Can peer learning support doctoral education? Evidence from an ethnography of a research team

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Abstract

This paper focuses on peer learning as a process to develop PhD students' disciplinary and scholarly skills. PhD students' experience is not usually framed in terms of peer learning, because peer learning is more often studied and applied at the undergraduate level. This contribution builds on an ethnography of a research team to show the potential of peer learning over the course of the doctorate. A socio-constructivist conceptualisation of learning, inspired by activity theory, guides the analysis. The contribution of this paper is threefold. First, it proposes an original definition of learning that highlights process and practice, and shows how to work with it. Second, it demonstrates how peer learning unfolds in the interplay between structured and emergent types of interactions. Third, it provides scholars with insights into the conditions facilitating peer learning and stimulates debate around the initiatives that institutions can put in place to support PhD students.

Keywords

peer learning, doctoral education, research team, activity theory, ethnography

Introduction: what do we know about doctoral experiences?

Peer learning in higher education is widespread in the US, Australia, and Europe (Boud, Cohen, and Sampson 2001, Sambell, Brown, and Graham 2017). However, it is not well tackled by the literature on doctoral education: Flores-Scott and Nerad (2012, 74) argue that the literature does not seem to recognise that doctoral students might be effective learning partners. This reflects a broader problem, which is the paucity of in-depth investigations of doctoral students' experiences (Boud and Lee 2009). The literature on doctoral students usually draws on self-reported measures such as surveys and interviews, and the dynamics of peer learning might remain hidden. Furthermore, Hopwood (2010b), Baker and Lattuca (2010) and Jazvac-Martek, Chen, and McAlpine (2011), maintain that the role of doctoral students as active agents shaping their own path has been overlooked.

Peer learning is a reciprocal learning relationship among peers (i.e. people with a similar level of expertise), for their mutual benefit (Boud, Cohen, and Sampson 2001). This relationship helps students to organise and engage in collaborative activities, give and receive feedback, develop critical thinking and experiment with more ways of communicating concepts and skills. In this paper, peers are defined as colleagues of the same academic rank (PhD students) and from the same group; this is consistent with previous literature (Hopwood 2010b, Boud, Cohen, and Sampson 2001, Boud and Lee 2005, Wegener, Meier, and Ingerslev 2016, Baker and Lattuca 2010). As the PhD is a long journey, even among PhD students there can be a range of expertise, but there is no supervisory relationship. Learning is defined following cultural-historical activity theory (AT), that stresses the relational, emergent, processual and contextual nature of learning (Vygotsky 1980).

Peer support might be essential in completing a PhD (Gardner 2007, Littlefield, Taddei, and Radosh 2015, Devenish et al. 2009, Leonard and Becker 2009, Lovitts 2001, Boyle and Boice 1998, Wegener, Meier, and Ingerslev 2016, Teeuwsen, Ratković, and Tilley 2014,

Gardner 2010, Boud and Lee 2005). Nevertheless, it is not clear how peers intervene in the learning process (Flores-Scott and Nerad 2012, Baker and Lattuca 2010, Boud 1999). Devenish and colleagues (2009) stress that peer learning often goes unnoticed since it is not part of wider narratives about students' development and research success.

This paper investigates how peer learning takes place among PhD students and how this supports the development of disciplinary knowledge and scholarly skills (e.g., presenting, writing, critical reasoning, problem solving). The study of PhD students' learning addresses an important lack both in the literature and academic practice. Doctoral studies are traditionally seen as constituted by a quasi-exclusive relationship between the PhD student and the dissertation supervisor, but this vision is limiting (Baker and Lattuca 2010, Flores-Scott and Nerad 2012). In today's higher education landscape, characterised by increased competition and internationalisation, this relationship might not be enough to prepare a new scholar. Gardner (2008), in her US-based study on how doctoral students in chemistry become independent researchers, found that the most successful students heavily relied on their peers. In relation to Europe, despite the Bologna Process aimed at harmonising doctoral programmes, significant differences persist, and learning scholarly skills is an informal endeavour (Raddon 2011). Furthermore, literature on PhD students' learning experiences presents many lacunae, especially in relation to learning disciplinary and scholarly skills (Sinclair, Barnacle, and Cuthbert 2014, Evans 2012).

