



Mabley, S. and Ventura-Medina, E. and Anderson, T. (2018) The student as facilitator - A qualitative exploration of monitoring strategies used by 'dominant' team members in PBL groups. In: 46th SEFI Annual Conference 2018. European Society for Engineering Education, Brussels, pp. 278-285. ISBN 9782873520168 ,

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The student as facilitator

A qualitative exploration of monitoring strategies used by 'dominant' team members in PBL groups.

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Conference Key Areas: Engineering Skills, Innovative Teaching and Learning Methods, Fostering entrepreneurship

Keywords: Problem-based learning, Student-led Learning, Entrepreneurial Competencies, Problem-solving

INTRODUCTION

At present there is a concern that modern engineering graduates are beginning professional work without the necessary preparation; current educational practices are so far removed from the reality of industrial work that graduates have difficulty adapting [1]. Educational and industrial professionals have different opinions on what is important for working life, with academics focusing mainly on technical knowledge and often overlooking the need to develop students' professional skills [2]. There are currently few opportunities for students to improve their entrepreneurial skills which

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are necessary to help solve the global challenges facing industry in the twenty first century [3].

Problem-based learning (PBL) has been adopted by engineering education as one method to improve students' performance and engagement while providing an environment for them to develop entrepreneurial competencies, e.g. problem-solving, teamwork and leadership. PBL for 'professional action' is an authentic pedagogy which imitates a real-life working environment and gives students the responsibility for their own learning [4]. The existing body of research on PBL for skill development has so far utilised quantitative methodologies, investigating mainly the perceptions of students or the products of learning (e.g. assignments, reports or grades) rather than the processes involved in learning itself. In the last decade there has been a greater focus placed upon the interactions and group processes which occur during PBL or small group tutorials [5-7]. The work presented here adopts a novel approach using a qualitative method to analyse the behavioural characteristics of students when doing problem-solving to understand 'what works' in PBL. This aims to inform educational practices on methods that can promote the development of professional skills in graduates.

The theoretical background to this study is based on the social constructivist view of learning [8, 9]. Where learning is grounded in an individual's experience, knowledge is uniquely constructed based upon these experiences and is influenced by the social environment. This is further built on through the concept of situated cognition which believes that learning is influenced not only from interactions with peers but it is also dependent on the context where it occurs [10]. This gives argument for learning environments to be closely linked to the situation in which the knowledge might need to be applied, e.g. problem-based learning. Focus on the social aspect of learning is something which has not been emphasised by previous researchers. Thus, this paper presents an investigation into 'how' students solve problems in a group and 'how' their interactions impact on their learning process when the guidance of a tutor is limited. Specifically, in this paper we investigate instances when dominant students take on a leadership role in their PBL tutorials and further analyse the response this behaviour receives by peers.

1 METHODS AND RESEARCH DESIGN

1.1 Data Collection and Participant Recruitment

The data reported on in this paper are from video recordings of third year undergraduate PBL sessions, collected from a core Chemical Engineering Design module, taught over two semesters, at a UK university from September 2016 - March 2018. The purpose of collecting video footage is to gain close insight to the naturalistic interactions which take place in PBL tutorials with the intermittent presence of a tutor (a floating facilitator). This means that the researcher can continuously go back to the raw data and unlike traditional observations the data can be revisited to validate the analysis. Approximately fifty hours of data has been gathered and analysed for this ongoing study but only a portion of the results and analysis will be presented in this paper. The first stage in the process of PBL, when teams brainstorm a problem definition and decide on learning objectives, was analysed for this work.

Ethical approval was obtained from the departmental committee before participants were recruited and filming commenced. Overall twenty-five third-year undergraduate

students, taking part in the design module, volunteered to participate in the study making up four small tutorial groups of 5-7 students (see Table 1). This is the first time students in these cohorts experience PBL. To provide anonymity all participants were given pseudonyms for the analysis.

Table 1. Characteristics of participant student groups by academic year and formation method.

Group	No. of Students	Academic Year	Cohort Size	Group formation
1	7	2016-2017	136	Random
2	7			
3	5	2017-2018	150	Belbin Scores
4	6			

1.2 Data Analysis

Studies which assess the success of PBL, for skill development, have traditionally employed a quantitative approach. Warnock and Mohammadi-Aragh (2015) conducted a case study based on student perceptions before and after taking part in a PBL led module [2]. However, the current study focuses on 'how' students work collaboratively in order to describe the processes taking place during problem-solving which requires a qualitative approach. The advantage of this approach, using video recorded data, is that the behaviour and interactions which occur throughout this process can be examined in detail to gain insight into the techniques that students use. Imafuku and Bridges (2016) point out that there is a need for qualitative interactional investigations of PBL to strengthen the current corpus of research [5].

