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Research Article

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Interactive Conversational Words as Markers of Knowledge-Negotiation in Medical Problem-Based Learning Transcripts: A Corpus-Based Study

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Abstract

Background: *The study aims to provide a more global understanding of the knowledge-negotiation interactions occurring in problem-based learning tutorials by analysing interactive conversational words (ICWs) as structural markers of students' interactional boundaries.*

Methods: *We used Wmatrix 3 software to extract frequent ICWs from 253,145 word-corpus compiled from professionally transcribed transcripts of 56 first-year medical students and seven facilitators. The concordance lines of the frequent ICWs were thematically analysed to define their functions. Extracts of verbal exchanges were provided to illustrate how the knowledge negotiation unfolded. Chi-square statistics were used to quantitatively compare the ICWs frequencies across the tutorial sessions. A significant p-value was set at less than 0.05.*

Results: *Overall, the ICWs were least prevalent in the second tutorial session. Affirmation ICWs were more prevalent than other types of ICWs across the tutorial sessions. The ICWs served seventeen frequent functions of which acknowledgement, confirming and addition predominated. The students frequently discussed subject matter content, and the discussion was of exploratory nature. There were several incomplete and sentence-completion statements.*

Conclusion: *The corpus-based analysis provides a complementary perspective on the verbal interactions occurring in the PBL tutorials in practice. The students' verbal exchanges were collaborative and exploratory, but the students seemed to have had turn-taking problems. The implications of the study are that the corpus-based methodology could be used to explore several PBL research questions including those previously explored non-linguistically. The PBL discourse, as a means of initiating medical students into professional practice, requires monitoring to ensure compliance with educational theory and policy.*

Keywords: Corpus Analysis, Shared Knowledge, Problem-Based Learning, Medical Students, Tutorial Discourse, Conversation Continuity Adjuncts

Introduction

Miscommunication is a serious hazard in healthcare settings [1]. Studies have shown that doctors do not often communicate well with their patients and other healthcare professionals [2, 3]. Communication failures among health professionals and between patients and professionals are associated with poor patient outcomes and increased litigation [3, 4]. In the UK, the costs of medicolegal claims have skyrocketed. Between 2018 and 2019, the NHS paid £2.4bn in clinical litigation claims [5]. Good professional information sharing has been proposed to suppress rising medicolegal costs in the NHS [6]. In the US, clinical miscommunication results in $1.7 billion in cost and in about 2000 lives annually [7]. The problem is accentuated by the global migration of healthcare workers and by language diversity [8]. Professional communication skills are essential for team-based health services and doctor-patient partnerships.

Curricular reforms, interprofessional education, and regulatory measures have been implemented to address the deficit in clinical communication among health workers [3]. Clinical communication skills are now taught in most medical schools in the western world [9, 10]. The UK General Medical Council has advised students to seek opportunities to practise communication skills [11]. Students in a problem-based learning (PBL) curriculum spend several hours engaging in medical-scientific conversation in their tutorials. Such discourse practice is expected to enhance the students' interpersonal skills [12].

However, classroom discourse is a complex, interactive and multidimensional process [13]. Previous PBL studies have analysed tutorial discourse using microanalysis approaches to do justice to the characteristics of the classroom discourse. Visschers-Pleijers et al. and Yew and Schmidt used a coding instrument to analyse transcribed tutorial talk to report the presence of knowledge elaboration and co-construction, learning-oriented and procedural as well as self-directed activities [14-16]. O'Neil et al. coded the transcripts of twelve third-year medical students' tutorial talks at the reporting phase of the PBL cycle to document how medical students utilised experience in clinical contexts to understand case problems [17]. The studies by Woodward-Kron and Remedios and Imafuku et al. analysed tutorial talk using the discourse analysis method to describe the occurrence of knowledge elaboration, co-construction and negotiation in the students' verbal interactions [18, 19]. Hmelo-Silver and Barrows described collective knowledge construction processes in a complete cycle of a single tutorial group using a manual move analysis approach [20].

These studies have produced interesting results and have enriched our understanding regarding the verbal interactions occurring in the PBL tutorials. A disadvantage of such studies, however, is that they examined small tutorial groups or fragments of the PBL cycle in several tutorial groups. In contrast, quantitative analyses could be used to capture features of tutorial discourse in large samples, but such studies tend to oversimplify the complexity of classroom discourse. In our opinion, analysing and describing the interactions in a large number of PBL tutorials as suggested by Hay and Maguire demands the integration of macro- and micro-analysis approaches [21, 22]. This goal can be achieved using a corpus-based methodology which can filter verbal interaction words into frequency and category lists for further text-in-context analysis [23]. We have investigated knowledge negotiation processes in PBL tutorials using Wmatrix 3 software that can automatically analyse verbal data quantitatively for subsequent qualitative analysis. The overall objective of the study is to provide more global information about how the students use specific linguistic forms to make sense of each other and to each other in the PBL classrooms. The study examined the following questions to achieve the objective:

(1) What is the frequency of common interactive conversation words (ICWs) in the PBL transcripts?
(2) What are the most common functions of interactive conversational words?
(3) What are the discourse contexts of the frequent interactive conversational words?

Significance of the Study

The significance of this study is that linguistic forms encode content knowledge along with attitudes, values, and social interests of a community and talking science helps to create and re-create the community [24]. An investigation into the students' verbal exchanges will help to predict the wider implications of the student talk and assess how the interactions align with the constructive philosophy and medical education goals. The information may facilitate making recommendations for policy and educational development.

