it is done online. You know, someone will ask a question or sort of share a resource or, erm, erm, yeah I think it started off kind of asking a lot more questions like ‘how have you done this? What have you done for this?’ and then as time’s gone on we've kind of more shared resources rather than ask, you know, for guidance I guess.

Gemma also spoke about sharing resources. She reported that if any of them got in touch with the programme leaders about the course material or more general questions as a result of the work on their placements, this information was shared with the others:

Gemma: Yeah if any of them do ever speak to either [programme leaders] they normally reiterate it, it gets sort of disseminated among our group.

So across the individual one year cohorts there appears to be collaborative working and support for one another thereby suggesting individual communities of practice, defined by year group. The next section examines whether there is collaborative working across the years.

1. **Within the three year groups currently studying at the University of Manchester**
2. ***Communities of Practice – shared repertoire (bioinformatics) of new practice***

Although the interviewees spoke about the way they worked together and felt able to ask one another questions etc. in their year groups according to Chloé, this congeniality did not extend across to the other two years:

Chloé: Yeah so it would be really beneficial I think if there was some way of getting us to do stuff together at some point, you know, maybe towards the end of the first year, you know, meeting with the second years, even if it is not a ‘third years meet first years’ but at least know the year below. It doesn’t seem to work across, I mean they probably works horizontally if that makes sense but I think we need something to make it vertical. I think the fact that we don’t know each other so if I didn't have my two trainees, they're not mine really but our lab’s trainees, erm, but if they weren't there I wouldn’t know anybody in the second year at all so it would be I'd feel weird emailing out complete random strangers going ‘hi’ because you don't know if you're if they appreciate the resources or they thinking you're annoying or stressing them out because we have some people that the more resources you give them the more the kind of like, you know, stress so in that respect you, I think that I wouldn’t feel as free to kind of go ‘I found a really, really good course about blah’ and just emailing it which is what I do with my course because I know who get, who basically does them and who just ignores the email which is fine and they know that I just bombard them with ‘oh this is a great course and blah, blah’ or and like today I'm just about to put the calculus lectures that I've been doing this week because I thought it could be useful, you know, I've seen what we’re doing now and I think knowing the level of maths of at least three of the trainees below I think one of them will benefit so I’ll put it up, you know what I mean?

Louise also does not have much interaction with the other years, apart from during her role as year representative:

Louise: I don’t think there's much I mean I see the other representatives when we have the committee meetings so I have contact with them through that, erm, and then obviously the ones that are in, that are kind of above us and below us in our labs we talk to them and then as a group we would maybe share things about those people that we work with but I don’t think the kind of three groups ever as a group interact really. We see each other sometimes if we’re at a conference but again that would be, we would be introduced to them because they work with someone that we know rather than they just come up to us and be like ‘oh you're another bioinformatics trainee’ kind of thing so, erm, I think we do kind of know of the other trainees but we don’t really know them.

Louise also had views about whether having the opportunity to get to know the other two years would have been useful:

Louise: I think it would, erm, I think (pause) especially in kind of future after we finish the programme. I think if sometimes it would maybe be abused from kind of the lower years constantly emailing saying ‘what did you do for this? How did you do that?’ and, you know, that kind of thing and that would maybe be somewhat frustrating for the people who were always being emailed, erm, but as long as that kind of balance was maintained then I think it would be good to have more of a relationship with them pure and especially because there are some hospitals that take a trainee and then don’t take anymore or have a break for a year so they've only got one that but that one is a year above all of the new trainees and or the first time they get a trainee they've not really got any experience in the training programme, particularly with bioinformatics ‘cos it’s so new, no one really knows how to go about it so if they've not had a trainee before, knowing *a* second year trainee might be helpful for them, erm, and it would just be nice to kind of get to know them really because eventually we’ll probably end up working together so, erm, I think it would be it would be nice.

1. **On placement**
2. ***Communities of Practice – shared repertoire (bioinformatics) of new practice***

In addition to email and social media that has been commented on previously, Emma described the value of the Google Group albeit that it is used most when the students were not in university:

Emma: Er, yeah well they posted it in the Google group they’ll post it, they’ll post there saying like, you know, ‘[the programme leader] posted this paper’ and then people will go like ‘cool’ or whatever. Yeah so it works I think in terms of we do try to help each other and if there's a deadline coming up people will post as well saying ‘there's a deadline don’t forget’, ‘we need to submit this stuff’, erm, but for the project they've asked us to submit something for preparation work presumably because they want to discuss it this week. I think they try to keep the workload as light as they can because they know that we’re just swamped with rubbish in our, basically rubbish, in our Trusts because people are in such awkward situations with very limited support erm, so, you know, people are trying to work out how to do things themselves rather than being shown how to do them so I think they're trying to keep extra busy work to, they keep busy work to a minimum I think and try and keep things sort of on target and focused which is nice ‘cos if they were just handing out random assignments I don’t think I don’t think I could cope to be honest.

Emma has explained how difficult things can be and the students fell that this is in part because bioinformatics is a new discipline and therefore they are embarking on a new career where the specialism has no history and so depends on negotiation with potential employers.

1. ***New career***

As previously described, clinical bioinformatics is a very new subject at university and also as a career. Heather explains that before she started the programme, she had no contact with anyone who was already in the role:

Heather: All I knew about it was what was on the National School website. It was, it’s quite intimidating I think because you don’t quite know what you're going to be expected to do especially as the information on the website wasn’t very, erm, comprehensive save for genetics.

She also did not seem entirely sure about her responsibilities when she went out on her placement but the hospital staff seemed uncertain too. However she felt that the programme has prepared her for all eventualities:

Heather: So I think the reason that it’s not entirely clear what our role will be is because, erm, different people seem to have different ideas, even within the hospital different people have different ideas of what we will be doing day to day, but I feel like the course has kind of prepared me quite well for a variety of people’s opinions. Basically so I’ve got everything from being able to, erm, analyse sequencing and writing reports all the way through to kind of building the pipeline itself in order to extract data.

When asked if she received any support from management or from colleagues, she replied:

Heather: Erm, not really no, erm, once I started at the, once I started at the hospital because I obviously had my training officer and, erm, another girl who’s in the year above me who’s on the same course, erm, but I think it’s quite a widespread problem of there's not very many specifics on what our role will be in the NHS so it’s kind of , or our lab anyway, I think it’s a bit kind of do what is appropriate at the time to help people out, things like that, and learn on the way.