The data was examined using qualitative content analysis (QCA) to describe patterns which emerge in the students' discussions [11]. This method requires the data to be transcribed verbatim so that the textual data can be coded. The transcripts were then collated and coded following a process outlined by Schreier (2012). The analysis for this work has been mostly data-driven, with codes emerging from the transcripts rather than being predetermined. The initial coding pass identified several techniques used by the students to help the team when formulating ideas and creating learning objectives during the initial phase of the PBL cycle (i.e. from brainstorming to formulation of learning objectives). Following this, a meta-analysis was completed to investigate relationships between the codes and the participants. This secondary analysis has allowed the researchers to look further into 'how' these identified techniques are used in problem-based learning tutorials. One key discovery from this secondary analysis is outlined and thoroughly examined in this paper.

2 RESULTS

The purpose of this original study was to gain some understanding of 'how' students approach problem solving as a group through analysis of the discussions which occur in their PBL sessions. A coding frame was reached using QCA to establish the conversational techniques used by students in the problem definition stage of PBL to create an action plan moving forward. Examples of these codes/techniques include implementing order to the session and making use of different resources such as the case material or the tutor. Further analysis was carried out to shed light on the interrelation of the codes with each other and the participants. This paper presents and discusses one phenomenon apparent in the secondary analysis and seen throughout the data corpus considering different student groups.

One of the strategies for problem-solving, derived in the initial analysis (as per section

1.2), was the use of a 'structure'; by identifying stages in the problem-solving process for which expectations of what needed to be achieved at each stage were clear. This was a method by which the groups monitored progress and prompted productivity. It often was implemented using specific words, from the PBL cycle (e.g. brainstorm, issues, problem definition etc.) which directed the discussion and reminded the team to reach a conclusion. Further investigation delving into the coding frame and focusing on individuals' interactions within the team, made it clear that this structure, which is used to facilitate the PBL sessions, is primarily and continuously used by specific individuals within the team. These individuals often happen to be the most dominant team members as seen through high participation in the discourse. They appear to be acting as a substitute tutor or facilitator throughout the PBL sessions in the semester and not only in specific meetings. Even when groups had made a role rotation the dominant team members appear to take up the leadership role regularly.

To illustrate this phenomenon, three examples where 'dominant' students have exhibited this particular behaviour as shown below. The extracts selected illustrate how group members react to these attempts at facilitation. The first extract has been taken from group 3 when working on a case focused on the design of a heat exchanger which took place at the beginning of the module when the students were very new to the PBL process.

Extract 1. Group 3 – Heat exchanger -case number 3, Week 1.

A-Aaron, R-Richard, C-Conor, E-Eva and J-Jamal

1. A: right so the big big situ- (0.3) the big picture is that
2. we're designing a heat exchanger
3. R: yeah
4. A: thats the problem
5. C: thats the problem
6. (5.0)
7. A: so they'll be a load of
8. E: so is this
9. A: problems underneath that which stop us doing that but the
10. main problem is
11. J: what does it mean by the 'temperature of the ammonia
12. dictated by the process side' does that mean is it
13. supposed to be size is that a typo or what is
14. E: 'the inlet and outlet temperatures' ah I think it means
15. whether or not its inlet or outlet cause if its inlet it
16. will be a different temperature
17. J: oh its talking about the side of the heat exchanger
18. E: I think so

Extract 1 shows how Aaron has tried to instigate the conversation about the case at hand. The group have had the new material for twenty minutes but so far have had extensive discussions about the module organisation and upcoming deadlines but have not addressed the case itself. Approximately thirty seconds prior to this excerpt Aaron asks the group "so whats the problem lets do that first" but there is no uptake by the other team members who continue their off-topic discussions. In line 1 (Extract 1) we see Aaron proposing an answer to his earlier question with both Richard and Conor acknowledging him in lines 3 and 5 respectively. It seems that Aaron is not just prompting the group to consider the meaning of the case, but he is determined to establish a decision for the problem definition. He is not satisfied by the agreement of Richard and Conor as he continues to justify his thoughts in lines 7, 9 and 10

interrupting Eva (line 8) in the process. This extract provides evidence to suggest that this facilitation is not having the desired effect because the team is unresponsive to Aaron's prompts.

It is also noticeable that Jamal does not appear to have the same priorities as Aaron, in line 11-13 we see that Jamal swiftly moves the conversation to more specific details about the case itself. The need to follow the PBL cycle – the seven steps – is not reciprocated. Thus showing that there are two ways of approaching these cases, the first by following the PBL steps to establish an action plan and the second through delving deep into the content immediately attempting to solve the problem. This may suggest that Jamal is not only ignoring Aaron's prompts because he is not the prototypical leader but because they are working towards different goals.

