



Mcquade, R. , Ventura-Medina, E., Wiggins, S. and Anderson, T. (2020) Examining self-managed problem-based learning interactions in engineering education. *European Journal of Engineering Education*, 45(2), pp. 232-248. (doi: [10.1080/03043797.2019.1649366](https://doi.org/10.1080/03043797.2019.1649366))

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Examining self-managed problem-based learning interactions in engineering education

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With the increasing complexity of the engineering role, today's graduates must be capable of confronting both technical and societal problems which are underpinned by effective teamwork at their core. Problem-based learning – one of a range of collaborative pedagogies – has been implemented in engineering teaching as an avenue to better prepare students for the realities of modern industry. However, there has been limited research which examines the complexities of the social processes involved in PBL tutorials, and even less so within tutorless contexts. The present study, therefore, reports on *how* students working in tutorless PBL groups – owing to teaching limitations – must effectively self-manage their team efforts if they are to succeed. This PBL arrangement involved a 'floating facilitator' – offering students only minimal contact – but the analysis focuses exclusively on the students' tutorless interactions. The data collected is from 22 third-year chemical engineering undergraduate students in four groups, and consists of naturalistic video-recordings over the course of 32 PBL meetings, resulting in 35 hours of video data. This large data corpus was examined empirically using conversation analysis to elucidate students' recurrent communicational practices. The microanalyses showed how students continuously established the PBL tasks as being the collective responsibility of the group. Furthermore, students maintained 'average' – and equal – social identities (e.g. not outperforming one's peers within the public space) and used displays of humour/self-deprecation as means of constructing an informal learning environment. It is argued that – in the absence of the tutor who would normally maintain cohesion – these interactional strategies offer a means through which students adapt to the unfamiliarity of the tutorless PBL setting, where no one member is positioned as the substitute tutor (i.e. 'othered' by their peers).

Keywords: problem-based learning, teamwork, interaction, conversation analysis, tutorless groups

1. Introduction

While previously the employability of engineering graduates was reliant on technical ability alone (Lehmann, Christensen, De, and Thrane 2008), the ever-evolving demands of industry now mean that being a contemporary engineer involves considerably more than possessing the relevant knowledge (Lutsenko 2018; Monteiro, Leite, and Rocha 2018). As engineering professionals, graduates must be leaders and communicators, equipped to deal with complexity and unpredictability, in addition to knowledge mastery (Atman, Yasuhara, Adams, Barker,

Turns, and Rhone 2008). These prerequisites are especially prominent within 21st century engineering, where societal and technical problems are more interdependent than before. This interdependence requires an additional skillset which holds that modern engineers must be capable of sustaining effective working relationships (e.g. with colleagues, customers, and clients), and where communication underpins the very practice of engineering itself (Darling and Dannels 2003; Fitzpatrick 2017; Lehmann et al. 2008).

Current degree programmes, however, have been criticised for their misalignment with the needs of real-life engineering (Boklage, Coley and Kellam 2018) with industry reporting inadequate problem-solving and interpersonal skills amongst hired graduates (RAEng 2014), and the ineffective development of communication skills – thanks to the traditional pedagogies often used – remaining a longstanding concern (Darling and Dannels 2003). These issues stem from engineering education’s longstanding reliance on conventional teaching, where practice is overwhelmingly tutor-centred (Dahms, Spliid, and Nielsen 2017; Prince 2004). In ‘chalk and talk’ learning cultures, the transmission approach to imparting knowledge does not facilitate subsequent usage of engineering domain knowledge in authentic problems (Almajed, Skinner, Peterson and Winning 2016), as students may learn content, but they lack the ability to apply this newly acquired knowledge in real-life engineering situations (Thomas 2009). To effectively learn material, students must develop skills of reflection, discussion and meaning-making with peers and tutors (Dochy, Segers, Van Den Bossche and Struyven 2005; Mills and Treagust 2003).

Although many institutions remain apprehensive of educational reform (Segalàs, Ferrer-Balas, and Mulder 2010), graduate engineers simply cannot contribute to the challenges of modern society without the necessary professional (or ‘soft’) skills to do so (Köhler, Bakker, and Peck 2013). As a result, engineering teaching has gradually transitioned toward student-centred pedagogies which encourage the job-readiness of graduates (Kumar and Hsiao 2007). In problem-based learning (PBL) – where core technical knowledge is combined with group work on real-life scenarios (Dolmans, De Grave, Wolfhagen, and Van Der Vleuten 2005; Prince 2004) – the shared cognitive burden amongst one’s group of peers, as well as the collaborative, communicative skills involved in navigating to solutions for problem tasks, improve critical thinking and enhance retention of long-term skills through self-directed learning (Lima, Andersson, and Saalman 2017; Hmelo-Silver 2004). By redefining the authoritative dynamics of traditional teaching, PBL empowers its students to take charge of their own learning and recognises that they must be socialised towards professional engineering identities through their group interactions.

Since its inception, various models of PBL have been adopted across different settings (Davidson and Major 2014; De Graaff and Kolmos 2007; Savin-Baden and Major 2004) depending on the type of problems, the type of tutoring used, and the type of support delivery (e.g. within a lecture, or alongside lectures). In a climate where engineering cohorts are increasing in size but teaching resources are often limited, the tutor cannot commit their undivided attention to each group, and so, a tutorless PBL approach may be used (see Woods, Hall, Eyles, and Hrymak 1996). Alternatively, the floating facilitator PBL model (Allen, Duch, and Groh 1996) – to be explored within the current study – involves the tutor splitting their time between multiple groups, with the vast majority of learning being student-managed. While not as intensive as the tutorless approach, floating facilitator PBL shares similar principles in terms of the tutor withdrawing from their standard cognitive assistive role (e.g. amending errors and delegating the group agenda on behalf of the students), and its explicit preference for students taking on educational accountability (Delaney, Pattinson, McCarthy, and Beecham 2017). That is, by only very loosely driving the tasks ahead, students in small groups are forced to work independently of the nurturing tutor’s participation. Instead, they must lean on the scaffolding of peer support which PBL provides, and through these social interactions, their

shared knowledge is reconstructed and validated until a meaningful resolution is made for the problems at hand (Hmelo-Silver 2004; Perrenet, Bouhuijs, and Smits 2000). Through its intrinsic untidiness, PBL fosters creativity and attends to one of the central needs of current engineering teaching: “to build curriculum and assessments that replicate the uncertain, messy, problem-based, people-intense, and time-limited world of work” (RAEng 2014, page 16).