Louise also sees an element of her role on placement as being ‘to help people out’ but she is more pragmatic about the workload during hospital placements in that she/she recognizes that it is very much a case of what the hospital can offer:

Louise: I think that, yeah, mostly circumstances. I think it’s just dependent on what your hospital can offer you, erm, I was fortunate in that when I went on my rotations I had a very specific project to do and that helped me kind of gain a lot of skills and then as soon as I came back our bioinformatician was very keen for me to get involved with working on the pipeline and understanding how it works and looking at some of the tools and stuff, erm, mostly because she didn't have time to do all that stuff.

Currently, because there are so few trainees, they find that they are ‘the only one’ in their placement hospitals.

1. ***Isolation in practice***

Although the interviewees have already explained that there is little or no interaction with the other years studying bioinformatics, Heather felt that it would be helpful for standardising procedures etc. as the students take up positions in hospitals throughout the UK. Also, Heather felt that she would stay in touch with the people she worked with in hospital but not the other years at university:

Heather: Erm, the people that I'm in the hospital with I probably will but I haven't we haven't really interacted at University at all with the other, in fact we haven't interacted at University at all, erm, with the other two years, erm, but I think that might be something that would be really useful if that could be rearranged because there's so few relatively few people in our discipline at the moment in the NHS I think it would be really useful and helpful for building contacts throughout the whole of the UK so that we get more of, erm, a standardised procedure for things ‘cos at the moment it’s all very different in each of the hospitals how they go about making their pipelines and doing that sort of thing so I think it would be useful from an NHS point of view if we could all, erm, kind of use the same techniques or the same languages to programme in so that we could share resources so that each hospital didn't have to create their own.

Heather believed that as a fledgling career, university was the right place for these introductions so that newly qualified people had contacts from whom they could seek information:

Heather: Yeah, err, I mean at least initially, obviously there's other bioinformaticians that are already in service, erm, so wouldn't cover them but seeing as I'm only in the second year of people who are qualifying it might be quite nice to meet the people in the years around you so that you have some more idea of who to contact or find out what they're doing in their future jobs or something once they've finished.

In the future Gemma hoped that she would not be the only one in the hospital but knew that she has her friends within the cohort to support her:

Gemma: Yeah definitely, erm, I'm hoping that I won’t always be the only one, erm, and that's how we will work in the future, erm, although aside from that we, erm, as a cohort we're quite good friends, erm, we keep in contact constantly, erm, and I think that group work really helps with that so if I've got any problems or any questions even though I am isolated within my department, erm, I've always got the other people on my cohort to refer back to if I've got any questions.

Due to bioinformatics being a new discipline and a new career and the majority of the students are working in isolation in their respective hospitals, the practice is not established and so there is the matter of accountability.

1. ***Accountability***

The programme leaders are obliged to account for the curriculum delivered on the new MSc in Bioinformatics and must accept responsibility for the decisions made about the programme. The programme leaders are obliged to account for the curriculum delivered on the new MSc in Bioinformatics and must accept responsibility for the decisions made about the programme. In order to ensure that the course is relevant, they discuss the students’ experiences in hospital and Peter recounts the type of questions that he is asked:

Peter: ..I, you know, had lots of conversations with [the programme leaders] about how and why they've designed a programme and they come to myself and, erm, my colleague in [hospital] and said, you know, ‘does this’, you know, ‘do you do this? ‘does this fit in with what the workplace training needs to deliver?’ ‘can, you know, can we be more efficient, can we kill two birds with one stone?’ that sort of thing. You can really see that there's a definite deliberate effort to make the academic stuff really applicable in the workplace, yeah.

The programme leaders also ensure that the tasks that they set are not simply relevant to the programme but also for the students’ future careers, as Ryan explains:

Ryan: Erm, I think like [the programme leaders] are very good at remembering that we are like kind of learning what the demands of clinical setting are; I think they're very aware of that the demands can be very, very different to other settings… Whenever they ask us to do things, they ask us to do things with that in mind which is very, erm, relevant to our programme and to our jobs long-term so without that I think the sort of stuff we would be doing would be far less or, you know, we’d end up kind of using things that would not be relevant and waste, not wasting time but, er, you water down the important bits.

1. ***To what extent has the pedagogic methodology helped to create and nurture this community?***
2. ***Teaching/Learning***
	1. ***Group work***

Whilst in university, the students are taught in groups and Heather was asked if she could remember the very first taught section of the course and, if she could, how did she find the relationship with the students in that first face to face session:

Heather: Erm, it was actually quite good, erm, because we were immediately kind of introduced to each other and put into teams to work in so we got to know a few of them very well very quickly and then after that, in the weeks that followed the first day that we did that, we were put into different teams. I think I ended up getting to know most of the people in my group very well.

Apart from the social aspects of team-working, Heather also recognizes that the differences in students’ backgrounds may bring the advantage of working with a more knowledgeable peer:

Heather: It is it’s nice because we all bring different aspects to or different points of view to our challenges that we get set to do, erm, so there might be somebody who’s more confident so, for example, in our group work this time one of the girls had quite a lot of experience of looking at the files that we were trying to extract the data from whereas I'd had experience in outputting a file using code so I was able to bring that experience, she was able to show me what it was that they wanted from the document and one of the other girls had experience of searching through information, erm, so we were able to kind of use each of our different expertise that may teach each other what we already knew to try and figure out what we were trying to get the answer from.

Chloé also believes that this is a really good way to learn, especially because the groups are mixed up i.e. the students are not always working with the same people:

Chloé: So they have made it so that we’re not always in the same group which is really good because it means you don't stuck stick to your friend Betty, etc.

However Chloé explained that occasionally there were drawbacks when someone in the group had prior experience of the topic and knew what they were doing and there was therefore insufficient work for the four of them to do:

Chloé: … it got done too quickly by the person that really knew what they were doing and the rest were just kind of a bit tense because you still then had to continue working on that thing that was already pretty much finished for another three days so it was kind of trying to find things you could learn on top of that which we did and it was fine and we’re, you know, quite a nice group and we still get along, like that person we have no problem with them as a person, it was just in that particular scenario the dynamics of group work can be better or worse depending on how you work with people if that makes sense?

Chloé was quite philosophical about this situation; appreciating that it was really useful because it provided an opportunity to learn from one another and people feel comfortable about asking one another questions:

Chloé: You learn a lot more from each other and we have this situation where people have no problem expressing when they don’t understand something which is a very good thing because that is something that when I was a teacher I used to find people really struggled with is admitting that they didn't know but because of the way it works and because everybody’s getting a different amount of training we are all very happy to go ‘I have no idea what you're talking about’ ‘oh right we do this in our Trust’ you have different things that you do or you've been studying in your Trust etc. so in that respect you learn a lot more I think than I would have done if it was just lectures which I could do at home by myself.