Methods

Theoretical Framework

The present study is based on Halliday's functional linguistic perspectives which postulate that knowledge learning and language learning are synonymous [25]. Language encodes knowledge and knowledge-sharing among talk participants is a meaning-making process [24, 26]. Halliday's perspective of language as a meaning-making system describes the exchanges occurring between discourse participants as a give-and-take process that requires repairs and expansion of understanding [27].

Conceptual Framework

Knowledge sharing involves negotiation. The knowledge and perspectives of the discussants are first made public (Figure 1). The negotiation process involves the refinement of ambiguities and meanings through confirmation, clarification, questioning, and repair of utterances [27]. The process leads to shared knowledge, which indicates that the participants in the conversation have attained a certain understanding that overlaps [28]. At a sophisticated level, the discussants expand, complete, or continue each other's contributions [29]. The discursive processes are influenced by curricular and contextual factors and the cultural and linguistic context of the students [13].

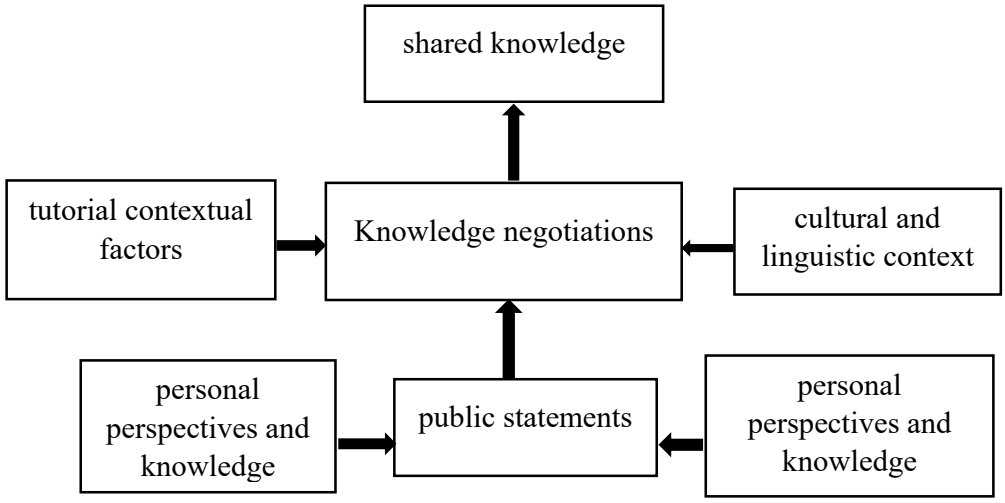

Figure 1: Visual representation of the conceptual framework for knowledge negotiation indicating (1) the transformation of personal knowledge and perspectives into public discourse statements for the attainment of shared knowledge and (2) tutorial contextual factors and the cultural and linguistic context of the curriculum.

Corpus Analysis

A corpus-based approach is an empirical study of language use and could follow several methodologies. The methodologies share common characteristics. They investigate naturally occurring texts, use computers for automatic and interactive analyses and involve quantitative analyses and functional interpretation to describe patterns in language use. The methodologies facilitate the analyses of language features over a large number of texts and the comparison of texts across audiences [30]. The research approach involves using software to analyse machine-readable texts [23]. We have used Wmatrix 3 programme to analyse our language data in this study [31].

Study Site

The context of the study is the University of Nottingham Medical School in Derby, United Kingdom. The school runs a hybrid curriculum for PBL students. Nursing, science, social science, and arts students are admitted to the school. Some students had completed their first degree, masters, and Ph.D. programs, and some had considerable work experience. The student participants from Derby medical school consist of first- and second-year cohorts.

PBL Process

The PBL process at the research site consists of three meetings. Students and supervisors meet weekly for about 4–5 hours. Each session lasts about 90 minutes. The first session is about problem analysis and the generation of learning topics. It is followed by a period of self-study wherein students research the learning topics and participate in lectures, workshops, clinical placements, and simulation sessions. The results of the self-study are presented until the learning objectives are covered in the second session. Students also had a question-and-answer period to improve their understanding of the problem. In the third session, students develop a management plan and reflect on a specific case.

Participants and Case Problems

First-year medical students and their supervisors were allowed to participate in the study to reduce heterogeneity in the sample due to the year of study. Fifty-six medical students and seven supervisors from the first-year cohort participated in the study. Of the students, 32 were male and 24 were female. Each study group was supervised by a tutor. There were three female and four male tutors. They were from the fields of basic medical sciences, nursing, sociology, general medicine, pathology, and clinical medicine.

All the students and the facilitators in the 2009 and 2010 year-one cohorts were eligible to participate in the study. Of the twelve tutorial groups in each cohort, six groups of the 2009 cohort and five of the 2010 cohort participated in the study. Groups in which at least one participant declined to participate in the study were excluded. The groups facilitated by temporary and new facilitators were also excluded from the study. Of the eleven participating groups, the recording in four groups was incomplete or inaudible owing to equipment malfunction. We compiled the study corpus from the transcripts of the seven groups with complete recordings. Recruitment into the study took place after the students had three months' experience with the PBL curriculum. The case problems were asthma, chronic obstructive pulmonary disease, atrial fibrillation, sudden collapse, tuberculosis, peripheral arterial disease, and heart failure.