The study of peer learning in doctoral education might be better accomplished through an ethnographic approach, in which the researcher enters into direct contact with the daily routines of PhD students. This approach ensures a longitudinal perspective that is fundamental to understanding how learning occurs. This study builds on a one-year long ethnography of a research team: the relevance of peer learning in this team emerged unexpectedly over the course

of the research. The paper shows how peer learning works by commenting on lively interactions among the PhD students of in their team meetings.

This study extends the literature on doctoral practices, and will stimulate debate about peer learning as a strategy for supporting doctoral students. It draws on literature stressing the position of students as agents and the role of peer learning in building core competences (Hopwood 2010b, McAlpine et al. 2012, Wegener, Meier, and Ingerslev 2016, Baker and Lattuca 2010). The theoretical objective is to contribute to the recent strand of literature underlining the relevance of sociocultural approaches to the role of emergent experiences for learning (Hopwood 2010a, Raddon 2011, Beauchamp, Jazvac‐Martek, and McAlpine 2009, Baker and Lattuca 2010). AT constitutes the theoretical background: this is an original choice, since many studies undertaking a sociocultural vision of learning tend to stick to the community of practice framework (Tight 2015); also, AT is used more often as an analytical tool than for framing research problems (Bligh and Flood 2017). This paper demonstrates how AT is beneficial in opening up new perspectives for researchers of higher education.

Positioning peer learning in the literature on doctoral students' experiences

The concept of peer learning is original in itself in that it represents a move from learning in which a hierarchical relation is assumed, to a reciprocal relationship. Importantly, it underlines the active role of students in both engaging in their own learning and supporting the learning of others, and the contextual nature of learning. These assumptions draw a clear line between the literature on peer learning and the literature on PhD students' socialisation; in the latter, learning is not analysed in context and the role of students is assumed as passive (Austin 2002, Gardner 2007, Boyle and Boice 1998, Golde and Dore 2001). Nevertheless, the socialisation literature has been the first to show the factors contributing to a successful completion of the doctorate: the presence of supportive and collegial environments (Gardner 2010, 2009), and of

a fertile terrain for peer support to grow (Golde 1998). Gardner (2007) highlights how the importance of peer support proved to be an unexpected and surprising finding.

The study of peer relations and learning in doctoral education has emerged only recently. Remarkable examples are studies by Wegener, Meier, and Ingerslev (2016), showing how peer interaction supports the development of an identity as a researcher; and Littlefield, Taddei and Radosh's (2015) analysis of the narratives of their own support group, showing how peer collaboration can help the completion of a part-time doctoral programme. Hopwood (2010b, a) underlines the contribution of sociocultural approaches to detecting the practices that enhance doctoral learning. This paper stresses that learning is contextual and relational, so sociocultural approaches are well-suited to studying it; these approaches highlight the relevance of practicing and interacting in a specific context of activity, and the role of agency and purposeful action (Gaskins 1999, Hopwood 2010b, a, Lattuca 2002).

AT conceptualises learning as a socially initiated process, characterised by dynamics of internalisation and externalisation. Developed in the 1920s by Vygotsky and colleagues, AT stresses that learning is first of all a social practice: it unfolds in an 'activity system', where human action is oriented towards a specific outcome, and mediated by artefacts (Vygotsky 1980). Vygotsky highlighted that, since childhood, learning develops in interactions where an expert guides a novice step-by-step in accomplishing an activity. In other words, the expert leverages the 'zone of proximal development' (Vygotsky 1980), which is the space between what an individual can do alone, and what she can do with help. The work on the zone of proximal development can be enacted through 'scaffolding' (Wood, Bruner, and Ross 1976). Working on the zone of proximal development means to help a person internalise new knowledge and skills, so that she will then be able to externalise by herself in future instances (Roth and Radford 2010).