Despite this push for pedagogical change in the form of collaborative learning, as well as the emphasis on the development of communication skills within engineering education – “the lifeblood of a practicing engineer” (Darling and Dannels, page 15) – there is a significant lack of empirical research which examines PBL at the interactional level (Imafuku and Bridges 2016). This is problematic for instructional design and delivery, as conversation analytic research has shown that “we build, maintain and end our personal and professional relationships through talk” (Albert, Albury, Alexander, Harris, Hofstetter, Holmes, and Stokoe 2018, page 399), yet little is known about the intricacies of student interactions themselves. In the case of the floating facilitator in PBL, for example, given its social intensity which calls for students to self-manage group dynamics alongside educational business, it is vital that we gain insight into what works – and what does not – if we are to determine pedagogical best practice (Allen, Duch, and Groh 1996).

The objectives of this study, therefore, are to shed light on how engineering students manage the social processes of PBL when the tutor is not on hand to guide the learning on their behalf. Whereas in **conventional** learning tutors and students are members of distinct groups – that is, students are epistemically subordinate to the expert tutor – PBL positions its participants equally, where the tutor is no longer the expert, so it is essential to understand how (if at all) they manage this newfound learner autonomy (as well as the shift in power dynamics), and the impact this has on their student identities (see e.g. Benwell and Stokoe 2002; Benwell and Stokoe, 2010; Stokoe, Benwell, and Attenborough 2013). Social identities are the drivers of our interactions with one another, and they reveal the implicit norms within a given social space; here, the expectations – and violations – of being a student within tutorless PBL, and the conditions necessary in maintaining one’s group membership. Using a rigorous conversation analysis (CA) across a rich data corpus of chemical engineers, we share the interactional strategies of students within the *tutorless* fragments of a PBL approach involving a floating facilitator, with the aim of informing future implementations of PBL within institutions with similar resource restrictions.

2. Methods

2.1. Learning setting

Savin-Baden’s (2000) PBL for professional action was adopted in the learning setting considered within this study, centring on the development of skills and knowledge that are directly applicable to the engineering workplace. Through real-life problem scenarios, students are encouraged to take an action-based approach in collaboratively developing practical solutions to the challenges at hand. Given the large class size and limited number of available tutors, Savin-Baden’s (2000) approach was also combined with the floating facilitator PBL model (Allen, Duch, and Groh 1996). In this way, students were forced to develop their autonomy from the very beginning of the PBL experience, receiving only intermittent tutor contact.

In the case of the study participants, at the start of each PBL session, the groups were visited in their individual meeting rooms by a tutor. This tutor would provide students with materials for the current week’s case, and would converse with the groups regarding any unresolved issues from the previous session. On the whole, however, tutor-student contact at

the start of the PBL session was normally brief, with the tutor promptly leaving the room so the groups could begin their self-managed efforts. The same tutor would then return to the groups around the midpoint of each session to ensure that progress was being made. On occasion, the class leader would visit the participants in place of the tutor at this midpoint as means of maintaining a degree of personal contact. Tutors were instructed to take a non-expert stance and to remain largely neutral as means of facilitating self-directed learning (Wiggins and Burns 2009). Their role was to enable the necessary skills required to solve the problem (i.e. validating task goals and providing gentle learning prompts as the PBL scaffolding), rather than being a direct source of knowledge.

In terms of the PBL curriculum, students were presented with instructional materials and an open-ended problem case each week. They submitted both their learning objectives for new cases – all of which related to issues of process design – and their reflective reports of the previous session on a weekly basis as means of monitoring progress and having accountability. Upon completion of these PBL cases, students were assessed on the basis of a final group design project. In the aim of helping students to manage their own group processes, written feedback was provided for each of these submissions. As the students had not been exposed to the PBL approach before – the university in which the study takes place typically adopts the traditional lecture-based format – they received training workshops centring on effective teamwork and the core components of the PBL methodology, prior to the commencement of PBL tutorials. The first workshop problem they were presented with – delivered by the module leader – was one that exemplified a conflict scenario that could potentially arise in group work, where the students were exposed to the practice and cycle of PBL (see Hmelo-Silver 2004) and expected to develop possible solutions.

2.2. Conversation analysis (CA)

The current paper employs the methodology of conversation analysis (CA); an approach based upon the principles of ethnomethodology and linguistics, and a means through which the fine-grained, empirical study of human communication is made possible. In CA, the data is naturally occurring, meaning that it is examined in its original form, and is free from the researcher's manipulation (Hutchby and Wooffitt 2008). CA is inductive, where it is driven entirely by the discourse of its speakers, as opposed to being led by predetermined objectives or prior theory. The upcoming analyses, therefore, are underpinned by the *speakers'* orientations; that is, what the students actively make relevant in their 'talk', and what is shown to be consequential to their ongoing interactions (Heritage and Raymond 2005). It is not possible, then, to make assumptions about a particular speaker's personality or cognitive state of mind, nor can we comment upon the impact of, for example, unequal gender ratios within the PBL groups, without the *students* themselves orienting to these as relevant analytical issues. Instead, the analyst's sole concern is the 'here and now'; the lens through which the actual social processes in naturalistic learning can be unearthed (Psathas 1995).