Data Collection

Video and audio recordings of first-year medical students' PBL tutorials were made using an Olympus DS-2500 voice recorder and a Sony HD camcorder, respectively. Audio and video recordings were made simultaneously to secure the recordings and to facilitate the correct attribution of utterances to speakers. The first author set up the recording devices before each tutorial session. Students

were allowed to pause the recording to exclude any aspect of their interactions that they did not wish to record. An external professional transcriber with English as the first language transcribed the audio recordings verbatim. The first author used the video footage to match the utterances of the tutorial participants.

Corpus Formation

Transcripts were compiled by PBL session to form subcorpora. The contributions of the students formed the students' file, and the whole corpus file contained the contributions of the students and the facilitators. The transcript files were converted to plain text files and uploaded to the Wmatrix 3 online software. The students' file was used for measuring the interactional word frequency, while the whole corpus file was used for concordance analysis. The study corpus consisted of 253,145 words consisting of 86,414, 108,655 and 58,076 in the PBL session 1, 2 and 3 sub-corpora respectively. Further information on Wmatrix 3 is available at the https://ucrel.lancs.ac.uk/wmatrix/tutorial/

Markers of Knowledge-Negotiation Processes

Interactive conversational words (ICWs) refer to lexical expressions that signal a relationship between the interpretation of the segment they introduce and the prior segment. They frequently occur at the boundaries of verbal interactions [32]. They are defined on the basis of their apparent meanings. Affirmation words ('yeah'/'yes') describe lexical expressions used to agree or confirm a prior talk segment. Negation words ('No') refer to lexical expressions that disagree or deny the previous talk while reaction words ('Oh'/'Ah') refer to words or phrases used to express feelings.

Extraction of Knowledge-Negotiation Markers

We used the ICWs as interactional signalling. The interactive conversational words (ICWs) were extracted from the interjection (UH) domain of the parts-of-speech (POS) category of the Wmatrix 3 programme. We extracted the five frequently used interactive conversational words. Concordance lines of the interactive words were downloaded from the Wmatrix 3 programme (for example Table 1 below) and exported into an Excel spreadsheet file such that the interactive words (Key-Word-In-Context – KWIC) lie in the middle of right and left co-texts. The co-texts can be expanded as required.

Table 1: A concordance sample from 20 occurrences of the interactive conversational words (ICWs), set at 80 characters wide, as extracted from the transcription of problem-based learning session three by the Wmatrix 3 programme.

read it said fibrillation. M1	Yes	. I think [ref] Mat
o move and vary so widely. M2	Yeah	. So a flutter can give rise to
fibrillation and vice versa,	yeah	, these two ... M1 Most common
ion to flutter. M2 Is it M1	Yeah	, because sometimes if you try
reckon you should try .. ? M1	Oh	Carotid. F2 Yeah, I think you
ld try .. ? M1 Oh Carotid. F2	Yeah	, I think you should try that.
ot to get your head round. M2	Yeah	, no, I am not buying it for t
et your head round. M2	Yeah,	no, I am not buying it for the
ter if it looks like that. M2	Yeah	. M1 There is really only one i
en the flutter? M2 . I have,	yeah	. M1 Have you seen an ECG of a
m looking at that and thinking	yeah	that is ... see that is what I
ou know, the ECG library. M1	Yeah	. Can you see though, the atri
the QRSs are very regular? M2	Yeah	, that is I mean an ideal trace
that stuff all the time ... M2	Yeah	I know ... M1 Difficult diagnosis
It is called an iPod isn't it? M1	Yeah	. F2 We stuck them on our chest
F2 They have got a F2 Four but	yeah	... M2 If I was a cardiologist
you get. Sometimes less. M2	Yeah	? M1 Because if it is been done
e ..... M1 Sorry go on. F2	No	that is what I was going to say
do that. M1 [ref]	No	, no, it is electrophysiology
at . M1 [ref]	No,	no, it is electrophysiology study

Data Analysis

Frequency Analysis: We determined the raw frequency (RF) and normalised frequency (NF) of each category of the ICWs in each sub-corpus. The quantitative analysis helped to identify and compare the distributional patterns of the ICWs across the three PBL sub-corpora. The analysis enabled us to suggest how the distributional patterns may be related to the goals of each tutorial session.

Concordance Analysis: The qualitative interpretation of the concordance lines is to define the functions that the ICWs served. The analysis was based on the thematic interpretations of the ICWs' functions in the context of the surrounding words. The repeated ICWs (e.g., "yeah," "yeah," or "no," "no," "no") were analysed as one ICW. The additional discourse units that followed the ICWs were coded as detailed in Appendix 1. Some of the functions were categorised as elaboration, extension and enhancement. We reported the functions of the ICWs together because of the observed overlap in their functions (for example, 'yes'/'yeah' were used for agreement and for disagreement). We reported the functions as normalised frequencies per 100 words. We did not determine the statistical significance of the frequency differences between sessions in line with the qualitative design. We coded the discourse context in which the ICWs occurred as knowledge content, task planning, physical action, appraisal and task reflection. We exercise flexibility in conducting the concordance analysis using Key-Word-in-Context (KWIC) of variable format, sentence context, paragraph context and whole corpus browsing [33]. We presented segments of the discourse to illustrate the verbal exchanges that occurred in the PBL classrooms as shown in the extracts.