AT gives scholars a more sophisticated definition of learning than other sociocultural approaches such as the situated learning theory (SLT) and community of practice framework. In SLT, learning is represented by the trajectory of a newcomer in a community, but it is not clear how this trajectory unfolds and is supported. SLT also assumes that learning happens exclusively within a community, where harmonious relationships seem to be the rule. In contrast, AT posits that learning can happen in different contexts (systems) and not necessarily in a group; additionally, tensions might characterise the process and be functional to learning. Table I compares AT with SLT.

Table I: Sociocultural approaches in comparison

[Table I near here]

AT is well-suited to conceptualise peer learning (Hogan and Tudge 1999, Wass, Harland, and Mercer 2011, Havnes 2008, Raddon 2011); nevertheless, empirical studies of doctoral education are still in their infancy. Studies by Havnes (2008) and Wass, Harland and Mercer (2011) focus on undergraduates and the research design is based on interviews; however, both use AT to investigate peer learning. AT helps Wass and colleagues (2011) to study how critical thinking develops, and Havnes (2008) uses it to show the importance of peers to learn 'how to be a student'. Interestingly, Havnes (2008) extends the concept of zone of proximal development by arguing that this is possible not because of a diversity of expertise, but because of a diversity of past and current experiences.

Unlike those two studies, this paper focuses on how peers support learning disciplinary and scholarly skills, issues that are currently overlooked. Additionally, this paper investigates learning not only through self-reported measures such as interviews, but through an extended

period of observation, this being more consistent with a sociocultural definition of learning and giving a better view on how learning develops.

Research design

This paper investigates how dynamics of peer learning happen among PhD students who are part of the same group, and it aims at understanding how peer learning can support the development of disciplinary knowledge and scholarly expertise. The study has been designed as a year-long ethnography, with a focus on observing team interactions. Over one year, the author conducted 30 observation sessions of team activities (team meetings and seminars), and two rounds of individual in-depth interviews (at the beginning and towards the end of the research). Quite early in the study the author attended and observed weekly team meetings, since the interactions there were particularly rich: 23 team meetings were video-recorded, to better support the analysis. The data presented in this paper are part of this corpus.

When collecting the data, the author negotiated a position inspired by the role of observer (O'Reilly 2005). As this research was built on a social-constructionist epistemology, there is the awareness that researcher and participants shape together the reality under observation (Lincoln and Guba 1985, Schwartz-Shea and Yanow 2013). Nevertheless, the variety of the data collected and the sustained period of engagement with the team enhance the interpretive power of this study.

Learning is a complex process to be detected in an interaction. When focusing on the data, learning can be observed when participants are actively debating concepts or practicing skills, and show a progressively deeper engagement with these practices (and possibly a willingness to support colleagues); such an engagement can be observed along the same interaction (i.e. in one meeting) or across different interactions. Furthermore, observations can be triangulated with interviews to offer a more comprehensive perspective.

The presentation of the findings focuses on meetings limited to PhD students, observations of casual activities, and individual interviews, to understand how support among PhD students helps them to learn more about the academic profession and their discipline. Focusing on the development of disciplinary knowledge and scholarly skills seems to assume that PhD students should be trained for an academic or research career. However, the interviews show that the study participants see themselves in a research career first, and learning about their discipline and the academic profession seems their priority.

The national and local context of the study

The research team participating in this study is located in a department of computer science in a Swiss university. Switzerland is a country renowned for research and development; OECD data report that the total public funding for education is higher than the EU and OECD average, its universities are well-placed in international rankings and the student composition is more international than the EU and OECD average (OECD 2016, SER 2011).