CA systematically analyses large-scale data corpora, documenting – at the micro-level – the recurrent interactional practices involved in everyday human communication. By elucidating the mechanics of talk – its structural design and sequential organisation – CA provides insight into how specific social phenomena are produced, and how sense-making and social order are collaboratively achieved by interactants in conversation (Psathas, 1995). Furthermore, through identification of deviant cases – those which violate the typical patterns of communication – CA exemplifies the implicit norms which govern the unfolding of social interactions (Heritage and Raymond 2005). In the upcoming analyses, for example, deviant cases highlight those interactional moves in conflict with the construction of the student identity; a prevalent concern, given the students' need to self-manage their groups. Here, to

openly display enthusiasm for academia, or to be seen as making overly authoritative moves, is to breach one's status as an average and equal group member (i.e. a non-expert who does not stand out amongst one's peers), thus running the risk of being substituted for the absent tutor role. Therefore, through CA, it is possible to shed light on the continual identity work engaged in by students, where their discursive strategies serve to mitigate potential threats to their standing as fellow 'team-players'.

The first stage of the analysis involved transcribing the tutorless portions of the video-recorded PBL data in accordance with the Jefferson (2004) system (see section 3). This meticulous process of transcription captures the subtleties of human communication, focusing on conversational design – intonation, overlap, volume, and silence, to name but a few – in addition to its multimodal properties – eye gaze, gesture, and the use of physical objects. The Jefferson (2004) system serves a fundamental role in conducting CA, as it makes the “precise identification and description of phenomena in interaction possible” (Wagner 2010, p.1474). To ensure the accuracy and robustness of the analyses, the data files were slowed in pace, and the transcripts were carefully refined – line-by-line – through repeated observation and listening of the data, as well as the authors engaging in joint data sessions. From these transcripts, a large catalogue of sequences involving orientations to student identity was compiled, with the final body of extracts chosen as the most salient examples of the overall analytical findings.

2.3. Participants and data collection

This naturalistic observational study involved PBL tutorials in an engineering programme being video-recorded during students' standard learning activities. 22 students – randomly allocated to one of four groups by the class leader – from a third-year chemical engineering cohort at a UK university participated. They were voluntarily video-recorded in private meeting rooms, where non-intrusive video cameras were positioned around the workspace.

In the first phase of data collection, Groups 1 and 2 each received 15 PBL cases – comprising a two-hour weekly session – throughout September 2015-February 2016. As the study had only recently come to fruition at this stage, video-recording commenced in the midst of the first semester (November 2015), with each of the two groups recorded – at the same time – across six of the total PBL sessions, capturing 12 hours of footage, overall. The incongruities between the PBL schedule and the amount of data collected was the consequence of technical difficulties, students leaving the meetings prematurely, and the researcher's external circumstances.

In phase two of the data collection, from September 2016 – February 2017, during a two-hour weekly session, Groups 3 and 4 received 17 PBL cases each. Due to delays in finalising ethical approval, however, video-recording did not begin until late October 2016. The groups were eventually recorded – again, at the same time – across 10 sessions of PBL each, producing 23 hours of recordings, overall. As above, the shortfall in recording hours occurred as a result of equipment malfunctions, and the students departing the sessions earlier than scheduled.

In summary, then, video-recording took place over a total of 32 PBL sessions across the four groups (2015-2017), providing a data corpus of 35 hours, which was analysed in its entirety for the present study. Of these recordings, only a fragment involved the tutor's presence, and these instances were excluded from transcription.

3. Results

The following extracts are representative of what was analytically significant throughout the 35-hour data corpus as a whole. As noted previously, the current analyses focus exclusively on the students' self-managed collaborations in PBL; that is, when the tutor was not present in the room, as was predominantly the case.

These extracts reveal the inner workings of the institutional setting in terms of the patterned interactional strategies adopted by students when powering through the social *and* educational elements of tutorless PBL group work. The analytical discussions are structured as follows:

- Section 3.1. Establishing shared responsibility for the PBL tasks, where leadership roles are resisted so as not to be positioned as the – authoritative – substitute tutor (e.g. using personal pronouns – ‘we’ and ‘us’ – and invoking the PBL worksheet – a shared physical object – to engage the entire group in the work).
- Section 3.2. Adherence to the co-constructed ‘average’ student identity, where the PBL work is treated as a necessary burden, rather than being one which students are willingly invested in, or attain enjoyment from (e.g. ‘just getting it done or she’ll fail us’). To be an average student is to be of equal status to one’s peers, so instances of academic outperformance are also managed accordingly.
- Section 3.3. Constructing the tutorless PBL environment as an informal space where humour and self-deprecation are used as means of detaching the group from the seriousness of academia during their self-managed interactions.

Although the data corpus has been fully transcribed in line with the Jefferson (2004) system, the upcoming extracts are presented in simplified form, focusing only on the key elements (shown below) of speech which are relevant to the analytical discussions:

(0.2)	Pauses in tenths of a second.
CAPITALS	Sound that is louder than the surrounding speech.
°quieter°	Sound that is quieter than the surrounding speech.
↑↓	Indicate rising or falling speech intonation.
£	Displays a ‘laughing voice’.
-	Indicates a cut-off sound in speech.
[Demonstrates overlapping speech.

3.1. *Establishing shared responsibility for PBL*

We begin this first section of the analysis with a prototypical extract of the interactional work associated with the organisation of tasks in tutorless PBL. Whereas standard models of PBL involve the tutor negotiating – or at least overseeing – the educational business on behalf of students, in tutorless PBL, it is the students themselves who are made accountable for the enactment of their group agendas. As identified in the present analysis, an added layer of complexity within this PBL setup stems from the students’ reluctance to take on – and to competently rotate – the various group roles (e.g. leader; notetaker; chair) on a weekly basis, despite being instructed to do so. Extract 1 sheds light on how students instead manage their newfound learner autonomy through lengthy clarification talk (see Stokoe 2000) and by continuously orienting to the duties of the collective group, so as to avoid one member being burdened with sole responsibility:

Extract 1: Group 4

1 NICK: °I suppose we could even use-y-our phone to do it°

2 (1.0)
3 **LIAM:** ↓oh (0.4) °I co-I could get that (0.2) jus' ↓now°
4 (2.2)
5 **EMILY:** ↓well (0.4) can we do th↑at? (.) can we get the-the assignment
6 instructions up?
7 **LIAM:** yeah I'm gonna do that-right [now
8 **EMILY:** [right
9 **LIAM:** wa↑hoof ((Emily laughs briefly))
10 **EMILY:** right well we'll work on the questions (.) at the same
11 time so we won't (.) have to do work outside of those
12 (0.2) allocated times
13 **LIAM:** right (.) ↑SO so we're saying meetings on Mondays three
14 'til five? (.) we're all gonna be workin' on the questions
15 at the sa::me time? (.) what else?