Chloé was also very positive about the group work but when asked if she felt that they would get to know one another so well if the cohort were larger:

Chloé: No, no it wouldn’t because it only works I think because you get to, well this is my opinion obviously I might be wrong, you get to work with the same people in slightly different groups over and over. We’re only here twice a year so if the group was of say two hundred people you wouldn't work with the same people person a second time so you wouldn't get to know them as well. Similarly if you just group it, work in the same group all the time you wouldn't get to the dynamics. Would this group of four become friendly or hate each other erm, and the rest would be complete unknown strangers; that would be my impression. So I think it’s an important, the size of the group is important I think. Yeah I think if we were like fifty it wouldn’t work. But maybe I’m wrong, I'm happy to be proved wrong but yeah I think it’s that's an important, unless it was like a full year if that makes sense. So if you had a full year module or a three month module where you had groups of three or four or whatever and you were constantly moving them round over a, you know, couple of months then you might be getting the same dynamics but I think because we have such short one week, one week, one week I don’t think you'd get that level of knowing the other person before you've left so you wouldn’t get that kind of openness I think.

Ryan agreed with this view of the group work, reiterating that everyone remains close although there may be frustrations over the work:

Ryan: I don’t think so I think, erm, (pause) I think everybody’s still very close and, erm, you know, if there are arguments it’s, there's no need to kind of, you know, kiss and make up or anything like that, you know, it’s everyone gets on with each other there's no, you know, it doesn’t cause any long lasting sort of issues.

However Ryan does have mixed feelings about the composition of the groups being left to the students during their final year which has resulted in cliques within the year group so that people always work together:

Ryan: I know the people I'm working with but you also know the problems that are associated so you don't have to, erm, you know what you're getting basically, erm, whereas if you were to just change groups again I wouldn't be against that at all, erm, but equally I think so but then, you know, you've also got the initial kind of working out how other people work, erm, to take on board as well but, erm (pause) so yes it’s, I don't know what's best.

* 1. ***Traditional lectures***

The programme has adopted a different pedagogical approach: flipped teaching where the students have the opportunity to familiarise themselves with the subject matter ahead of the sessions. As a non-native speaker, Sarah explains the problems that she encounters with traditional lectures, especially when she is not provided with the lecture materials ahead of time:

Sarah: Well I don't know how you're expect to prepare that because you will have the slides, you will read them and, you know, it’s bullet points. In between the bullet points it’s a lot that was said that you didn't capture but this that was not written will come into the exam and you won’t know, erm, for me this, and I always ask I always ask to everybody ‘can you put the presentation in advance so that I can bring them, go over first, go there’, and English is not my mother tongue, so I go over first, I have an idea what they are going to speak and oh this looks complicated and then when I am there thinking ‘oh the complicated part’ it’s not this complicated because I have already look at that and I know everybody prefers to be spontaneous and maybe they go very far and very well. In my case, no, and I think either you're a spontaneous person or you prepare a person. Putting a slide in advance is not a big deal for the teacher because they have to have them anyway and they may do some addition after that but, you know, it’s just one or two slide in a ninety four slides presentation it’s not a big deal and so I think is this a kind of not being systematic sometimes so I always ask ‘can you put the whole presentation in advance’ and then if people want to prepare it before or there's not but you have the option. I love it.

In addition to the issues with not having the lecture notes in their traditional lectures, they were also asked whether they felt that the communication that they had had with the other students outside of the face-to-face sessions would have still occurred if they had been taught exclusively in traditional lectures:

Ryan: Erm (pause) I doubt we’d be as close definitely, so the fact that we all have to come to uni for like couple weeks at a time will, you know, erm, and we’ll all go and we’re going through sort of a very confusing training programme as well that's kind of that's drawn us to, you know, that that would have drawn us together and looked for the support that I think that, yeah actually doing the group work has been the biggest sort of gel I think.

When asked why this should be so, Ryan responds:

Ryan: Because you just get to know each other more and, you know, ‘cos there's a quite a small group of us we, you know, do the lectures in the morning and then they’ll sort of put us into our groups before lunch and then we’ll all kind of go off to group, go off to lunch in our group as and when we want, erm, and same if we want to go off for coffee, so, erm, over the first few years because you're in the groups kept changing you’d go and spend some kind of time in very, very small groups together, erm, and event eventually, you know, you get to know each other whereas I think if you were just sitting in lectures you might talk to people sat next to you but, erm, I don’t I think people would then go and sit in the same places every day and you might get to know whoever you sit next to, it’s probably whoever you sit next to on the first day you then get to know for the rest of the programme or you get to know them best, erm, you know, it takes someone to kind of, it’ll take someone to organise a group like that just to stand up and say ‘does anyone want to go for a beer or anything?’ whereas what we've got now is a much more inclusive, erm, you know, group that with that didn't need one of us to kind of stand up and sort of be that that, erm, instigator I guess.

Part of the programme takes place at University X and their style of teaching is somewhat different from Manchester in that they have retained traditional lectures (some of them quite intense) as Ryan explains:

Ryan: Erm, and then when we went to [University X] for two weeks again that was more the traditional sort of lecture where you're just sitting there and taking notes, erm, I think there was a few practicals, erm, but that, you know, I think [University X] it was, they were teaching us physics which no I think only one of us actually did at A level even so and they're teaching us it at a Master’s level so the teaching wasn’t the problem it was the fact that we couldn’t understand a word they were saying and that was, yeah, a bit demoralising.

The students had started their programme at Manchester and Louise explained how he/she thought the relationships would have developed if the cohort had first met at University X:

Louise: I think, erm, I think if we’d had the, I definitely don’t think we’d have had the same relationships if we’d if it had been the other way around because we were completely mixed up in the first kind of lot of teaching so I mean automatically when you arrive you kind of try and talk to the people who are on your specialism because they're kind of a common you've got a common ground but because we were completely mixed we were kind of not forced to talk to them but there was more of an opportunity to build that kind of relationship and get more of an understanding of how they work and what they know and their background and things like that whereas if we’d been in the lectures I don’t think we’d have expanded much outside our small cohorts. I mean just basing that on the fact that we were also there with the medical physics students and we were still very segregated, we didn't really interact with them much, I mean briefly and we kind of went for drinks a couple of times but even that was very a very segregated social occasion anyway so, erm, I think if they it would, I mean I think maybe they would have evolved if in that second lot of teaching but it would have taken longer I think. Erm, and because we already had those relationships when we got to [University X] and found everything difficult we knew who we could talk to and be like ‘I don’t get it could you explain it to me?’ kind of thing, so I think that was helpful.