Definitions

Feedback provides information, comment or evaluation about an utterance or event, process or action: for example, recall, information awareness, agreement, disagreement, confirmation, acknowledgement, simple negation, appraisal statement and listening check.

Questioning refers to an interrogative statement or word: for example, indicators used as questioning tokens or indicators used to preface questions.

Elaboration provides more details about a previous contribution without adding new information: for example, restating, clarifying, commenting, and correcting statements.

Extension adds new information to the previous contribution through addition, contrast, alternation, and exception.

Enhancement adds to previous contributions by combining time, result, purpose, place, condition, comparison, cause, and concession information: for example, cause-effect statements.

Ethical Issues and Confidentiality

The University of Nottingham Ethics Committee approved the study. The participating tutors and students received verbal and written information about the research (including the study objectives, participants' expectation and involvement and their right to withdraw from participating at any time without any repercussion), and they signed a consent form. Participation in the study was entirely voluntary. The students' participants were anonymised, and the study results were presented in aggregates to preserve the participants' confidentiality.

Results

Common Interactive Conversational Words (ICWs)

Table 2 presents the top five ICWs (N = 4,213), which account for 96.0% of the total 4,388 words retrieved with the Wmatrix 3 software. The affirmation ICWs ('yeah'/'yes') was 2,886 (68.5%), No-negation ('No') 1,002 (23.8%) and reaction interactional words ('oh'/'ah') 325 (7.7%).

Table 2: Identifying knowledge-negotiation markers: Raw frequency (RF) and normalized frequency (NF) per hundred words of the top interactive conversational words (ICWs) as measured using the Wmatrix 3 UCREL CLAWS7 Tagset interjection (UH) across the first (PBL 1), second (PBL 2) and third (PBL 3) problem-based tutorial sessions.

ICW	PBL 1		PBL 2		PBL 3		Overall	
	RF	*NF*	RF	NF	RF	NF	RF	NF
Yeah/yes	1169	1.35	1017	0.94	700	1.21	2,886	1.14
No-negation	350	0.41	395	0.36	257	0.44	1,002	0.40
Oh/Ah	*137*	*0.16*	107	0.10	81	0.14	325	0.13
Total	**1656**	**1.96**	**1519**	**1.40**	**1038**	**1.79**	**4213**	**1.66**

The prevalence of the ICWs varies across the PBL sessions. Generally, the ICWs were more frequent in PBL1 than PBL 2 (1.96 vs 1.40 per 100 words, χ^2 78.14, $p<0.05$) but the prevalence in PBL 1 and 3 are comparable (1.96 vs 1.79 per 100 words, χ^2 3.05, $p>0.05$). The presence of affirmation words ('yeah'/'yes') varies across the PBL sessions. They were more prevalent in PBL 1 than in PBL 2 (1.35 vs 0.94 per 100 words, χ^2 73.75, $p<0.05$) and in PBL 3 (1.35 vs 1.21 per 100 words, χ^2 5.77, 1df, $p< 0.05$), and more prevalent in PBL 3 than in PBL 2 (1.21 vs 0.94 per 100 words, χ^2 26.37, 1df, $p<0.05$). No-negation ('No') was significantly overused in PBL 3 than in PBL 2 (0.44 vs 0.36 per 100 words, χ^2 6.01, 1df, $p<0.05$) but the use in PBL 3 and 1 are comparable (0.44 vs 0.41 per 100 words, χ^2 1.16, 1df, $p>0.05$). The reaction interactional words were overused in PBL 1 than in PBL 2 (0.16 vs 0.10 per 100 words,

χ^2 13.86, 1df, $p<0.05$), but there is no significant difference in their use in PBL 1 and 3 (0.16 vs 0.14 per 100 words, χ^2 0.84, 1df, $p>0.05$).

Most Common Functions of Frequent Interactive Conversational Words

Figure 2 (below) shows the pattern of the most common functions of the ICWs across the three PBL tutorial sessions. There are subtle differences in the functions of the ICWs across the three sessions. Generally, acknowledgement, addition and confirming functions were most frequent across the tutorial sessions.

In the first PBL session, feedback functions were dominant: confirming (0.28 per 100 words) and acknowledgement (0.27 per 100 words) followed by the extension (addition 0.19 per 100 words) and elaboration functions (comment 0.18 per 100 words and restate 0.15 per 100 words).

The second tutorial session was marked by the low prevalence of the ICWs generally, but the extension functions dominated (addition 0.24 per 100 words) followed by feedback (confirming 0.12 per 100 words; acknowledgement 0.11 per 100 words) and elaboration functions (restate 0.10 per 100 words).

As in the second session, extension functions (addition 0.22 per 100 words) were dominant in the third session while feedback functions (acknowledgement 0.19 per 100 words, agreement 0.17 per 100 words and confirming 0.12 per 100 words) ranked second.

The distribution of the enhancement functions was fairly uniform across the tutorial sessions (cause-effect PBL 1 0.07per 100 words, PBL 0.07 per 100 words and PBL 3 0.09 per 100 words).