We arrive at this extract as Group 4 – having received their PBL materials for the week – embark upon one of their first meetings together. The opening line follows on from a lengthy period of silence, where Nick – as a suggestion, rather than a command – gently initiates the group's commencing the work. See, for example, his quietened speech, its low modality (“suppose we could”), and the sudden reframing of his proposal's target audience (“y-our”), so as not to isolate one person as being answerable. Similarly, if we look at the subsequent turns, we see how Liam – the first respondent – avoids portraying himself as the overly keen volunteer, responding (line 3) only after an extended pause (line 2) – rather than immediately tending to the educational business – and hedging (“↓oh (0.4) °I co-I”) around his offer with both quietened speech and low modality (“I could get that”).

In lines 5-6, following a substantial pause (line 4), Emily enters the conversation to build upon Liam's turn. Much like Nick in line 1, however, given the group's assumed status as equals, Emily is in no position to formally assign her peers' duties, and therefore, must indirectly negotiate matters, instead. For instance, note how she evades authority through her inquisitive stance (“do th↑at?”; “instructions up?”) which invokes the entire group (“can we”), as opposed to singling out Liam. Furthermore, by suggesting that the online “assignment instructions” are projected “up” on the screen for all to see – and not just one member's “phone” – Emily induces a *public* activity that the group must collaboratively engage in. Following this point, it is striking that the modality of Liam's discourse increases significantly (“gonna do that-right [now”, line 7) from his initial wariness in line 3 (“could”), now that he no longer risks being burdened with single ownership of the work. The group's alliances are further illuminated here through Liam and Emily's joint laughter in line 9.

As well as continuing to accentuate the shared workload of the group (“we'll work on the questions”), throughout lines 10-12, Emily also stresses the importance of sustaining their collaborations if they are to avoid working beyond the “allocated times” of the PBL sessions. Here, Emily provides a solid rationalisation for the group's need to remain on track with the PBL work *without* constructing herself as the dominant, substitute tutor; that they either efficiently confront the PBL work during the scheduled meetings, or face sacrificing their personal time. During lines 13-15, Ben's repeated “so” – a discourse marker which prefaces action initiation (Bolden 2006) – follows on from Emily's turn by determining the precise meeting time (“Mondays three 'til five”) to be adhered to by the group. Although, in making this move, Ben also exhibits several confirmation-seeking proffers directed at his peers (“'til five?”; “at the sa::me time?”; “wha::t else?”). This guarded approach (“we're all gonna be workin'”) is representative of the corpus overall, where individual members seek validation from one another as they gradually, and *co-constructively*, nudge the PBL agenda ahead; neutralising any traces of leadership along the way.

Whilst each of the examined groups typically managed the setup phase in the ways elucidated above, one of the main hazards of tutorless PBL is a member being substituted for the missing tutor figure. In the second extract, for example, we see how Caitlin – of Group 1 – resists the leadership role which Paul attempts to impose on her:

Extract 2: Group 1

1 **CAITLIN:** is that the-is it the case that it's these questions
2 are assignment A? you know how we've got an assignment
3 to hand in? (.) or is this-we're getting different
4 questions each- (.)
5 **PAUL:** week
6 **CAITLIN:** week
7 **PAUL:** is that what you think tutorial one is (.) analysis
8 and understanding? (.)
9 **CAITLIN:** well I'm just wondering because (.) it says on
10 the front that it's assess-assignment A (.) or is
11 that just separate notes for assignment A and this-
12 **PAUL:** so which one (.) do you think it's tutorial one?
13 **CAITLIN:** see I don't (.) if they're long questions-NAH-
14 let's see ((pointing at/lifting PBL worksheet)) (.) it's all
15 calculations so it might be that it's (.) it's one
16 tutorial

As in Group 4's PBL setup, Caitlin initiates task organisation through clarification talk ("is it the case", line 1), where – characteristically – togetherness is key ("you know how we've got", line 2). Caitlin's speech is prolonged throughout lines 1-4, but in seeking peer confirmation ("assignment A?"; "hand in?"; "is this?"), she sidesteps any leader-like behaviours. Paul attends to Caitlin's proffers for clarification through completion of her sentence ("week", line 5), which is repeated by Caitlin herself (line 6) in what appears to be an agreement formulation (Stivers 2005). However, Paul's use of "you" (line 7) directs authority towards Caitlin, as though she holds sole responsibility for making this group decision. It is also intriguing that Caitlin does not mention "analysis and understanding" (lines 7-8), yet Paul references his *own* interpretation of the task as though it is Caitlin's.

Despite Caitlin's minimisation of her expertise (e.g. "I'm just wondering", and "it says", as though she is merely relaying the contents of the worksheet), during lines 9-11, Paul continues his interrogations ("which one"; "do you think", line 12) which construct Caitlin as being personally accountable for the direction of the PBL task. In response, Caitlin – again – mitigates this threat by communicating her uncertainty ("I don't"; "NAH"; "might be") as an assurance that she has no concrete solution to Paul's requests; that she does not hold the authority – as the expert tutor would – to determine which action is – and is not – appropriate. At this point, she also makes reference to the PBL resources which are available on the desk for each of the members to read themselves. By directly handling the PBL worksheet (see figure 3.1) – coupled with her use of "let's see" (line 14) – Caitlin directs attention towards a publicly available object, making clear that this is not an individualistic task, but a collective one that they hold joint epistemic responsibility for (Berge and Weilenmann 2014). It is only after these exhaustive rebuttals, and more specifically, Caitlin's physical engagement with the PBL worksheet, that Paul withdraws pressure (not shown in the extract), and another student interjects with a new issue.