The department where the team works is aiming to build its reputation by attracting scholars from all over the world. The team participating in this research consists of ten members (see Table II): the chair (professor, male), a senior researcher (female), two research fellows (male) and six PhD students at different stages of their doctorate (four males and two females). All of them, except one of the PhD students, come from outside Switzerland. The team is focused on topics related to information retrieval, and it privileges basic research (elaborating models rather than creating applications). The team members have their own allocated space, with most of the PhD students sitting at nearby desks; therefore they are used to meeting informally each day. The team has its own schedule, with weekly meetings and regular seminars with invited speakers. The weekly meetings are used as reading groups or slots to discuss one's own research; usually all the team members attend, the interaction is informal and anybody can propose a topic to discuss. A previous contribution (REFERENCE TO BE

ADDED AFTER REVIEW) showed that these meetings allow a new person to be integrated into the team because of the different activities and the richness of the interaction. This paper demonstrates that these weekly meetings might also have an important role in supporting peer learning.

Table II: The team members

[Table II near here]

Dynamics of peer learning

The presentation of the findings proceeds through vignettes, extended excerpts of data that are especially powerful in showing how learning develops over the course of the peer interaction. In one year of data collection, more than 80% of the weekly meetings clearly presented instances of learning disciplinary or scholarly skills (i.e. instances where the PhD students show a progressively deeper engagement with debating concepts or practicing skills). Meetings are not the only places where learning takes place: students talk informally each day, and they have been observed while working together; however, because the meetings have been recorded, this makes it easier to present these data in a paper.

Vignette I shows how meetings work: the PhD students comment on the contribution of a paper they have read, and draw comparisons with other papers. The students report that this paper does not make any theoretical contribution and does not detail the features of the methods used. They speculate on the reasons that brought the authors to write and publish it (turn 270). The discussion becomes more animated since Brad thinks the paper makes a contribution (turn 271), a topic that will come back later. It is interesting that the PhD students are strategically thinking about how to publish their research results, showing that they are at ease with the informal rules of the academic community.

Vignette I – learning and practicing scholarly skills

260.	Dan	I guess the idea was like that, they tried for blog retrieval they published separately, they tried for form something…
261.	Kate	Right.
262.	Dan	There are several references…
263.	Brad	Yes.
264.	Dan	For online community search, blog retrieval, and for, for something else *(looks into paper)*, but (…), retrieval the best group of documents, so…
265.	Brad	But those are all applications, here they (…)
266.	Dan	[Yes (...)], no no, then they, they have two more like, what…
267.	Kate	[Relevance feedback]
268.	Dan	Relevance feedback and…
269.	Kevin	[Clustering]
270.	Dan	[Clustering], which are not well, not worse than the all papers, so they kind of put all this mathematics, that is standard mathematics, and they published another paper, on, on geometric representations, so they went from applications I'm sure, so, they had three applications, now they have two more, they want to publish them, either you go with the poster, or, if you have a nice, I mean, if you can represent a nice theory, you can go with the full paper. At least that, it's my feeling.
271.	Brad	Yes maybe it's right, but still, it's a huge work to prove all this
272.	Dan	But it doesn't prove [anything]
273.	Kate	[Where's their proof?]
274.	Kevin	[That's the problem]

The exchange is animated, and everybody feels free to express their opinions. The students are committed to making the meetings work: they came prepared, and now they share their thoughts and build critiques by considering each other's views. Additionally, this interaction reveals which practices are privileged by this team in terms of conducting and publishing sound scientific research (turns 265 and 270): not starting by application, but framing the problems with a 'nice theory'. Engaging in this interaction is a strategic way to practice scholarly skills: being able to read and debate a scientific text critically is a core competence for an academic, it is essential for both being up-to-date with the literature and strengthening disciplinary

knowledge. Furthermore, less experienced PhD students can learn by observing their more seasoned colleagues: this is what Rose does; she listens but does not participate.

Following AT, such a lively interaction paves the way for dynamics of externalisation: language is a precious mediating tool to externalise ideas and opinions. It should be stressed that 'practicing' is an essential process of externalisation. Externalisation is followed by the internalisation of skills, to the ability to externalise them again, maybe in a different fashion, thus showing that learning has taken place (Roth and Radford 2010).