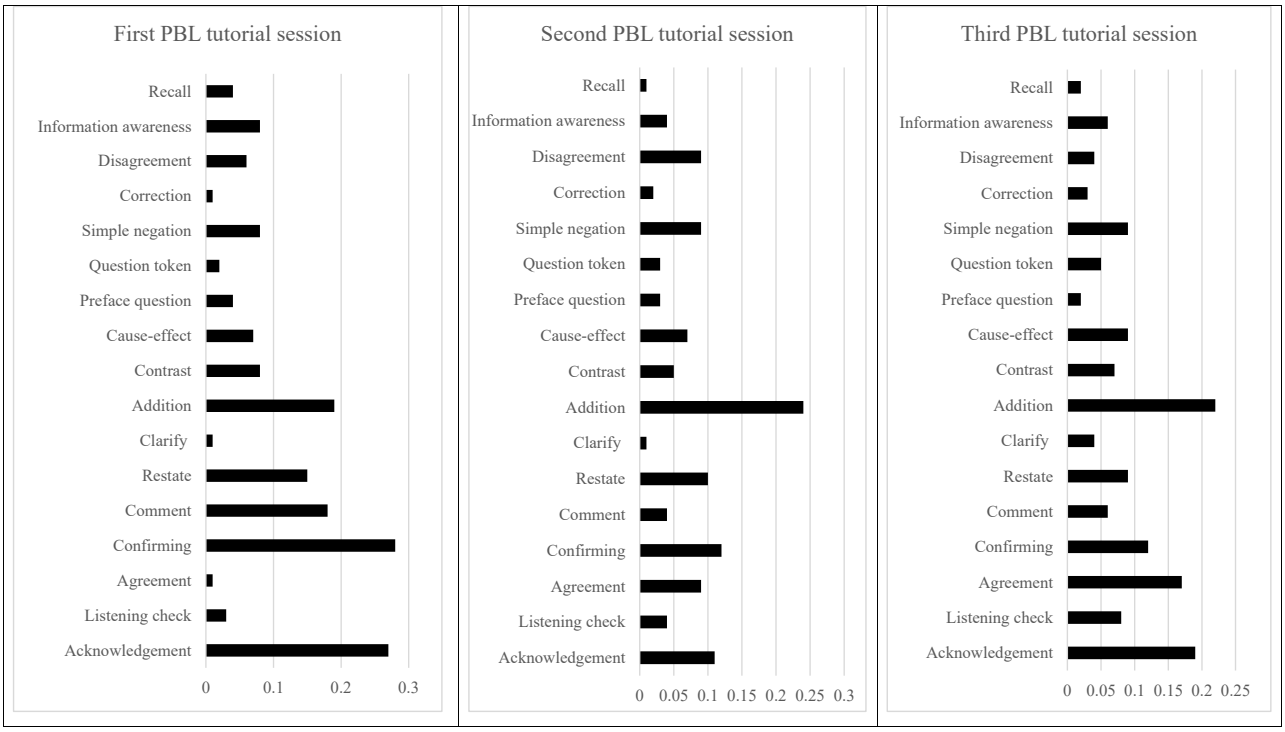

Figure 2: The figure shows the normalised frequencies per hundred words of the most common functions of the interactive conversational words (ICWs) in the first (PBL 1), second (PBL 2) and third session (PBL 3).

The First PBL Tutorial Session

Extract 1 (below) describes how the students negotiated the differential diagnosis of the case problem. The dominant interactive characteristic is a collaborative atmosphere. The propositions made by group members were recognised, alternative hypotheses were offered, and there were completion statements, comments and positive appraisals. There were talk interruptions leading to incomplete utterances.

Extract of Talk from the First PBL Tutorial Session

M1 Dry cough could be viral. (*Proposition*)
M4 Yes. (*acknowledgement*)
M1 Or like you said it could be allergic …. (*Alternative proposition*)
M2 He might be going out on grassy fields when he plays football. (*Elaboration*)
M4 Hum hum. (*Reactive token*)
M1 Yeah, quite right, that's very good; I like that. (*Appraisal*)
F1 That might be the only time he goes out. (*Comment*)

M1 We're ignoring the obvious one of asthma. (*Proposition*)
F1 Can we put that antibiotics hem …...? (*Incomplete suggestion*)
M3 Is asthma technically an allergy then? (*Confirmation request*)
M1 Yeah. (*Confirmation*)
F1 ……. antibiotics whether it's the wrong diagnosis or treating the wrong pathogen. (*Suggestion continuation*)
M1 That's right. That's going to make a link with that sometime. (*Agreement/comment*)
M4 Yeah, we'll put it in next to allergy. (*Suggestion*)
M2 Is it an antibiotic issue or is it something else? (*Clarification request*)
F1 Or is it, is it ……? (*Incomplete clarification request*)
F2 wrong diagnosis or wrong pathogen. (*Clarification request completion*)

The Second PBL Tutorial Session

The second tutorial session seems to have operated under an atmosphere of collective action. It started with M2 asking a clarification question which led to a series of verbal exchanges that culminated in overt evidence of agreement. There was feedback (acknowledgements), questions (clarification requests), and exchanges were elaborated (clarification statements), extended (additions), and enhanced (reasoning). Agreements were marked with continuation statements and disagreements were elaborated. The exchanges were characterised by technical words networked together. There were incomplete statements.