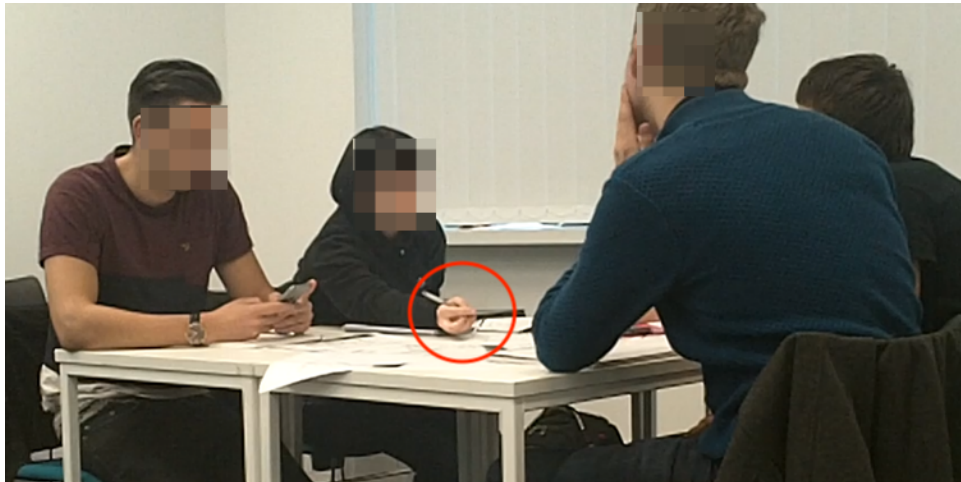


Figure 3.1. In line 14, Caitlin points at the PBL worksheet, before picking it up.

In sum, this particular case aligns well with Hammar Chiriac's (2008) model of student group dynamics, in that Paul – working as the passive group member – seeks out the support of a leadership figure; a blatant void in this predominantly tutorless PBL model under study. Caitlin's resistance to Paul orients to the fact that, by appeasing his requests (i.e. being accountable for the group's educational business), she would construct herself as more knowing than her peers (Heritage 1998), and this would be most problematic for her identity as an equal group member; an interactional issue which is explored in depth within the forthcoming analytical section.

3.2. Maintaining average student identities

Previous conversation analytic research involving British university tutorials (e.g. Benwell and Stokoe, 2010) has shown how students – when interacting with their peers – are often highly resistant to academic identities; despite their mutual standing as university students. By downplaying their educational capabilities, and minimising their investment in university, students avoid being positioned as the 'studious one', or as being overly engaged with academia; instead maintaining their sameness as 'average' students who do what is required of them, but – strictly – no more. These findings are especially true of the current analyses involving *tutorless* PBL, where students work to maintain equal epistemic status by resisting expert-like moves that could violate their average membership, and – potentially – 'other' them into the absent tutor role.

An example of this interactional identity work is provided in extract 3, where Group 2 are scrutinising the tutor feedback they received on the previous week's graded PBL report. The "pen" they are referring to reflects the amount of handwritten comments provided by the tutor for each section, and we see how Sam has to neutralise his knowhow to avoid being outcast by his – underachieving – peers:

Extract 3: Group 2

- 1 **BEN:** SHE'S NOT ACTUALLY-YOUR SIX HASN'T GOT MUCH PEN (.) 'cos some
 2 pen here ((pointing at the report))
 3 **SAM:** YEAH but crap though
 4 (2.0) ((Ben's gazes at Sam))
 5 **SAM:** well-wasn't CRAP crap but °it wasn't great°
 6 **BEN:** I KNOW BUT-
 7 **GARY:** 'COS I MEAN EVERYONE GOT A REALLY CRAP MARK FOR THAT
 8 IT'S LIKE (.) what more do you want for a block flow

- 9 diagram?
 10 **SAM:** not everyone-Ryan got NINETYFIVE
 11 **GARY** yeah not everyone but we did crap

Whereas the majority of Group 2 have underperformed on this latest PBL task, in line 1, Ben notes that Sam’s section of the report has received considerably less critique from the tutor (“SHE’S NOT ACTUALLY”) than any other member’s attempts (“HASN’T GOT MUCH PEN”). In making this point, Ben abolishes the usual interactional preference for group togetherness (“YOUR SIX”); rather than the PBL report being viewed as the collaborative task it is intended to be, the incongruities in tutor feedback override the group’s sense of solidarity, where individual accountability comes into action. Ben’s loudened assertion is accompanied by a physical pointing gesture (line 2) towards Sam’s specific section of the report (see figure 3.2), ensuring he is heard not only by Sam, but by the rest of the group, too (Berge and Weilenmann 2014). Essentially, Ben calls out Sam’s overperformance, thus threatening Sam’s stance as an equal – and average – group member.



Figure 3.2. In line 2, Ben points at Sam’s contribution to the group’s PBL report – and its lack of handwritten tutor critique – as the other members look on.

Consequently, in line 3, Sam is forced to acknowledge Ben’s observation (“YEAH”) – but follows with an immediate downgrade (“but crap though”). A lengthy two-second pause ensues – a common indicator of conversational trouble (Kuo 1994) – during which Ben directs his gaze at Sam (line 4); forcing him to amend his initial account (line 3) with more self-deprecating talk (line 5). Here, Sam demonstrates that, whilst his own efforts were not as poorly received as his peers’ (“wasn’t CRAP crap”), his tutor feedback is by no means impressive (“it wasn’t great”). This is a vulnerable point in the interaction for Sam, as he cannot ignore the blatant disparities in critique – this would impair the authenticity of his discourse – but must downplay this unavoidable superiority, or face potential ostracism from the group (Hendry, Wiggins, and Anderson 2016).