* 1. ***Flipped teaching***

In flipped teaching, the students gain their first exposure to new material outside the lecture hall, laboratory or tutorial room. It is usually presented via reading or lecture videos, and then the sessions can be used for utilising this new knowledge; in this project via group problem-solving activities. Emma finds this approach helpful but sometimes has problems in trying to fit the reading in to the time she has available:

Emma: Erm, it varies a bit so sometimes there's, we've been given a few papers to read and things but then, you know, you start reading them and you think ‘oh I don’t understand this’ or you start reading them but when you've got time, erm, and it goes well erm, so I was reading some on the train last night but I was just like ‘I just I just can’t , I can’t follow this paper’, you know, sometimes they start I think a bit too hard.

Although Emma has some issues with the reading, Gemma feels that it gives her adequate background information to be able to complete the tasks during the group sessions at university:

Gemma: I think they do really well preparing us for that sort of thing most of the time.

Interviewer: Okay but it’s not that you're not kind of told too much? So do you still feel like you're learning from the group task as well?

Gemma: Yeah exactly and then if you get really stuck, erm, there's always multiple people that help you and make you feel a bit better about it so, yeah I think they are good at doing that.

Louise found the preparation materials useful in that they helped her to understand what the software packages were actually doing ‘underneath’:

Louise: It’s not that they kind of give you a task and say ‘go away and do it’. You've kind of had that teaching of what's actually going on underneath and then you do the underneath and then they show you the top, erm, and it’s logical when you think about it… I think for people who don’t understand what’s going on underneath it is very beneficial because it’s very easy to find a piece of software that does what you want it to do and not actually understand what it’s doing and I found that a lot from working with the clinical scientists; they've been recommended something by another lab or the best practice guidelines and they just use it and they take it at face value and to the point where I've done some training with them to say, ‘actually you should be looking at this and this is what you should look out for and this is where the problems are’ and things like that and they were kind of unaware of that because they just they see what comes out and just think it’s the same every time or it’s completely accurate or it’s, you know, where if they did it again they’d get the same result and that's not necessarily always the case.

Although Louise appreciates the value of the flipped teaching because it has helped her to understand ‘at a kind of deeper level’ what the computer program is actually doing because she’s done it by hand, on occasions, she does find this approach frustrating:

Louise: I think, erm, in my experience as I said before that I've sometimes come across the tasks before the teaching but if it had been the other way around it definitely would have been a very good starting point, erm to go into things. I sometimes think the lectures and the tasks are a bit backwards in terms, just in terms of like we’d have an aim for that kind of group work session and then the next morning they'd say ‘oh so you spent a really long time doing this and now we're going to show you a really quick way to do it’ and it’s kind of it’s sometimes a bit frustrating because you've spent three hours working on something that, once you've had that second lecture, takes you ten minutes.

There is also something of a discord between this new pedagogy and the students’ own heavily academic backgrounds which are, almost exclusively, based on traditional pedagogy. It could be that flipped teaching actually challenges their identities as successful academics and this view is supported by a comment from Peter (below) where he talks about the coursework deadlines and says ‘then you're kind of ‘undergraduate self’ kicks in and, you know, it gets left until the last month’.

1. ***Ownership of the course***

The students appreciate the fact that their feedback on the programme has influenced subsequent presentations of the course as Chloé explained:

Chloé: ... and the best thing about Manchester is they really take feedback seriously which is amazing.

Heather felt that this acceptance of the students’ feedback made her feel valued:

Heather: Erm, oh what I think that they've taken on our feedback and our comments really well to kind of, erm, improve and alter the way that they've done things like especially from what we've heard from last year to our year it seems like they've really, erm, understood what we wanted but what the other year wanted and they've implemented that for us, erm, and from what I've heard from my year onto the next year they've already kind of taken on board some of our feedback and have, erm, given an extra day of teaching and things like that for the first years which has been good.

Interviewer: So that's something that you’d asked for as a cohort is it, more of the face to face?

Heather: Yeah. I think it makes me feel that more valued as a student because you can really see that they do care what we think and what our opinions are.

When Peter (3rd year) was asked about whether he thought the students in years 1 and 2 would be having quite a different experience to the one that he had had, he replied:

Peter: Erm, a little bit yeah but just as a combination of not being the first people to do it and their own backgrounds as well, erm, obviously know that the course has changed actually quite a bit since we did it which is good actually. I love that it’s somewhat different because, you know, because it wasn’t perfect, it’s still not perfect but it’s nice to see that the lecturers are responsive to feedback, you know.

Interviewer: Yeah can you summarise what it was that wasn’t working and things changed?

Peter: Erm, so a good example would be the coursework deadlines so we had kind of maybe two or three, three or four months to write up coursework which at first plan you kind of think ‘great’ but then you're kind of ‘undergraduate self’ kicks in and, you know, it gets left until the last month and it’s three months since you've had your teaching and you've kind of forgotten it all so you have to go back and re-learn it but now I know that the first years have only, have maybe six to eight weeks to do it and that that closer time pressure has definitely been well received by our two trainees.

When Louise was asked about her sense of how the course was changing now for the first years compared with what she did in her first year, she replied:

Louise: Erm, I think there is definitely hope for it, erm, the changes have been slow. Some of them some of them have been really quick and a lot of the stuff we've all just kind of said it was great, it doesn’t need to be changed, if anything you should add more to it because, you know, it’s fine how it is, it works very well, we all got something out of it, erm, but some of the stuff, particularly with the [University X] teaching, there's been a lot of a lot of problems from a lot of people and there it’s quite hard to just completely overhaul something especially when it was initially a module for a different specialism so we've kind of just been sucked into that teaching.

Louise went on to describe the main issue that the students had with the teaching at University X:

Louise: Erm, I think it was just the intensity of it, we weren't given much information on the stuff that we should prepare and any stuff that we were given to prepare with wasn’t helpful, ... erm, so it was just kind of that accessibility really, erm, and some of the, assignments were, they just kind of said to us ‘go and find a task and carry it out’ and when you're in a genetics laboratory looking for a task that involves image processing it’s quite a hard but they’d originally changed the assignment because they thought the previous one wasn’t applicable to us so they tried to change it to something that mapped better to our work place competencies but none of us were in that part of the kind of programme so that was kind of, I think it was maybe just an oversight by them. They expected it to go in that order and not everyone does it in that order so, erm, but as far as I'm aware that has changed since then again so there are things that are changing and they're definitely, erm, open to discussion of what we think is good, what we think could be improved and things like that.