Similarly in Extract 2, an excerpt from group 1, shows them working on a case based on the design of a phase separator completed over half way through the module. It is interesting to notice the same behaviours occurring once the group have had some time to familiarise themselves with the PBL process as well as team members.

Extract 2. Group 1 – Separator case number 13, Week 14.

A-Annie, C-Craig, La-Laura, S-Sharon, M-Molly and Li-Linzi

1. A: oh we have a new case (0.2) we should do that first
2. La: mmhm
3. (6.0) ((A yawns))
4. A: what do we need to know about separators
5. (3.0)
6. A: oh whos writing
7. S: I think I'm writing but I'll check
8. A: oh yeah Linzi do you (.) want to be leader
9. C: we don't use our mass erm sorry mass separations stuff for this
10. (5.0)
11. A: oh
12. S: I'm writing Laura is leader

Extract 2 begins with Annie's statement starting the new case six minutes after the team have received the case material but she receives no uptake from the team, see line 3. Annie again tries to instigate discussion in line 4 where she asks a more detailed question but is met with the same silence. Annie only achieves uptake from the group when she back tracks to different topic (i.e. roles) which does elicit a response from Sharon in line 7. It appears that the topic of role assignment is more acceptable than discussion of the case at this point in time. This is further confirmed when Craig poses another question in line 9 but Sharon responds, in line 12, to Annie instead. This shows that members of group 1 react similarly to Annie's prompts as group 3 did to Aaron despite the group in this second extract being more familiar with the PBL process. In fact there are two team members who remain completely silent throughout the second extract, indicating their reluctance to join the conversation. It is interesting to note that in this instance Annie does prompt the team but she is less direct than Aaron, possibly because Aaron (in Extract 1) appears to be pushing the group to reach a decision whereas Annie (in Extract 2) is initiating a discussion. This suggests that it is not the way in which 'dominant' students facilitate that makes team members resistant to it.

Extract 3. Group 2 – Material balances case number 9, Week 8.

K-Katie, M-Matt, J-Josh, R-Ryan, O-Oliver, H-Hannah and Y-Yasmin

1. K: right can we do this
2. (*(group laughter)*)
3. M: yeah sorry (man)
4. (*(unclear speech)*)
5. J: give problems
6. (0.2)
7. K: right (.) let's actually write something - (*(addressing Matt)*)
8. M: me
9. K: aha
10. M: yeah sure su-that's what I was doing right now was
11. writing down stuff
12. K: okay
13. M: so emm I said that (1.0) for the (.) basic calculation sheet
14. (0.2) so this project's based on ammonia so I said the mass
15. balance (.) so I done the stoichiometry...
16. (*(Matt continues to read out what he has written down)*)
17. K: well it's nice of you to do that but now I think we should
18. fill in the sheet
19. M: oh ok (.) oh this sheet
20. K: yeah
21. M: oh ok

Extract 3 is an example where this facilitation is in fact accepted and taken up by the rest of the team. It is from a video of group 2 midway through the module and is focused on material and energy balances, which are familiar concepts that have not been applied in this context previously. Extract 3 occurs 23 minutes after the case material has been given to the group and it immediately follows on from an off-topic conversation between two team members (Matt and Ryan). Katie is the 'dominant' student and again she is encouraging the group to make progress. In line 1 she says "right can we do this" which is an explicit statement trying to get the group on track but is met with laughter from the group suggesting they are not taking her seriously. She persists with this line of thought repeating "right lets actually write something" in line 7 specifically addressed to another team member, Matt. This is taken up by Matt in line 8 and he then begins a long monologue, which has been cut short in this paper for the purpose of succinctness and explains what he had already been "writing down". Despite this extensive response to Katie's request she again tells Matt that was not actually what she had meant in the beginning. Eventually they reach a mutual understanding and Matt acknowledges Katie's prompts in line 19 and 21.

This is a long sequence with persistent intervention from Katie to get Matt to fulfil his assigned role. This shows a deviant case compared to those in Extract 1 and Extract 2 where Katie's facilitation and policing of Matt appears to be necessary and acceptable, this is seen by his continued uptake and also by the rest of the group remaining quiet. None of the other group members either affiliate or disagree with Katie but remain neutral instead. At the beginning of the tutorial Katie identified Ryan as the leader for the upcoming session but then continually demonstrated leadership behaviour herself. This phenomenon has frequently been noticed to occur throughout the data corpus despite other team members having been assigned to assume the leadership role.