Extract of Talk from the Second PBL Tutorial Session

M2 – ……. bronchoconstrictor, isn't that an inflammatory mediator? (*Request* confirmation)
M1 – I can't remember which one of the mediators released by mast cells causes bronchoconstriction. Leukotrienes, prostaglandins and histamine are released by mast cells. Histamine is released immediately; prostaglandins and leukotrienes are produced a little bit later. (*Addition*)
M2 – Yeah. (*Acknowledgement*)
F2 – Yeah. (*Acknowledgement*)
M2 – It might be prostaglandins because as far as I know, which primes bronchoconstrictors. (*Proposition*)
F2 – There's some stuff that we can read up on that. (*Suggestion*)
M4 – There's a good book, you know, in the …. (*Incomplete suggestion*)
F1 – Library? (*Request confirmation*)
M4 – workshop. (*Disconfirmation*)
M2– It's got all of the ……. (*Incomplete*)
M4 – No, not asthma …., the other one in that workshop I went to and I asked ……. histamine and they all interact with smooth muscle. (*Elaborated disagreement*)
M1 – Leukotrienes? (*Request confirmation*)
M4 – Yes. (*Confirmation*)
M2 – So the bronchoconstrictors …. (*Incomplete cause-effect statement*)
M1 – Leukotriene receptors in the bronchial smooth muscle that trigger…... (*Incomplete addition*)
F3 – Yes, that gets obstructed by the thingy. (*Addition*)
M1 – Yeah, I'm trying to find it. I knew it was in here somewhere…... "by leukotriene receptor antagonists which reduce bronchial constriction." (*Reading lecture notes*)
M2 – So is it vasodilating? I mean is it dilating the capillaries and constricting bronchioles? (*Request clarification*)
M1 – The histamine does that, but histamine causes the …. (*Incomplete clarification*)
M2 – vasodilatation (*Completion*)
M1 – …… and what do we call it; vascular permeability and ……. and leukotrienes… I was thinking you know, with reference to exercise-induced asthma causing bronchial smooth muscle contraction via leukotriene receptors. (*Continuation/Cause-effect*)
F1 – So there are two different things, there's the dilation which is narrowing it anyway and there's also constriction. (*Summarising*)
M1 – Yes. And mucous secretion on top of that as well. So, that's another triad for you. (*Agreement/Addition*)
M4 – That's right. (*Agreement*)

The Third PBL Tutorial Session

In the third session, the students discussed case problem management. The extract below suggests that the third session had a cooperative climate. The verbal exchanges show that the students built on each other's ideas through elaboration, extension (addition statements), enhancement (cause-effect statements) and mutual completion. Questions were indirectly asked to seek information, confirmation and clarifications and disagreements were expressed in a mature and collegial manner. There were positive appraisals, agreements were well elaborated and conflicts were resolved by integrating opposing perspectives through concession.

Extract of Talk from the third PBL Tutorial Session

F3 – One of the things I saw was breathing retraining because when you are breathless, obviously you take short, rapid breaths in; that's the worst possible thing that you could do if you've got no instant recoil…… (*Proposition/Elaboration*)
F1 – You do that in yoga as well. (*Exemplifying/Elaboration*)
M1 – And what about you? (*Request contribution*)
F3 – Yeah, It's only one of the things. (*Comment*)
M1 – So that will help clear all the CO2 out as well……, won't it? (*Cause-effect/request confirmation*)
F3 – Yeah. (*Acknowledgement*)
M2 – I don't know what we can do about the family situation other than just advise him. (*Proposition*)
F1 – Bring them all in for group therapy. (*Paraphrase/Elaboration*)
M2 – Bring them in for group therapy? (*Request confirmation*)
M1 – Yes, Family cessation therapy. (*Agreement/Elaboration*)
M2 – Yeah, excellent idea. (*Appraisal*)
F2 – What about Asher ...? (*Request contribution*)
F3 – There're obviously, things like in the home that you have to change, so maybe something simple like bringing a bed downstairs or moving things around like using a remote control rather than going up to the TV to change it. (*Exemplifying/Elaboration*)
F2 – You're in constant motion. (*Paraphrase/Elaboration*)
M4 – Really? (*Expressing doubt*)

M1 – But then won't he become more sedentary and put more weight on again like that? (*Challenging proposition*)
F3 – There is a value in the exercise-like activity that he can manage; it could just be walking to the shops or something so he could do it whenever he's ready for it and when he's prepared for it, but don't waste energy by running up and downstairs. (*Resolving conflict by concession*)

Discourse Content of the Most Common Functions

Across the PBL sessions (Figure 3 below), the subject matter was the predominant content in which the ICWs were used (1.57 per 100 words in PBL 1, 1.36 per 100 words in PBL 2 and 1.65 per 100 words in PBL 3). They were mostly used in the context of task planning discourse in PBL 1 (0.20 per 100 words) but less used for the same context in PBL 2 and PBL 3. Again, the ICWs were used in relation to physical action (like writing on the whiteboard) predominantly in PBL 1 and less used in the same context in PBL 2 and 3. The use of the ICWs for reflection was limited to PBL 3. They were minimally used for socioemotional reasons in the first and second PBL sessions.