1. ***Joint enterprise***

With bioinformatics being a new discipline, nothing is really decided and so ‘joint enterprise’ is the decision and the responsibility of the group. When asked about whether there was anything about the course that she thought would influence the way she worked when she becomes a practitioner at the end of her programme, Heather suggested that she would adopt the ways/methods that she has been taught at Manchester:

Heather: Oh yeah definitely so the way that I've been taught to use, erm, some of the specific software like there's there might be a variety of different ways of, erm, saving your comments or the way that you've coded that I’ll be using the way that Manchester has showed me to do it because I've been taught very well and how to do it and how to troubleshoot it and how to share that information and what will go wrong, so I think that will influence how I work in the future.

Peter reiterated that fact that the programme had changed how he worked in the workplace:

Peter: There's certainly loads of useful stuff I've taken from the academic teaching which, erm, interactive new tool, certainly a lot of the like the best practices for, erm, software development that a lot of that's come from the academic teaching that's been really good, erm, certainly things like version control, erm, which we have implemented since we started the programme but I actually feel kind of comfortable using it because we've had the chance to learn that in this academic environment, been able to take it back to the clinical lab whereas I think if I'd have just been playing around with it at work it might not quite have gone so well because it’s quite complicated, erm, yeah.

Regarding the work that the students do during their placements, Emma was asked to explain whether their response to the assignments influenced the way in which they are marked and she explained that there were no marks awarded and so ‘people just accept that you are competent or not’:

Interviewer: Just wondering if perhaps what you've all submitted, what you've agreed, has influenced the way that it’s been assessed, if you if you see what I mean?

Emma: I think they probably would just say ‘yes’ pretty much to anything ‘cos, as long as you've done it, they've got no guidance on how to assess it either so it’s kind of opinion based really… We try to help each other with what we think and that's about all you can say. Erm, we haven't done that so much recently because I think people’s Trusts have sort of got a bit more, like a bit more helpful in trying to help them get stuff done or people have perhaps got a bit more confident. Like ‘I know what a competency is now’; ‘I know I need to submit about X pages’ you know to satisfy my Trust’s requirement. As people, you know we have sort of got into the rhythm of what it is that we need to be submitting. It wasn’t really the tasks it was more the ‘what do we, what do we upload?’

Emma was also asked about whether there were any online posts about the day-to-day job and she explained that these were specific problems because more general posts like, ‘oh we had this really interesting QC problem’ would take too long for people to write a response although being very willing to share the information. These more general problems were discussed face-to-face, as Emma explains:

Emma: When we get together in Manchester is when we kind of chat about stuff, erm, and also we have these bioinformaticians’ meetings now that we occasionally go to just organised by the bioinformaticians as a whole not just the trainees, erm, and those are pretty good. They're, erm, various people will discuss tools that they've use, problems that they've had, QC issues, erm, but yeah not much of that gets posted but, like I said, that's mostly to do with time constraints, people will be like ‘can you help me with this specific problem?’ or ‘what tool are you using for this particularly task?’ or ‘I can’t get this to work has anyone tried it?’ rather than like, ‘today we did this problem and this is how we solved it’ and stuff, although that would be really interesting, I think it’s more that people just don’t have the time to you know, and chat about what things we've been doing, what we've found, problems we've encountered.

1. ***Talk about group and dynamics***

Outside of their studies for/during the programme sessions and the placements where the majority of students were ‘the only one’, they did find ways to stay in touch socially via Facebook:

Peter: We have like, erm, an email list that we tend to work with, erm, and but various, but, you know, and then like private emails a few of us that are on Facebook together but that's not really very work related obviously, erm, yeah so like we have various lines of communication that do remain open and in use pretty constantly.

They also made opportunities to engage in social activities and when Heather was asked about her relationship with the other students, she replied:

Heather: Oh yeah we've been on holiday together. So we yeah we went, erm, yeah we went away on holiday the six of us from, there's nine on my course and six of us all went on holiday last Easter time, just after Easter, erm, which is good so I'd say that we’re all very good friends. We share accommodation when we go up to the University, things like that.

When she was asked about the other three students who did not go on the holiday, she said:

Heather: Yeah, erm, so the other three I still stay in contact with as well but, erm, through WhatsApp and emails and stuff like that just to see how they're getting on, things like that.

Heather was also asked whether she thought she’d stay in contact with her cohort of students in the long-term and she said that she definitely would:

Heather: I hope I hope it will be a long term because I kind of see them as my friends as well as my colleagues, erm, so hopefully I’ll keep in contact with them both professionally and personally in the future.

Louise could also see the relationships continuing after they finished the course:

Louise: Yeah I definitely think so I think, erm, we all get on well and we all know that we can help each other, even if, you know, even after we finish we’re still going to be learning and we’re still going to be developing things and there's going to be people who have developed things that you then want to work on so and we do have a really good relationship. I mean I think there are stronger bonds between certain people in the group but I think you'd expect that in any group situation, erm, but as a I wouldn’t have any problem with emailing everybody if even if I knew that there were specific people that I would rather work with I don’t think I would have an issue with talking to them at all.

Although Gemma could see that she would ‘keep in contact for work and definitely keep in contact with them [her own cohort] as friends’, she could not foresee the same relationship with the other year groups:

Gemma: Erm, I think definitely through work but I don't know them as well so maybe not as friends.

Heather, Louise and Gemma could see the group remaining friends but Emma was not so sure that she would stay in touch after the programme finished because of the distances involved and the lack of funding for bioinformaticians’ travel expenses:

Emma: Erm, I don’t know really if we, if we carry on with this bioinformaticians network, if the people who stay in the NHS do anyway, then, erm, they probably I’ll try and meet up and chat through that. I don't know. Be a bit, be a bit interesting, I can’t say, I mean we don’t see each other for months on end really, erm, so but it doesn’t ever feel like it’s been a long time so it should be quite easy to keep that going. It’s just it’s a practical thing rather than, I think people would be willing, I think that they, just practically we’d find it difficult because we’re all over the country, people’s Trusts don't want to pay for travelling and things, and, erm, yeah I mean there's a missing sort of community I suppose in a way within your Trust because there's so few of us. So whereas the geneticists who probably not they're not as interested in really being talking to other geneticists. I mean they have some contact but, you know, it’s kind of like very, very limited. I think we're more interested in it because we haven't got an established community of practice already in our Trusts. We haven't got like, you know, fifteen or fifty genetic scientists; we've got maybe one or two bioinformaticians.