As we arrive at line 6, Ben continues to dwell on Sam’s accomplishment (“I KNOW BUT-”), before another student – Gary – interjects (“COS I MEAN”, line 7). Note how Gary diverts attention from Sam’s individual contribution by generalising the cohort’s overall underperformance (“EVERYONE GOT A REALLY CRAP MARK”), and by fixating blame upon the ‘hard to please’ tutor (“what more do you want”, line 8). In positioning the institution as overly demanding, the group construct a common enemy; in this instance, an interactional strategy which serves to repair their unsteady alliances (Hammar Chiriatic 2008). Intriguingly, it is also at this point where Sam seizes the opportunity to reference Ryan – a student within

another PBL group who truly excelled in the report – as an attempt to alleviate the consequences of his own achievements (“Ryan got NINETYFIVE”, line 10). In doing so, *Ryan* – as opposed to Sam – is positioned as the actual ‘expert’ outsider. Through teasing the absent party, Sam works to restore group cohesiveness, shown by Gary’s inclusion of Sam in his joking assessment of *their* group (“but we did crap”, line 11).

In summary of extract 3, then, as was prevalent throughout the data corpus, to be perceived as outperforming one’s peers is disruptive to the maintenance of one’s equal member status. Sam’s academic achievements are policed by Ben, where he makes him accountable for the studious behaviours which breach his average credentials; a core prerequisite of the student identity. As we shall now see in extract 4, overinvestment in academia is also treated as a violation of this average status. In this instance, Craig approaches working outwith the formal PBL times; an activity which must be managed cautiously, as shown previously in extract 1. The act of engaging in academia *beyond* the allocated PBL meeting is an optional one – as opposed to being compulsory – and, thus, could portray Craig as being too enthusiastic about the burden of PBL:

Extract 4: Group 3

- 1 **CRAIG:** are you stayin’ in today?
2 **ANNIE:** (.) yeah
3 **CRAIG:** are you gonna be in tomorrow morning?
4 **ANNIE:** (.) pardon?
5 **CRAIG:** are you gonna be in tomorrow morning?
6 **ANNIE:** yeah
7 **CRAIG:** do you want me and you to do the process description?
8 *((Annie briefly smiles and makes thumbs up gesture))*
9 **CRAIG:** °okay° NAH ‘cos it just gets it DONE so then everybody
10 else can get
11 **SHARON:** can do the rest of it yeah
12 **CRAIG:** ‘cos it’s like-if we try and stay on this timetable
13 as close as possible then it means it’ll get done

By singling Annie out, Craig could be perceived as checking up on her, as the tutor may do (“are you stayin’ in today?” line 1; “are you gonna be in tomorrow morning?”, lines 3 and 5). This is an uncomfortable point in the interaction, demonstrated through Annie’s minimal responses (“yeah”, lines 2 and 6) and hesitance to fully engage in Craig’s talk (“pardon?”, line 4). What Craig suggests to Annie is socially undesirable; to openly commit to partaking in further study outside of the PBL schedule lies at odds with appearing detached from academia (i.e. ‘being’ a student) (Stokoe, Benwell, and Attenborough 2013). In light of this, if we consider Annie’s eventual acceptance of Craig’s invitation, it is notable that she does not vocalise her response (line 8), nor does she expand upon Craig’s request; merely raising her thumbs, and offering a brief smile, instead.

In line 9, following Annie’s hesitant uptake, Craig orients to his dispreferred moves through subsequent repair work. His loudened “NAH” dismisses any enthusiasm for the PBL tasks and establishes that he is merely doing what is required of him (“just gets it DONE”). Note how Craig also draws upon the ‘everybody’ person category (“so then everybody else can get”, 9-10), as though his failure to carry out these tasks would have detrimental consequences for the rest of the group. In this way, Craig references the group’s collective need to complete the task, where his own efforts fulfil an integral duty to his fellow peers. It is only after Craig’s justification of his proposed actions that his requests are legitimised by another member of the group (Sharon’s “can do the rest of it yeah”, line 11).

In the final lines of the extract, Craig reiterates the importance of getting the work “done” (line 13), where the completion of the PBL tasks are positioned as the central group

objective. In this way, the educational demands are treated as a burden, and for this burden to be eradicated, their collective ‘doing education’ is necessary (“stay on this timetable as close as possible”, lines 12-13). As in the previous extracts, this notion of powering through serves an important cohesive role for the students, as well as diffusing responsibility amongst the group; that is, rather than Craig being pushy or overly keen, he wishes to free the group of their commitments as soon as possible. It is also interesting that, here, Craig reverts back to the notion of the group remaining on schedule; now opting for the socially preferred course of action, rather than lingering on his initial requests which command his peers to ‘work overtime’ (i.e. to sacrifice their social lives)

3.3. *The informal PBL environment*

Students frequently used displays of humour, sarcasm and self-deprecation as means of constructing an informal learning environment. As shown in extract 5, as part of a compulsory reflective worksheet, students were expected to reflect upon group performance at the end of each PBL session, and to summarise their learning of the specific problem case. This wrap-up phase has proven to be a valuable point of exploration across the present video corpus, in that these discussions inevitably involve some degree of ‘doing education’ (e.g. technical discourse), thus making them problematic to the ‘non-serious’ or average students (Benwell and Stokoe 2002). Here we gain insight into how students self-manage the conversational preference for academic detachment *alongside* this core expectation of PBL:

Extract 5: Group 3

- 1 ANNIE: guys what did we learn?
2 CRAIG: nothing
3 SHARON: Craig wrote the document£
4 ANNIE: we have a big document£
5 CRAIG: I read through books in the library in my spare
6 time£
7 ANNIE: Craig read books£
8 ((group laughter))
9 ANNIE: OKAY (.) how did we work as a team? (.)
10 CRAIG: poorly (.) I did not like Annie£
11 ANNIE: E:HH you're meant to be LEADING (.) HOW DID WE WORK
12 AS A TEAM GUYS?£

If we first consider line 1, following Annie’s topic initiation of group reflections (“guys what did we learn?”), Craig establishes this conversation as one which should not be treated seriously, where he sarcastically disregards any knowledge gains from the PBL session (“nothing”, line 2). This stance is reciprocated by Sharon and Annie’s laughing voices (“Craig wrote the document£”, line 3; “we have a big document£”, line 4) and in Craig’s facetious reference to “books in the library” during his “spare time” (lines 5-6); an activity deserving of mockery, given its clear academic connotations. In this way, the group do not treat their evaluations of PBL as a pressing matter; instead, their co-constructed humour edges around this ‘studious’ topic.