Vignette II allows for a deeper investigation of how dynamics of peer learning develop. It is taken from the same meeting as Vignette I, to better understand learning processes in time. The discussion in Vignette I motivates the colleagues to dig into the methods used in the paper, as happens in Vignette II where the students work together to sort out their doubts around a specific part of the paper (Fréchet mean). Dan seems more at ease with the paper, although he also has some doubts (see turn 314 and the repeated use of 'I guess'); he sketches some formulas on the board to reconstruct the authors' reasoning, and he relies on Wikipedia to introduce the less expert colleagues to the method under discussion. The PhD students working in this team come from different disciplines, which facilitates sharing of knowledge and then learning. Dan has a strong background in mathematics and often people turn to him when advice about math is needed. The differences in background and expertise here are key for learning.

Vignette II – Learning new methods

303.	Brad	Yes, that was the part I don't get, what's the point of all getting this index space, and changing the space, and stuff…
304.	Dan	Yes, I guess it was just, empirically, some people used it, ok, why don't use here also, so they they said ok, these are the papers that used this space, let's try to use this space, and, again, is not their math, they don't invent anything (…)

(few comments by Dan, Kevin, Brad)

312. Dan Yes, shortcoming, of this paper I guess, that they, they present the mathematics in a way nobody understands, they use lot of mathematical terms and if you just (...) manifold (...) of metric space this would be the same, but…
313. Kate And actually the explanations are not different from a search in Wikipedia I mean *(laughs)*, is the same amount of explanations here, and doesn't make anything easier, what they explain.
314. Dan I mean, I didn't understand only one transition in the derivations, others you can really understand.
315. Kevin Yes, which one?
316. Kate Yes, but...
317. Dan 146.
318. Kevin Yes.
319. Dan Where the integral is equal to distance I, I guess they didn't just have the place to put one more sentence…
320. Kevin I got lost from 5.
321. Dan From 5 they try to, to show that…
322. Kevin Until 5 it is ok.
323. Dan Yes.
324. Kevin And then you get, you got the difference.
325. Kate No, even before that for instance, I didn't get why, how they approx, why they should approximate with ***KL*** divergence, I mean (…)…
326. Dan From the book I guess.
327. Brad I guess.

(other comments by Dan, Brad and Kate)

336. Brad (…) because, if you put the distance ***log c – log i*** there *(indicates board)*, you can (…) with the geometric mean…
337. Dan Yes.
338. Brad Get the derivatives, and…
339. Dan Yes.
340. Brad Calculate ***i***, I guess maybe they come from other side, the only similar thing to this distance is ***KL***, so you can derive this distance from ***KL***, so if you put that, then you can prove the…
341. Kate How do…
342. Dan I guess is all very interconnected.
343. Kate How do you see that is similar to ***KL***?
344. Dan Well...
345. Kate From where?
346. Dan Difference of logs.
347. Kate Ah, the distance, considered distance, from log, ok.
348. Dan Yes, if you, ok probably I show you Wikipedia page, that tells almost everything. *(connects laptop to beamer)*

The detailed discussion about this section of the paper, following a sort of reconstruction of reasoning, elicits doubts: this helps to learn about more general topics (geometric spaces, means, distances). The PhD students seem eager to support each other; importantly, everybody feels free to express ignorance or lack of understanding (see Brad at turn 303, Dan at 314, Kevin at 320, Kate at 325). This is a sign that these meetings are a safe space, and literature recognises this as a prerequisite for learning (Edmondson and Lei 2014). During this meeting, all the PhD students work hard for establishing, step-by-step, common ground to solve a shared problem. The interaction is collaboratively constructed: for example, Dan and Brad complete each other's sentences. Dan seems to cover the position of the teacher, which is marked by non-verbal communication: he stands in front of his colleagues, near the board. However, he is cautious in expressing opinions (see the continuous use of 'I guess').

The use of artefacts is essential to support the externalisation process: the board allows everyone to be on the top of the discussion. The use of Wikipedia to support less expert colleagues is interesting: Wikipedia is not considered an authoritative source, and Kate criticises the paper because it reports the formulas similarly to Wikipedia (turn 313). However, the author has observed this practice in other research teams, and recent literature shows that Wikipedia is regularly used by students and scholars (Okoli et al. 2014). This is probably because Wikipedia allows a quick overview of the method, this saving time as the formulas do not need to be written on the board.