However, Emma was not just concerned with the social aspects of staying in touch. She had fears about safety implications (and presumably the professional status of bioinformaticians more generally if there were a mistake) if they did lose contact with one another:

Emma: I think it’s risky as well if we lose the, if we lost that that feel that ability to talk to one another in any way like if like we lost the forum as well or whatever, it would it would just be bad because people would just make the wrong choices because there's nobody to check. There's no one to help them, you know, I mean it’s so you are going to make a mistake, doesn’t matter how experienced you are, eventually you're going to screw up and use the wrong tool or something, miss something, not catch something, you know, so yeah I think it’s important that we try to keep something going and that I'm pleased that the, you know, the bioinformatician professional guys have got such a strong network that they've worked really hard to establish as well, I've assumed for the same reasons.

**Discussion**

Clinical Bioinformatics is a new discipline and the three cohorts of students who were interviewed for this project were the only students who had studied the subject at the University of Manchester at that time. Not only was clinical bioinformatics a new subject but it was also an interdisciplinary subject where Tait and Lyall (2007) could foresee problems but also suggested the skills needed to mediate/resolve any issues. This meant that the students needed to be willing to learn from other subject areas and be open-minded to ideas originating from other disciplines and experiences but this did not extend outside the students’ own year cohorts. For example, Louise (2nd year) described how she might speak to students from the 1st and 3rd years at conferences because she might be ‘introduced to them because they work with someone that we know’ or they might come over and say ‘oh you're another bioinformatics trainee’ but generally there was only limited interaction. Louise was also concerned that, if there were more interaction, the lower years might be ‘constantly emailing’ her for help. However, if there were some sort of ‘balance’, she could see it might be helpful to know people in other years because the experience might prove useful when they get their own trainees and also they might eventually be working together. Chloé (3rd year) also thought that it would be ‘really beneficial’ to meet the year below so that, if they were working in the same lab, she would not ‘feel weird emailing out complete random strangers going ‘hi’ because you don't know if you're if they appreciate the resources or they thinking you're annoying or stressing them…’

The programme leaders have incorporated ‘flipped teaching’ into the bioinformatics programme because they hoped that this pedagogic approach would facilitate interaction between the students and promote the formation of a CoP (or CoPs). This break with the traditional transmissionist lecture format means that the students ‘read up’ about the topic before the teaching/learning sessions and can spend the time more fruitfully by discussing the material face-to-face whilst engaged on problem-solving activities.

The students found this way of working useful. Ryan (3rd year) believed that the group work was ‘the biggest sort of gel’ and doubted that the group would have been as close without this collaborative way of working, especially as they were only in university for brief periods of time. This was because he thought that if he were sat in traditional lectures, he would probably only get to know the people sat next to him whereas, with the group work, he knew everyone. Gemma (2nd year) also found this way of learning very helpful but she said, if she did get stuck with the work, ‘there's always multiple people that help you and make you feel a bit better about it’. Sarah (1st year) liked the flipped teaching because, as a non-native English speaker, she struggled to keep up with PowerPoint slides and the narration that explained them in more detail. Louise (2nd year) liked the fact that flipped teaching enabled her to learn about what went on ‘underneath’ the software and she was given the opportunity to try it that way and was then shown the correct (quicker) way. However, she felt that this would enable her to spot errors because she understood what the software was doing rather than accepting the answer that the software produced at ‘face value’. The only down side of this for Louise was that she could spend three hours on something only to find the next day that it should take ten minutes.

Nevertheless the flipped teaching does encourage interaction between members of the cohort and this is key to a CoP which can be defined as ‘a group of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise by interacting on an ongoing basis’ (Wenger, McDermott & Snyder (2002, p.4). Also, in order for a CoP to exist, there need to be three distinct elements: mutual engagement of participants (e.g. discussions, collaborative activities and relationship building); a joint enterprise (i.e. working together towards a common goal); and a shared repertoire (e.g. common resources and terminologies that participants use to negotiate meaning and facilitate learning within the group and ways of addressing recurring problems) (refer to Appendix 2). These three dimensions outline the process of the students’ interactions within the CoP groups and there were examples within all three cohorts, albeit that the CoPs did not currently extend beyond each year group of students. As such, each year group may have its own joint enterprise, way of engaging and shared repertoire. There will be similarities between groups but there may also be unique differences as well which may not be apparent in these interviews because of the nature of the questions. However, since there is little interaction between the cohorts, it seems sensible to consider each group as a discrete CoP.

**Mutual engagement of participants:**

Mutual engagement means members engaging in regular interaction. However, the bioinformatics programme is structured so that there are only a few days each year when the students meet face-to-face with the remainder of the time on placement in hospitals, usually with no one else from their cohort at the university. Although the term CoP tends to suggest that members come together in the form of direct person contact (e.g. discussing projects in small groups or meeting in a large group to discuss particular issues, etc.), Wenger (1998) doubts whether this is necessary since, ‘given the right context, talking on the phone, exchanging electronic mail, or being connected by radio can be part of what makes mutual engagement possible’ (p. 74). Across all three years, when the students are not meeting in person, they use their university email as the prime method of communication. In addition, the second year use WhatsApp, there is a Google Group in the third year and also some of the third years use private emails and Facebook but, according to Peter, ‘that's not really very work related obviously’.

Many of the postgraduates spoke about how helpful the other students in their years were and, in particular, Peter (3rd year) explained that there was a lot of course material with which he was unfamiliar. He described the other students as ‘just nice normal people’ who, because they had already covered the problem material as part of their PhDs or previous work, were willing and able to share their expertise. Heather (2nd year) described how everyone would respond to an email if anyone has any issues. Although not the response that the 2nd years achieved, Chloé (3rd year) explained that she was able to email questions to the cohort with the certainty that four or five of the thirteen students would respond. Chloé also commented that without the assistance of the other students, she thought that more people would have left the course during the first year because of the lack of support from the staff at the placement hospitals. There were lots of emails going ‘back and forth’ and she believed that this ‘good environment and the fact that everyone was helping each other out, it kind of felt like we could just push through’.

As time has gone by, Ryan (3rd year) believes that their community has changed. In the beginning the emails were used to ask questions but now they tend to use it to share resources. Gemma also explained that any information that individual students obtained from the programme leaders about the course material or more general questions as a result of the work on their placements was shared with the others. Chloe would like this resource-sharing to extend to the other years as, in particular, she believes that she could support the second years.