Throughout this extract, it is notable that – alongside partaking in the ongoing humour – Annie repeatedly calls for group reflection. However, in making these requests, she applies a ‘reading speech voice’ (e.g. “how did we work as a team?”, line 9), where she strips her speech of its usual defining character, opting instead for lower intonation, and an avoidance of vocal exclamation; she merely regurgitates the contents of the worksheet in front of her (Stivers 2005). In doing so, Annie mitigates the effects of being the only member to raise the PBL

evaluations; that is, this very scripted tone establishes that she is reading from the worksheet, rather than actively drawing an answer out of her peers, as the authoritative tutor would do.

As this joking stance continues through lines 10-12 (“poorly (.) I did not like Annie£”), note how Annie orients to being burdened with inciting these group reflections, as a direct result of Craig’s abstaining from his allocated leader role (“E:HH you’re meant to be LEADING”). Annie detaches herself from a position of authority and establishes that she has not taken on this role through choice. These lines also show that the allocation of group roles is one which is not taken very seriously. In this way, Annie’s final prompt (produced in a laughing voice) positions her ‘doing education’ as a matter of necessity, rather than being reflective of her own enthusiasm for learning; an issue which is explored in more depth in extract 6:

Extract 6: Group 3

- 1 **ANNIE:** RIGHT ((writing on board)) ↑BRAINSTORM TIME
2 **CRAIG:** are-are you serious?
3 **SHARON:** it’s not as fun as location£
4 **ANNIE:** it’s not£ (.) okay (.) energy balances what
5 do we think we need to know? (0.2) well I think
6 we can download the (sheet diagram)
7 **SHARON:** [yeah]
8 **LINZI:** [yeah]
9 **ANNIE:** OKAY energy balances (.) come on brainstorm people
10 **CRAIG:** so energy out equals energy in (.) finished
11 ((all group laugh, except for Annie))
12 **ANNIE:** so what type of THINGS can we think through?
13 I couldn’t be a teacher£ ((writing on board))
14 **CRAIG:** Mrs Annie£

Following a series of off-topic conversations, Annie’s “RIGHT” (line 1) serves as a change of state token which attempts to drive the conversation back towards PBL (Heritage 1998). Annie engages with the classroom environment by writing on the board, and loudly emphasises “↑BRAINSTORM TIME” (line 1) as the activity the group should be pursuing. However, there are immediate problems in the uptake of Annie’s turn, given Craig’s negatively framed response (“are-are you serious?”, line 2), which casts her behaviour as offensive. Whilst no member directly acknowledges Craig’s comments, Sharon orients to his criticisms of Annie’s “serious” agenda by making a humorous remark (“it’s not as fun as location£”, line 3), as though the uninteresting PBL case is to blame, rather than Annie’s actions (Hammar Chiriac 2008). Annie reciprocates Sharon’s laughing voice (line 4) in her brief alignment with this negative topic assessment (“it’s not£”), before continuing with her educational agenda once more (“okay (.) energy balances”).

As the conversation progresses, Annie continuously orients to her fellow group members (the recurring “we”, lines 5-6), with suggestions for their next course of action (“download the (sheet diagram)”, line 6). These proffers prove to be ineffective, given the minimal responses offered by Sharon and Linzi (lines 7-8), who take no action upon Annie’s proposal. In what is Annie’s third attempt at formulating a plan (“OKAY energy balances”, line 9) – where she uses a directive to actively call upon her “people” – Craig’s eventual response seems to satisfy her appeals for progression (“so energy out”, line 10). Given the subsequent group laughter (line 11), however, Craig’s talk does not suggest genuine engagement with Annie’s turn. In fact, he is teasingly dismissive of Annie’s “brainstorm”. Note how Annie does not engage in this humour as she remains intent on being heard (“so what type of THINGS”, line 12).

As the extract comes to a close, despite an extensive series of proffers, Annie's push towards educational business receives no significant uptake. Coupled with her current resistance to the ongoing group humour (line 11), Annie's detachment from the group becomes more apparent, and as result, she orients to her vulnerability in being 'othered' (Read, Francis, and Robson 2001). Following her final prompt, for instance, Annie's self-deprecating comment ("I couldn't be a teacher", line 13) coincides with her writing on the board; an action which has already been negatively established as assuming a position of authority, given Craig's evaluation in line 3. Through self-criticism, Annie distinguishes the boundaries between being "a teacher", and her own *merely* being a student. In this way, Annie discursively backs down from any misconstrued authority in an attempt to restore alliances with her peers. As shown in line 14, she seems to be successful in this interactional work, where Craig's teasing comment ("Mrs Annie") and shared group laughter lighten the seriousness of the situation.

In conclusion, extract 6 is particularly intriguing as it illuminates the implicit cultural codes of these PBL groups (Read, Francis, and Robson 2001). From the very onset of Annie's opening utterances, her heightened pitch and increased volume form a dramatic transition from off-topic to on-topic discussions, where she is positioned as commanding her peers to 'do education', as an authoritative tutor would do. Annie's repeated topic initiators demonstrate her fight for discursive space, and this self-imposed leadership is troublesome when all students should be on equal par with one another (especially in floating facilitator PBL, as shown in the aforementioned analyses). Instead, it seems that these points of off-topic transition must be very delicately negotiated, as this chat serves a cohesive function which is especially important amongst student-led groups (Hendry, Wiggins, and Anderson 2016).