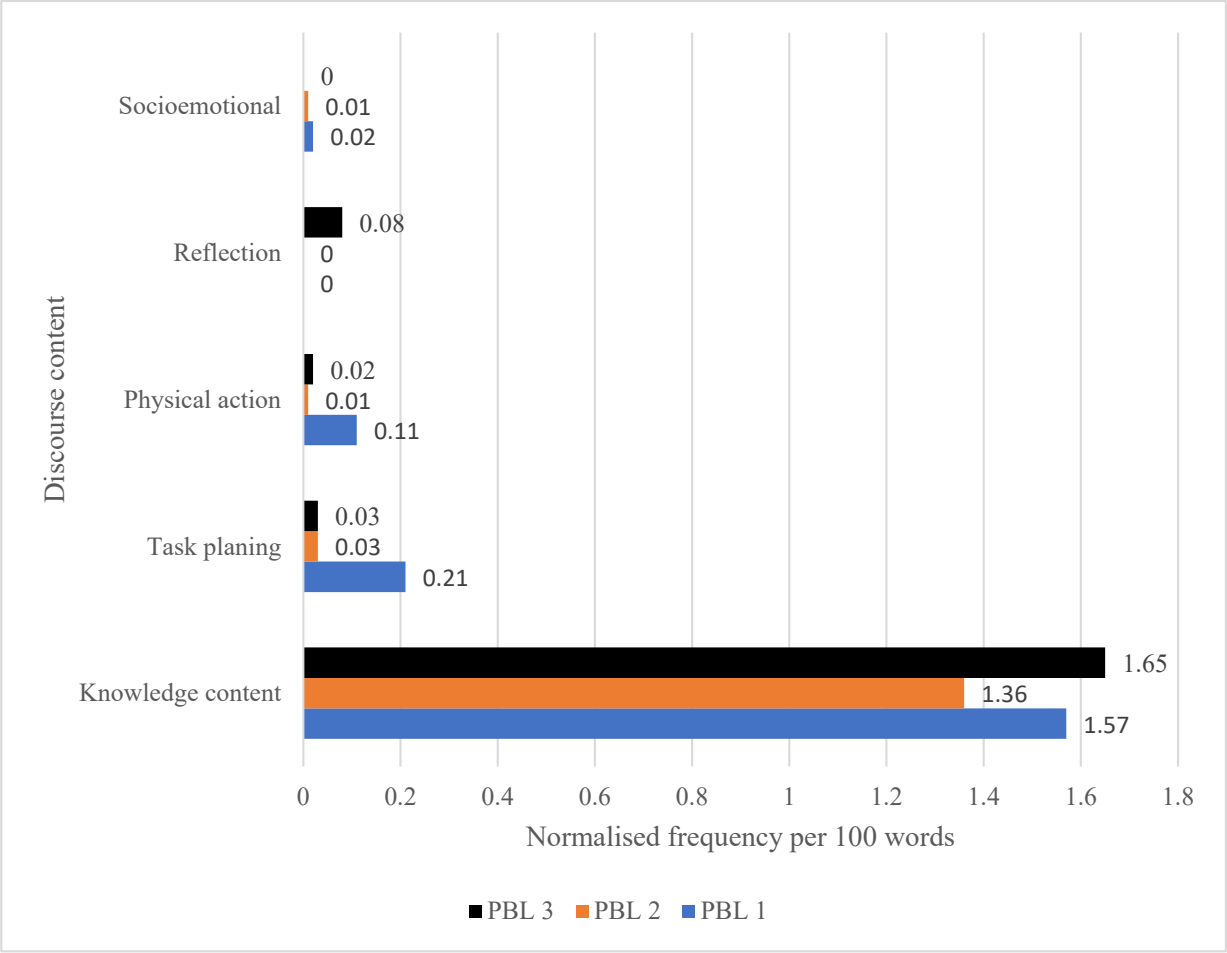

Figure 3: The figure shows the normalised frequencies per hundred words of the discourse context in which the most common interactive conversational words (ICWs) were used.

Discussion

The purpose of this study is to describe how medical students interactively negotiate meaning in their PBL classrooms. We used interactive conversational words (ICWs) to identify their interactional boundaries. We observed a lower prevalence of the ICWs in the second PBL session sub-corpus but similar amounts in the first and third sessions subcorpora. Feedback and extension functions of the interactive markers were most common and enhancement functions were uniformly distributed across the tutorial sessions. There is evidence of conflict resolution by integrating opposing views. The analysis of the tutorial extracts suggests that ICWs were used to preface a limited amount of tutorial exchanges. The interactive atmosphere across the tutorial sessions seemed collaborative and collegial, and the student offered propositions, requested and offered clarifications, and co-construct meanings through elaboration, extension and enhancement and agreed with each other. There were positive appraisals to recognise and reward peer efforts. The students mainly discussed knowledge content across the tutorial sessions and their discussions were exploratory in nature [34].

The findings of the present study are congruent with our expectations and support previous studies demonstrating that PBL students communicate well and their verbal interactions promote knowledge elaboration and meaning co-construction [14-16, 18]. Such collaborative and expansive student interactions were identified as valuable to collaborative conceptual learning [35]. We noted the ICWs were less often used to preface subject matter talk in the second tutorial session possibly because the students engaged in a long stretch of talk during this reporting phase. The students' verbal exchanges were marked with several incomplete, completion and continuation statements which might indicate that they have problems taking turns during their discussions as they frequently talked over each other.