The practice of questioning colleagues and asking for (or giving) confirmation, supports the internalisation of knowledge. Internalisation is difficult to observe; it is noticeable when topics discussed in one meeting then are referred to in future meetings, or when students state that a discussion has been important for them to learn more about a topic.

In Vignette II there is a much stronger learning effort than in Vignette I. The PhD students discuss an article presenting some methods that are not familiar to most of them, and

learning can happen only thanks to everyone's contribution. Later in the meeting, Brad and Dan go to the board and demonstrate together the difference between an arithmetic and geometric mean as a way to unravel the paper's argument.

It is interesting to consider the two vignettes together: from a more superficial critique, as expressed in Vignette I, to a deeper reflection that then brings participants to investigate the method, in Vignette II. This shows the participants' commitment to scientific practice and learning. The result is the construction of new disciplinary knowledge, and this can happen only in an atmosphere of open discussion. Furthermore, this meeting is a moment where important scholarly skills are practiced (reconstruction of reasoning and demonstration of methods).

Vignette III is taken from another meeting: Kevin's PhD project is being discussed with Dan, Rose, and Kate. This discussion had not been planned; it arose because the topic of a paper being discussed was related to his PhD.

Vignette III – scaffolding

372.	Kevin	Anyway, some students had someone accessed data, someone else accessed facebook…
373.	Dan	Mm mm.
374.	Kevin	Instead of them.
375.	Dan	Mm mm.
376.	Kevin	And started posting.
377.	Dan	Right.
378.	Kevin	Ok. What happened, that these postings were really strange…
379.	Dan	Yes.
380.	Kevin	In term of topic, but also among the topic.
381.	Dan	So, basically another thing that you want to detect, is the user behaviour change, I would say.
382.	Kevin	Yes. *(writes on the board under the point I, that he wrote down previously)*
383.	Dan	Ok, good.
384.	Kevin	That's also useful for me.
385.	Dan	Yes, that's why we are discussing this.
386.	Kevin	I'm not sure about…

387.	Kate	But you cannot be sure if it's an author change or a topic change, because if you just…
388.	Dan	Wait wait.
389.	Kevin	That's the problem, I mean, it's not easy to do this, because…
390.	Dan	Wait, let's come to the solution later.
391.	Kevin	Ok.
392.	Dan	Let's finish what you want to do in general, is it all?

Kevin is in the second year of his doctorate, and his research is on authorship attribution in chat rooms. Colleagues asked about his research questions, but Kevin had some difficulty in stating them concisely; here, they are talking about the second research question. The excerpt starts with Kevin taking an example from everyday life to explain his research questions. This example leads Dan to infer the second research aim and attempt to state it (turn 381). Kevin agrees and writes the objective on the board, to keep track of the discussion. Interestingly, Kevin says that the discussion is useful for him (turn 384). Dan works to better structure the interaction: he interrupts Kate (turn 387) because, as he states two turns later, first they have to conclude this part of the debate. It seems that Dan wants to fend off questions which, at that moment, could create confusion. Dan is strongly moderating the discussion: this is important because it keeps the focus of the conversation.

In this excerpt, we recognise scaffolding in Dan's act to make Kevin focus on a precise feature of his project (one of the research aims). Then, after having carefully listened to Kevin, Dan formulates the objective in an excellent way, but then finishes the sentence with 'I would say' to leave the floor open to Kevin to correct or comment (turn 381). Finally, Dan's intervention structures the discussion. Dan's act of supporting Kevin step-by-step, helping him gradually to elicit and structure his own thoughts (i.e. to externalise them), shows how scaffolding develops. This process is emergent here: it develops through the discussion.

Thanks to Dan's support, Kevin is able to describe his project more comprehensively, and he develops a scholarly skill (i.e. showing the contribution of his research) that he could apply in other settings. This is the essence of scaffolding: learning a skill that can be reused to

support new learning processes (Wass, Harland, and Mercer 2011). At the end of this meeting, Kevin takes a picture of the board and Rose asks to have a similar session the week after. In subsequent interviews, both Kevin and Rose spontaneously mentioned the importance of discussing their work with colleagues in these meetings.