Apart from interaction contributing to the common goals of graduating as a qualified bioinformatician, much of the interaction described in the interviews includes the students’ attempts to understand the materials. However, Lambropoulos (2005, p.22) asserts that these interactions which ‘clarify, define and evolve practices’ are also forms of mutual engagement.

Although all this suggests a serene representation of academic endeavour, as might be expected from a disparate group, not everything always went well and Ryan (3rd year) revealed that there were disagreements, although not resulting in any long-term issues. This, however, is not unexpected and Wenger (1998, p.56) explains that participation in the group may involve ‘all kinds of relations, conflictual as well as harmonious or conflictual, intimate as well as political, competitive as well as cooperative.’ The key thing here is that the students here are members of a CoP because they are, ‘informally bound by what they do together—from participating in lunch-time discussions to solving difficult problems—and by what they have learned through their mutual engagement in these activities’ (Wenger 1998, p.2).

**Joint enterprise:**

The students do not only engage in random interaction but, through negotiation, they create a shared understanding of what binds them together and it is this that is termed ‘joint enterprise’. Wenger (1998, p.80) advises that joint enterprise produces a sense of mutual accountability amongst the members of a CoP. In the current project, mutual accountability becomes apparent when the students express concern about their roles and engagement as members of the CoP since their contributions will directly affect the mutual goal of qualifying as bioinformaticians. An example was given by Heather (2nd year) who explained that everyone brought different expertise to the problem-solving activities and so, although one person had experience of data-extraction of files and another had experience of searching through information, she had experience of outputting a file. They were therefore mutually accountable for the outcome of the activity since they had combined their knowledge in the quest for the answer to the problem. In Heather’s scenario, there seems to have been agreement but Wenger (1998) emphasises that joint enterprise does not imply homogeneity of ideas or agreement amongst all the CoP; negotiation is a significant aspect here. Joint enterprise is also about knowing what other people know or can do and therefore the ways in which people can contribute to the enterprise. Chloé found that the students were aware that they learnt a lot more from each other and consequently had no problem in stating that they did not understand something with the expectation that it would be explained.

During placement in the hospitals was another time when the students needed help. Gemma explained that the students are ‘quite good friends’ who ‘keep in contact constantly’ and so when she is isolated and has problems during her placement she can contact the other students for help. Emma described a different type of help where, if there was a deadline approaching, people would post a reminder so that other members of the CoP would not be penalized.

Mutual accountability also seems to be in the minds of the programme leaders who Peter tells us ask for his opinion (and his colleague in hospital) about whether they believe that the academic work is applicable in their workplace. Moreover, Ryan explains that the tasks they set are not simply relevant to the programme but also for their future careers.

Overall the accounts of group interactions were positive and there was reference to very little disagreement thus resulting in minimal negotiation. Also accountability for group endeavours was positive with all the students being committed to their groups and no reference was made by anyone to people sneaking away to work autonomously.

**Shared repertoire:**

With the sustained mutual engagement over time, the trainee bioinformaticians develop a shared repertoire of resources which can include helpful tools, ways of handling problems, etc. and also stories and experiences. This shared repertoire is a fundamental resource that creates, maintains and reinforces the bioinformaticians’ CoP. By the students being involved in the negotiation of meaning in this way, Wenger (1998, p.83) explains that this facilitates ‘further [mutual] engagement in practice’.

An absence of introductory formalities is one of Wenger’s indicators of a shared repertoire and Chloé suggests that this occurred with the bioinformaticians because of their introduction to emails: ‘guys what do you think?’’ The presence of specific tools is another indicator and Emma spoke about the bioinformaticians’ meetings where these were discussed and she thought it would be more interesting if people posted this type information rather than (almost exclusively) in-the-moment requests for help.

Somekh and Pearson (2002) explain that the shared repertoire is not a static phenomenon. Group members’ personal repertoires influence the shared repertoire over time and there is evidence of this in the interviews. Louise spoke about being fortunate on her placement because she had a specific project to do which helped her to gain a lot of skills which enabled her to be involved ‘with working on the pipeline and understanding how it works and looking at some of the tools and stuff’. All this new expertise then formed part of her personal repertoire but was also available to her CoP back at university. However the process can work in the opposite direction because Heather says she will be using ‘the way that Manchester has showed me to do it because I've been taught very well and how to do it and how to troubleshoot it and how to share that information and what will go wrong, so I think that will influence how I work in the future’.

Although this research has identified that a shared repertoire exists at least within the year groups, Heather is concerned about the lack of a shared repertoire more broadly across the UK i.e. she would welcome a ‘standardised procedure for things’. She explains that currently hospitals use different techniques/languages for programing and advocates a countrywide revision so that resources can be shared rather than each hospital creating their own.

**Conclusion**

This research suggests that the bioinformatics students were able to develop the three distinct elements of mutual engagement, joint enterprise and shared repertoire; as such they were therefore able to develop the essential characteristics of a CoP. However, the CoPs did not extend outside the year groups and some of the students seemed keen that opportunities should be provided to at least meet the other year groups so that they did not feel quite so isolated on their placements in hospitals throughout the UK.

Another aspect of the work that was not investigated was whether the year-group CoPs would continue after the students graduated but this enquiry would require further research and therefore further resources.

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**CHERIL QUESTIONNAIRE:**

**How has your project contributed to the strategic goals of the University and CHERIL?**

As bioinformatics is a new profession to the NHS and many of the clinical bioinformaticians are physically remote, this CHERIL-funded project investigated the role of flipped teaching in facilitating the development of CoP thereby ameliorating the students’ isolation from one another. The development of this new innovative pedagogical approach to teaching, which focusses on group-focussed problem-based learning, has therefore contributed to both the strategic goals of the University and of CHERIL. It aligns with Goal 2 of the 2020 Strategic Plan of the University on’ Outstanding Learning and Student Experience’, which states that “*the University will provide a superb higher education and learning* *experience to outstanding students, irrespective of their backgrounds, and will produce graduates* *distinguished by their intellectual capabilities, employability, leadership qualities and their ability and* *ambition to contribute to society*.” Further, this work maps onto the CHERIL theme (2015-6) of learning through research.

**What can others learn from this pedagogical approach?**

Flipped teaching has provided a way for the students to engage with the learning materials and with one another during their very limited time in university. This interaction has enabled them to build strong networks and communication links with their peers, or CoPs to provide support to one another and is seen as very significant in enabling them to perform their role when working in isolation in hospitals scattered across the UK. Practitioners from other disciplines who work in similar remote contexts can learn from this approach and use it to support their own students.