Although the present study corroborated the findings of the previous studies, it is unique in that it presents a global pattern of interactive linguistic forms over all the tutorial sessions and makes functional interpretations of the language used to present a complementary perspective on the verbal interactions occurring in the PBL classrooms. Most of the previous studies did not analyse linguistic forms except the study by Woodward-Kron and Remedios which presented data on linguistic forms, but the analysis was limited to a segment of the initial phase of the PBL cycle [18]. The authors of the study did not present data on whether the linguistic forms and patterns were similar to those in other phases in the PBL process. Through the linguistic form analysis and the extracts of the talk data, we have shown how the linguistic forms reflect the interactive patterns in the PBL tutorials. Through this mixed-methods approach, we have analysed and described the students' verbal interactions in the PBL tutorials and contributed to the current understanding of how the PBL sessions are carried out in practice.

The study has some limitations which need to be considered when interpreting the results. The use of interactive linguistic forms as surrogates for meaning negotiation is very simplistic because meaning is intangibly residing in the minds of people and beyond actual measurement. One might argue that the number of participants in the study is relatively small, but the aim of the study is to generalise the findings to theory rather than the population [36]. Participation in the study is voluntary and those who participated may be more motivated than those who did not. The findings of this study may differ from those of the unstudied tutorial groups. Human interactions and language use are influenced by institutional and societal culture. The results of this study may not be generalisable to tutorial groups in other centres with different participants, cultural contexts and curricula. The study is based on an analytical framework derived from the English language to study knowledge-negotiation processes; however, the notion of knowledge-negotiation may be different in other languages.

The findings of this study have important implications for theory, practice and further research. Theoretically, the study shows that our understanding of the students' verbal interactions in the PBL classrooms can benefit from methodologies that can provide a more global pattern of linguistic forms and functions across the phases of the PBL cycle. This is important because the interactive pattern and content knowledge cannot be divorced from the linguistics forms used in the classroom. The corpus-based methodology can be used to explore problem-based learning questions addressed by non-linguistic methodology such as tutor directiveness. Practically, the discourse activities in the PBL tutorials need to be seen as ways of initiating medical students into medical professional practice. The students' communicative practices may reflect in their future communication competencies with colleagues and their patients. The study findings thus highlight the importance of monitoring the conversation that occurs among the students and ensuring that they align with the educational philosophy and policy. The wider implication of the study results is that the students who communicate well may transfer the same communication skills to patient-physician interactions and may perform better as managers. Tietbohl showed that physicians that elaborate on patients' feelings are considered to be more empathetic than the ones who acknowledge patients' feelings [37]. Facilitators may also model the verbal interactions expected of the students. The corpus-based methodology may be used in future research that relates the quality of meaning-negotiation with students' achievements. The methodology can also be used to compare the quality of verbal behaviours of graduates of PBL and those of conventional curricula in clinical settings.

Conclusion

This study has used a corpus-based approach to provide a complementary and global perspective on the verbal interactive activities occurring in the PBL tutorials in practice. The quantitative analysis provided patterns of the ICWs across the tutorial sessions. Qualitatively, we note that the interactive behaviours were exploratory in nature. The students seemed to have had problems with turn-taking as they frequently talked over each other. The theoretical implications are that corpus-based methodology could be used to explore several PBL questions including those explored non-linguistically. It is recommended that the PBL discourse, as a means of initiating medical students into professional practice, requires monitoring to ensure compliance with educational theory and policy.

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Appendix 1: Functions Mostly Performed by the Frequent Interactive Conversational Words Along with Examples from the Corpus

Function	Definition	Example
Recall	The student remembers the knowledge of events of the past	M2 – Oh yes, Sarah told us in her last lecture.
Information awareness	The student indicates an understanding of a subject, issue or situation	F3 – Oh yeah
Agree	A student indicates having the same opinion or knowledge as a peer	M4 – Yeah, that's right.
Disagree	A student indicates having an opinion or knowledge different from that of a peer	M1 – No, I disagree totally.
Confirm	A student indicates that a peer's idea or knowledge is true.	M4 – Is it depolarisation contraction? F2 – Yes, it is. M3 – Is asthma technically an allergy then? M1 – Yeah.
Acknowledge	A student gives attention to a peer's talk	M3 – Yeah.
Simple negation	A student says 'no' in response to a peer's statement	F1 – No.
Listening check	A student checks that the peers are paying attention to his/her talk	M1 – The bit at the top here, yeah, is the thyroid cartilage
Question token	The interactive word is uttered as a question	M4 – Yeah?
Preface question	The interactive word is used to begin a question	M2 – Yeah, what about fungal?
Restate	A student repeats a statement by another student.	M1 – Atopic rhinitis. M2 – Yes, atopic rhinitis.
Clarify	A student explains information more clearly, so that is easier to understand.	F3 – Yeah, I mean, personally for me and probably for my dad as well.
Comment	A student gives an opinion about a peer's statement	F3 – Yeah, that's one of the things.
Correct	A student put right the idea offered by another student.	M1 – No, we're talking about hypercapnia.
Addition	A student gives more information or idea more that is related to what has been said already.	M1 – Yes. And mucous secretion on top of that as well.
Contrast	A student gives more information that is different from what has been said.	M1 Yes, but when you get loads and loads of secretions when you have pneumonia or something, it does not cause permanent damage, does it?
Cause-effect	A student gives a statement that suggests that one thing leads to another.	M6 – Yes, because there is a little bit of protein and other bits and bobs dragging water out.
Appraisal	A speaker gives an opinion about the effectiveness and quality of a peer's statement.	M2 – Yeah, excellent idea.