3 DISCUSSION AND CONCLUSION

3.1 Analytical Summary

Through the investigation into 'how' students solve unfamiliar problems in a PBL group, it is seen that students utilise the given PBL cycle to structure the session. The results shown here focused on exploring the fact that this 'structure' is put in place by only one or two students who are also most dominant within the team discussions but not necessarily appointed by the team or by an established rotation as leaders. We see that generally team members are resistant to this facilitation because it is often ignored. This might be because team members do not believe that only one person has the authority to take on only this leading role but should instead be contributing and joining in as part of the team. However there might be instances (i.e. Extract 3) when this type of leadership is necessary, for example when one student is not meeting the expectations of the group. This situation is much less frequently seen in the data corpus.

It is known that having an order to the discussion can be useful because it allows the group to monitor progress, keep on track and gives them an immediate task to complete [12]. However, having only one student pushing the team to follow this structure can be counterproductive as the 'dominant' student seems to be taking an authoritative role suggesting perhaps that they are 'more capable' than the other team members. For this type of behaviour to be successful it would need to have group consensus.

3.2 Practical Recommendations

Leadership is important for students to develop but a shared leadership would be more productive and have a positive effect on group processes in PBL [13]. In this PBL context, where students are at the same level in knowledge and experience, the group members should have shared ownership of the team's progress, performance and leadership. By only one student taking on the facilitator role the other team members are missing out on valuable opportunities to develop their own leadership skills.

Therefore in PBL practice more effort should be made to ensure that groups rotate leadership as to give each student the chance to practise managing a team. This could create a more comfortable atmosphere to encourage equal participation rather than having certain individuals dominate discussions. Similarly, students would benefit from support about managing participation when working in teams so that everyone can have a positive influence in the problem solving process.

3.3 Limitations

This study has only focused on one specific module that uses PBL where the students taking part have no previous experience with the pedagogy. One concern is that this does not give enough time and practice for learners to truly understand the process and fulfil their potential with PBL. This is particularly important as the PBL model used here is based on the tutor being present only intermittently consequently placing more emphasis in the group to manage their learning process from the beginning. Therefore it would also be useful to investigate students at other institutions and at different levels of their study.

4 ACKNOWLEDGEMENTS

The authors would like to gratefully acknowledge the students who volunteered to participate in the research. This ongoing study is supported with funding from the University of Strathclyde John Anderson Research Award.

REFERENCES

- [1] Chan, C. K. Y. and Fong E. T. Y. (2018), Disciplinary differences and implications for the development of generic skills: a study of engineering and business students' perceptions of generic skills, *European Journal of Engineering Education*, pp 1-23.
- [2] Warnock, J. N. and Mohammadi-Aragh, M. J. (2015), Case study: use of problem-based learning to develop students' technical and professional skills, *European Journal of Engineering Education*, Vol. 41, No. 2, pp. 142-153.
- [3] Fitzpatrick, J. J. (2017), Does engineering education need to engage more with the economic and social aspects of sustainability?, *European Journal of Engineering Education*, Vol. 42, No. 6, pp 916-926.
- [4] deGraaff, E. and Kolmos A. (2007), History of problem-based and project-based learning, *Management of Change*, Sense Publishers, pp. 1-8.
- [5] Imafuku, R. and Bridges, S. (2016), Guest Editors' Introduction: Special Issue on Analyzing Interactions in PBL-Where to Go From Here?, *Interdisciplinary Journal of Problem-Based Learning*, Vol. 10, No. 2, pp 1541-5015
- [6] Hammar Chiriach, E. (2008), A scheme for understanding group processes in problem-based learning, *Higher Education*, Vol. 55, No. 5, pp. 505-518.
- [7] Dolmans, D. H. J. M., De Grave, W., Wolfhagen, I. H. A. P. and Van Der Vleuten, C. P. M. (2005), Problem-based learning: future challenges for educational practice and research, *Medical Education*, Vol. 39, No. 7, pp. 732-741.
- [8] Ertmer, P. A. and Newby, T. J. (2013) Behaviorism, Cognitivism, Constructivism: Comparing Critical Features From an Instructional Design Perspective. *Performance Improvement Quarterly*, Vol. 26, No. 2, pp. 43-71.
- [9] Vygotsky, L. S. (1980), *Mind in society: The development of higher psychological processes*, Harvard university press.
- [10] Robbins, P, and Aydede, M. (2009) *The Cambridge handbook of situated cognition*, Cambridge University Press.
- [11] Schreier, M. (2012), *Qualitative Content Analysis in Practice*, SAGE Publications.
- [12] Woods, D. R. (2000), An evidence-based strategy for problem solving, *Journal of Engineering Education*, Vol. 89, No. 4, pp. 443-509.
- [13] Aubé, C., Rousseau, V. and Brunelle, E. (2018) Flow Experience in Teams: The Role of Shared Leadership. *Journal Of Occupational Health Psychology*, Vol. 23, No. 2, pp. 198 - 206