4. Discussion and conclusions

These microanalytic findings are the first known to illuminate the conversational strategies adopted by engineering students when they are left to their own devices in tutorless PBL. From the very initial sessions, each of the studied groups established the importance of maintaining equal footing in their interactions. In the PBL setup, for example, they displayed their lack of entitlement to individually carry out authoritative decisions; instead, using exhaustive clarification discourse to collectively nudge their educational business ahead. This was achieved through persistent use of personal pronouns, as well as their invoking the PBL worksheet as a communal object for group engagement. Public displays of tutor praise were marked as undesirable, where overachievers were interactionally policed (e.g. Sam's lack of tutor critique, extract 3) and, being perceived as average-performing – as opposed to 'the expert' – was pivotal to one's student membership. In this way, PBL was treated as a chore, but an unavoidable one; a burden to be eradicated, so as not to infringe upon the groups' external social lives (e.g. Craig's "just gets it DONE", extract 4).

Although the recurrent interactional practices may be somewhat perplexing at a first glance, they are reflective of the implicit cultural expectations that underpin being a student – amongst other students – within an educational space that removes the primary authoritative figure (i.e. the tutor). That is, the tutorless dimensions of PBL add a further layer of social – on top of the educational – responsibilities which must be efficiently managed by students if they are to preserve their cohesion as a functional engineering team. One way of catering to these social demands appears to be the students sharing in a joint interactional resistance against the institution. If we reconsider the final extract, we see how even slight deviations from these implicit norms were categorised as highly problematic for the group. For instance, Annie's seemingly insignificant behaviours (e.g. her directive prompts to engage in PBL, and her writing on the board) were enough to cast her as being overly commanding, and thus, in breach of the conditions of her average student identity.

Despite their protracted communications, the groups' neutrality shielded them from some of the most common implications of tutorless PBL (Woods, Hall, Eyles, and Hrymak 1996). Even with the pressures of self-governance, not one of the four groups encountered any serious interpersonal conflicts, reflecting de Grave, Dolmans, and Van der Vleuten's (2001) study of PBL perceptions which documented that students find dominant characters to be detrimental to group productivity. Furthermore, whilst the students continuously resisted academic identities within the institutional space, the analysis does not make any assertions about the students' cognitive states; that they *truly* are disengaged with academia, or that they *genuinely* strive for average performance. Rather, what is central to this empirical analysis are the social practices used by students in publicly negotiating implicit institutional norms. Here, to sustain one's socialisation within the PBL group was to adhere to the collaborative pursuit of PBL goals, and not to put the individual student voice at risk (Read, Francis, and Robson 2001).

4.1. Implications

From consideration of the analytical findings as a whole, the concluding reflections required at the end of each PBL session tended to be inadequately self-managed by the students. As shown in extract 5's "what did we learn?", the students treated their evaluations somewhat trivially, where their joking behaviours impaired the benefits of thoroughly reflecting on their learning within the PBL space. Given reflection is a core component of PBL itself, in future, a degree of tutor scaffolding may be necessary here (Wiggins and Burns 2009). Similarly, although they were repeatedly instructed to do so, the groups regularly failed to appoint specific group members within the various PBL roles, and in the rare instances that they did, they were subjected to mockery, and the accompanying duties undermined. This prevalent nonadherence to the allocation of PBL roles may rest upon the incompatibility between taking charge, and the social expectancies of being a regular student; the individual who blends in and does not readily mould into the absent tutor position. The studied groups leaned heavily upon peer support – as opposed to individual roles – as the driver of their PBL progress (Köhler, Bakker, and Peck 2013), and so, it may well be that to intervene here would be to upset the students' mechanisms for navigating the tutorless space.

Furthermore, from a wider pedagogical perspective, despite the push towards PBL, in many educational institutes, this is not integrated until the latter phases of the engineering degree, and by this point, it is difficult to alter the learning behaviours of students who have become so accustomed to the directive approach (Lima, Andersson, and Saalman 2017; Mills and Treagust 2003). Studies have shown how students more successfully meet their learning objectives through the use of PBL, but still rate this approach as secondary to standard lectures, as though they have been short-changed (Warnock and Mohammadi-Aragh 2016; Yadav, Subedi, Lundeberg, and Bunting, 2011). While the educational freedom brought by PBL may be a daunting one for teaching staff (Hendry, Wiggins, and Anderson 2016), it is this very lack of trust which fosters the 'needy' student. Instead, the willingness of educators as enablers of PBL lie at the core of its success (Azer 2005), and it is critical, therefore, that PBL is adopted from the very initial phases of the undergraduate degree. The present analyses show that students *do* have strategies for functioning autonomously – albeit in need of some adjustment – and these results thus bring promise to other engineering institutions experiencing resources limitations, where tutorless PBL can serve as a practical alternative to forms of learning requiring total tutor involvement.

In conclusion, then, given the mounting resource restrictions in higher education, alongside growing demands to immerse engineering students in authentic learning, it seems likely that the use of tutorless and floating facilitator PBL will continue. Consequently, it is

vital that further microanalyses are conducted in engineering education contexts so as to better understand the complexities of students' *actual* interactions as they occur, using these empirical findings as the basis for enhanced PBL training. Future research should consider tutorless PBL contexts beyond the UK in terms of the impact of differing cultural norms on the self-management strategies of engineering students. Research should also make use of the longitudinal insight that video-recorded data corpora provide in tracking students' PBL progression.

Acknowledgements

The authors gratefully acknowledge the Social Psychology Research Group at Linköping University for their invitation to present this work at their 2017 seminar series, as well as the Samtals-och-interaktionsanalys (SIS) Group for arranging an engaging data session involving our analytical findings. The authors also appreciate the students who so kindly volunteered to participate in the study.

Competing interests

None to declare.

Funding

This work was supported by the Engineering and Physical Sciences Research Council Award (1827113).

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Author accepted manuscript