Vignette III represents well the dance between externalisation and internalisation. Dan helps Kevin to externalise some knowledge, and the successful externalisation is marked by Kevin's act to write the objectives on the board. The act of externalisation helps Kevin's colleagues to follow the discussion, and learn from it; this also helps Kevin to further reflect on its project and consolidate new learning processes (internalisation). The act of taking a picture is especially meaningful: we can imagine that later on Kevin will go back to it and think about the next steps in his project.

Discussion and conclusion

These vignettes show that peer interaction may support learning scholarly skills and disciplinary knowledge; it is worth asking which conditions help peer learning to develop. The empirical research covers one year, a short time in doctoral work (in average, PhD students in this department take 3 to 4 years to complete their PhD). The composition of the team at the moment of the research might have been optimal for peer learning. The importance of having people from different backgrounds has already been mentioned, and there are other issues to consider in relation to team composition. For example, at some point during the empirical research, the PhD students are confronted with unexpected events affecting the team composition. As Kevin stated,

> Our chair is sick now, Mat and Ross [two of the post docs] disappeared, and we have to manage everything on our own. I could say we have been lucky, since we learned to do a little bit more of teamwork, we were not that much used to it before, well, we could do more, but the fact that our chair is not there motivates us to work together, and this is very good.

In a situation that could have been negative (more senior people not being there), students get organised by themselves: they continue having the weekly meetings to focus on readings, and this turns out to be very positive. Over the course of that period, that lasts around three months, meetings are particularly rich in terms of learning (Vignette III is from that time). Probably the absence of more senior people encouraged the PhD students to put more energy into helping each other and also, in being more assertive in asking for help. This anecdote demonstrates how the team composition has a strong effect on interpersonal relationships and ultimately on learning.

The findings show that sustained dialogue is a necessary condition for learning. First, it helps to negotiate roles and activities; second, it helps in detecting the zone of proximal development and enacting scaffolding. Scaffolding is possible thanks to the difference in expertise that allows students to pool their resources, confirming Havnes (2008). The focus of AT on the processes supporting learning greatly helped to understand the importance of dialogue and emergent interactions. Unlike previous research, where the balance between structure and emergent refers to different types of activities with well-defined borders (Hopwood 2010a), in this case this dynamic happens within the same activity (team meetings). Meetings represent a structure, but they have emergent features: students go there with some idea of what they will discuss, but not with a clear plan, and often significant pieces of the meetings are spontaneous (see the debate over Kevin's project in Vignette III). There is a delicate balance between emergent and structured types of interactions. On the one hand, students work to give to the interaction some structure: for example, they explicitly state the need to terminate the discussion about a specific point before going to another one; these very short-term objectives contribute to the creation of common ground, structure the discussion around specific topics, and pave the way for learning. On the other hand, the emergent nature

of the meeting interaction, with the possibility to dedicate a significant amount of time to issues emerging during the meeting itself, opens up unexpected learning spaces.

Earlier in this paper, AT and SLT were compared. SLT can now be mobilised to define the relationships in this team: these are characterised by mutual engagement, i.e. people's commitment to a set of activities 'those meanings they negotiate among one another' (Wenger 1998, 73). Following Wenger, mutual engagement keeps a group together and allows engaging in learning. In this team there are more potential factors conducive to mutual engagement: the PhD students all work with the same supervisor, who privileges collaboration and motivates them to have meetings. They are able to focus on their PhD because there are favourable material conditions (a fellowship that comfortably covers living costs). They have dedicated work spaces; also, their affiliating institution offers them more opportunities (such as the ability to attend summer schools or conferences). Nevertheless, some issues that could potentially create tension. Some participants highlighted that some students enjoy closer and more supportive relationships with each other. This may occasionally exclude other members of the team from learning. In addition, there are cultural differences in how open people are in expressing opinions and expectations. Finally, according to some students, the group chair should motivate teamwork better. However, there is a genuine interest in trying to support colleagues, and, throughout the research, a continued commitment in team activities and sustained dialogue among the colleagues have been observed.