**What is innovative about this study – how might it trigger pedagogic change?**

**Innovative aspects of research:**

* Design of an innovative style of flipped teaching for clinical genomics for a cohort of postgraduate taught (PGT) students who come from hospitals across the UK.
* Design of a postgraduate bioinformatics programme that incorporates authenticity in the course tasks and activities.
* Study conducted by impartial researchers from Manchester Institute of Education to explore how successful the flipped teaching had been for clinical genomics and whether it contributed to the development of CoPs in three cohorts from the course.
* Collaboration between the Schools of Computer Science and FBMH at the University of Manchester and the Manchester Institute of Education.

**Pedagogic changes:**

* Use of flipped teaching resources within the PG programme which focus on group-focussed problem-based learning to facilitate the formation of CoP.
* The interview data do provide evidence that the flipped teaching did provide the students with opportunities for talking to and learning from each other.
* The change in the pedagogic approach whilst in the University of Manchester enabled the students:
	+ to share ideas
	+ to learn from one another, which was particularly helpful for these PG students because they came from a wide variety of backgrounds
	+ to engage in the social aspects of learning
	+ to form a CoP.

**What are the dissemination plans to ensure that the project outcomes are capable of making the greatest possible impact?**

The project will be disseminated as follows during the next year:

* Presentation of findings at the CHERIL Annual Conference (January 2017).
* Report for the CHERIL website within MIE.
* Workshop and tutorial activities within the Schools of Computer Science and FBMH at the University of Manchester?
* Sharing of project findings with the programme’s sponsor, Health Education England, to ensure that the outcomes from the project influence NHS training and education at a national level
* Submission of research papers to peer-reviewed medical education-related journals (e.g. International Journal of Medical Education).
* The results of the research will also be presented at relevant educational conferences in the form of poster or oral presentations.

**How well did the project keep to budget?**

The project did keep to budget, with the main costs being incurred by employment of two researchers from MIE to undertake the coding and analysis of the interviews and the writing of the report. There was also the cost of transcribing the interviews.

**What is the sustainability plan for the project?**

Within the Clinical Bioinformatics Programme Team we are very keen to ensure that we undertake a continual process of review, reflection and adaptation of our teaching practices in order to ensure the best possible student experience during their study on the course. This study will provide sound evidence on which to base any changes we make to the delivery of our teaching in the future or indeed reinforce our confidence in this style. Therefore this project is an important piece of educational research, which will evaluate and influence how we teach healthcare and computer science students in the future, therefore ensuring that the project is sustainable. This development is seen as an essential and ongoing enhancement of the new Clinical Bioinformatics MSc at the University of Manchester and will require no further monetary investment. The study also aligns with the strategic objectives of both CHERIL and UoM in terms of enhancing the student experience and it also has the potential to have impact across the UK.

The information provided in the interviews will be fed back into the programme and learning materials in subsequent years.

**If you were to undertake the project again, what would you do differently?**

The students who were interviewed were self-selecting and as such it was not possible to ask for more people to be involved. However a greater number of interviewees across the three years of the programme would have enabled the team to gather more and therefore possibly more robust data. Of course, if this work is deemed necessary as the programme develops during subsequent years, more funding would be required to undertake this further research. A longitudinal study that followed the cohort into their first year of practice ‘proper’ would also be extremely helpful both in seeing how bioinformatics is taken up by hospitals and other healthcare providers, but also to explore whether the CoPs endure outside the postgraduate programme.

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**Appendix 1:** Learning Design for emergent CoPs in Health Informatics- Interview Schedule

|  |  |
| --- | --- |
| Starting question | Elements to draw out with sub questions |
| 1. Experiences of professional practice before starting the course | * Role
* Processes
* Support from management
* Support from/collaboration with colleagues
* Contact with those in similar roles
* How they felt about the role and themselves within the practice
 |
| 2. Student view of the structure and content of the course so far | How do they now perceive: * substantive content, what topics are covered;
* teachers;
* mode (f-2-f/
* online and balance between these;
* learning materials;
* type of activities (reading, preparing presentations etc., individual/group);
 |
| 3. What aspects of the course so far have stood out | * Positively and negatively;
* in terms of relevance to their role;
* anything that they were uncertain about at that time
* Most useful/least useful
 |
| 4. Relationship with fellow students during the *very first* taught section of the course | * Level of contact
* Experiences of group work
 |
| 5. Relationship with fellow students now | * Both within course and in practice
* Any influence on *shared repertoire* – do they ‘speak the same language’ more or less, are they ‘on the same page’ more often or no change etc.?
 |
| 6. Any contact with fellow students between taught sessions | * How often?
* By what means?
* How is that contact useful to their practice
* Do they have a sense that they are all trying to achieve the same things/deal with the same difficulties or not?
 |
| 7. Any contact with students in other cohorts | * Do they work together either in course or in practice/ locally or virtually?
* Do they communicate between sessions?
* Do they feel any intrusion from this group
* Has it altered the relationship between the first cohort?
 |
| 8. Student view of which aspects of the course contributed to above (relationship and contact with other students) | Returning to earlier answers, what aspect of the course (as per their perception Q2 – content, teachers, activities etc.) influenced:* Relationship with fellow students and why?
* Contact/communication with fellow students and why?
* Contact/communication with second cohort and why?
* Comparative to University X methods?
 |
| 9. Predict how course has/will influence future practice | * What roles and ways of working envisaged
 |

**Appendix 2**: Wenger's indicators for the presence of a Community of Practice

| **Wenger's indicators** |
| --- |
| 1. Sustained mutual relationships – harmonious or conflictual |
| 2. Shared ways of engaging in doing things together |
| 3. The rapid flow of information and propagation of innovation |
| 4. Absence of introductory preambles, as if conversations and interactions were merely the continuation of an ongoing process |
| 5. Very quick setup of a problem to be discussed |
| 6. Substantial overlap in participants' descriptions of who belongs |
| 7. Knowing what others know, what they can do, and how they can contribute to an enterprise |
| 8. Mutually defining identities |
| 9. The ability to assess the appropriateness of actions and products |
| 10. Specific tools, representations, and other artefacts |
| 11. Local lore, shared stories, inside jokes, knowing laughter |
| 12. Jargon and shortcuts to communication as well as the ease of producing new ones |
| 13. Certain styles recognized as displaying membership |
| 14. A shared discourse reflecting a certain perspective on the world |

From: Wenger, 1998 pg. 125-126