The institutional context is important: peer learning in this case is enabled by team leadership and the opportunities offered by the department. This confirms previous literature that the department is central to the doctoral experience (Gardner 2009). The introduction of peer learning initiatives in a university requires limited resources, but can greatly benefit PhD students. This paper focuses on PhD students in computer science; disciplinary cultures greatly impact on the doctoral experience, and disciplines such as the natural sciences and engineering

are more inclined to value collaboration (Barnes, Williams, and Stassen 2012). Nonetheless, literature demonstrates that accomplishing one's own PhD in isolation does not necessarily pay off in terms of becoming an independent researcher (Gardner 2008); also, peer learning, as described in this paper, could easily fit into different doctoral programmes. This should persuade scholars and institutions of the importance of creating a space for PhD students to learn from each other, without feeling any pressure to perform. Based on the findings, the following issues merit consideration.

1. Peer learning initiatives cannot be abstracted from the conditions and status of PhD students in a department. In principle, they should be easier to apply when referring to full-time students who are often in their department and can readily access specific resources (e.g. space). However, the findings show that such beneficial interactions can happen in an allocated weekly slot, meaning that careful planning should allow everybody to participate (even PhD students who work outside university or commute).
2. Peer learning works best in small groups (six PhD students in this case), and with people from similar disciplines, at least when the focus is on enhancing scholarly and disciplinary skills. In this study, the students all have the same supervisor; however, the most important factor in peer learning seems to be the similarity among disciplines. Having different supervisors might be another learning opportunity. This means that, to launch a peer learning initiative across an institution, it might be helpful to have one or more senior persons to act as a facilitator, to introduce students to the benefits of peer learning and support them to group and get organised.
3. The focus on a specific activity might help a peer learning initiative to get off to a good start. One suggestion is for each student to spend some time discussing a relevant piece of literature and critically link it with the dissertation topic (as happens in Vignette III).

Once the group has established its routine, students can adjust the type of activity to their needs.

4. Time brings change: while some PhD students finish their PhD and leave, others join. Students should ease the entrance of new members. In addition, tensions might arise on the team, but regular meetings with a facilitator (e.g. each term) might help to get the team reflect on their own practices and defuse tensions.

These points are intended to inspire PhD students, scholars and institutions willing to facilitate the PhD journey. The role of formal PhD training is not dismissed, and it should be reinforced by peer learning. Furthermore, peer learning could greatly help part-time students, who are more at risk of isolation (Deem and Brehony 2000, Zahl 2015). Similarly, it could benefit students enrolled in professional doctorates, by offering them a place to elaborate on the relations between disciplinary knowledge, professional identity and personal experience (Pratt et al. 2015, Wellington and Sikes 2006). Figure I summarises the factors involved in peer learning.

Figure I: Dynamics of peer learning

[Figure 1 near here]

The findings are drawn from a unique case, this limiting the conclusions. However, the richness of the data allowed to propose a few guidelines for people and institutions. Additionally, the findings allow for drawing some considerations in relation to theory. AT has been useful to disentangle the relations between structured and emergent interactions, and highlight the material aspects of learning, a topic that has been overlooked in higher education. An issue is that the concepts of internalisation, externalisation, zone of proximal development and scaffolding, seem to assume a hierarchy between a novice and an expert; however, these

roles are not predetermined, but can change from an interaction to another one. At the end, a concept from SLT (i.e. mutual engagement) has been mobilised. Future research could integrate AT and SLT to study peer learning. The two could be seen as complementary, since, as underlined by Arnseth (2008), AT works on multiple levels, while SLT better focuses at the group level. Empirically, scholars could investigate peer learning across institutions and disciplines, to better understand in which conditions it flourishes and what can be done to encourage it. It might also be worthwhile to investigate how peer learning supports PhD students in the transition from student to independent researcher/practitioner, since this is an especially difficult and understudied phase of their journey.

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