INSIGHTS INTO STUDENTS' THOUGHTS DURING PROBLEM BASED LEARNING SMALL GROUP DISCUSSIONS AND TRADITIONAL TUTORIALS

Suriya Shukor

Diploma in Accounting and Finance
Temasek Business School

Students' covert behaviours in PBL small-group discussions are as important as their overt behaviours. One way to study students' covert behaviours is to understand students' thoughts during these discussions. What exactly do students think during these discussions? Do they engage in reflective thinking or are they simply listening passively? Are students more reflective in PBL small-group discussions as compared to traditional tutorials? This paper aims to gain insights on students' thoughts during PBL small-group discussions and traditional tutorials, and subsequently highlight any significant characteristics of these thoughts for each instructional setting. The students' thoughts were obtained using a "thought-sampling" method.

During these discussions, students reported their thoughts at random times at the signal of a bell. The thought reports were classified into the following categories: content-related (passive), content-related (reflective), procedure-related, metacognitive-related, off-task, and miscellaneous. The first four categories are task-related thoughts. The result shows that one-third of students' thoughts are reflective content-related thoughts and seventy percent are task-related thoughts for both PBL small-group discussions and traditional tutorials. There are, however, distinct differences in results for content-related (passive), procedure-related and off-task thoughts. This paper confirms that instructional settings, task requirements and the tutor's role affect students' thoughts. The implications of results for students' learning approach and activation of prior knowledge are also discussed.

INTRODUCTION

Most PBL models expect students to do research from a variety of sources and identify relevant content to solve the given problems. They are also expected to sieve information they obtained from these sources and formulate learning issues and objectives. These tasks require

students' continuous analysis, synthesis, reasoning, inference, evaluation and application of knowledge. Students may do them openly (i.e. overt behaviour) or quietly in their minds (i.e. covert behaviour). Without doubt, the PBL process calls for students' cognitive judgment and skills, which may or may not be verbalised.

There are many studies on the importance of cognitive behaviour in students' learning in the traditional lecture-tutorial system. Since 1951, Bloom (1951, 1954) has researched to understand students' covert behaviours, specifically students' thoughts during learning. He recognised that student grades from formal assessments and explicit behaviours may not reflect conceptual change in students' learning. Webb (1980, 1991) reported that students' overt behaviours may not reflect their mental processes. Both overt and covert behaviours are equally important in understanding students' learning process. Moust *et al.,* (1987) reported that there was no relationship between verbal participation of students in group discussions and their academic performance.

PBL practitioners also acknowledge the importance of cognitive effects of the PBL process (Bereiter and Scardamalia, 2000). Geerligs (1995) studied students' thoughts in PBL small group discussions and reported that students engaged in task-related thoughts more than non-task related thoughts. De Grave *et al*., (1996) showed that PBL students have to manage cognitive conflict in order to handle different viewpoints from multiple sources before they undergo conceptual change. Hmelo *et al.,* (1997) studied the cognitive effects of PBL and non-PBL approaches on medical students' knowledge, reasoning skills and learning strategies. The study reported that the PBL students used hypothesis-driven reasoning as they were taught, while the non-PBL students used data-driven reasoning. In 1998, Hmelo confirmed these results with a longitudinal study (Hmelo, 1998). Pedersen and Liu (2003) proved that knowing an expert's cognitive processes in problem solving helped PBL students to solve their problems. The expert's cognitive process acted as an external stimulus for students.

Given many research findings, in both instructional settings, showing that cognitive conflicts and changes are inevitable in all students' learning, it is useful to examine the characteristics of these internal activities in students' minds. A simple way to understand cognitive changes is to examine patterns of students' thoughts. In this study, samples of students' thoughts are captured. It is hoped that the nature of these students' thoughts, as they have been categorised, would reflect and help in understanding students' covert behaviours in both instructional settings, and provide insights on how students subsequently manage other areas like curricula, assessments and learning.

With so much emphasis on the advantages of the PBL approach for students' thinking process (e.g., Hmelo, 1998), it is appropriate to compare students' thoughts during PBL discussions and traditional tutorial discussions. With this supposition in mind, it is hypothesised that students' thoughts during PBL small-group discussions are inclined towards reflective content-related and not passive content-related.

DATA COLLECTION

Participants

The study was carried out in Temasek Business School at Temasek Polytechnic. To enable comparison of students' thoughts in both PBL small-group discussions and traditional tutorials, participants selected must undergo discussions in both instructional settings within the same time frame. This is to ensure that results of the study would not be affected by different characteristics of participants. Based on this prerequisite, a group of third year business students studying the subject Financial Analysis was selected. These students were scheduled to do four weeks of traditional tutorial discussions followed by four weeks of PBL discussions and a further four weeks of traditional tutorial discussions. The subject content for all twelve weeks was different.

There was a total of four classes of eighty-eight students taking the subject. A total of forty-eight students from two classes, approximately 50% of the population, were selected randomly for the study.

Procedure

The thought sampling method was selected. The main objective of the thought sampling method is to obtain snapshots of the students' thinking process, which represent samples of the overall covert behaviour of the participants. The method enables the researcher to capture data within the natural settings of students' discussions, does not require many resources, and can be easily adopted for both the traditional tutorials and PBL discussions. To obtain snapshots of the students' thinking process, at random intervals, a call-bell was used to interrupt the discussions. The participants wrote down their thoughts at the time the call-bell was heard, on a small booklet given to them earlier. The random intervals were based on a random number table (numbers below 50). Depending on the random numbers, the number of rings varied between two to four per session. Students were requested to be as honest and as accurate as possible and they were ensured confidentiality.

Out of a fifteen week semester for the selected subject, four weeks were allocated for PBL discussions while the remaining weeks were conducted in the normal lecture-tutorial system. For consistency reasons, data were collected for eight weeks running: four weeks for PBL small group discussions and another four weeks for traditional tutorials. Each week's discussion (i.e. one session) lasted approximately one hour fifty minutes.

Instructional setting

In order to better understand the results of this study, it is imperative to discuss the instructional settings and task requirements of PBL and tutorials discussions, as they provide the framework for the analysis of research results and for future discussions and recommendations.

PBL process

Students were expected to solve problems using the following PBL process:

Stage 1: Problem identification
Stage 2: Problem inquiry
Stage 3: Identification of learning goals
Stage 4: Research, discovery, analysis
Stage 5: Peer teaching & discussions
Stage 6: Solution development
Stage 7: Reflect & refine (going back to previous stages if necessary)
Stage 8: Final solution

Students in each class were divided into five small groups, and each group was given a different real-life problem. Each group was given four weeks to analyse the problem, with one compulsory small-group discussion per week at the library in the presence of a tutor. During the compulsory discussions, all the five groups in one class discussed the problem simultaneously, and the tutor moved around answering students' enquiries. Outside the scheduled sessions, each group was free to meet as many times as they required without the presence of the tutor, and were also free to approach the tutor at any other time. The PBL project comprises 30% of the overall subject grade. Students had to submit two 5-mark progress reports at the end of Week 2 and Week 3, an individual reflection journal (10 marks), peer evaluation (10 marks) and a group report (40 marks) at the beginning of Week 5, and each group had to do a presentation (30 marks) at the end of Week 5. In this paper, PBL small-group discussions are represented by PSGD.

Tutorial discussions

Students were given questions and were expected to prepare answers prior to tutorial discussions. A total of seven short case studies were given to students for discussions in tutorials during the study. During tutorials, tutors led the discussions and randomly picked students to solicit answers. Sometimes, tutors required students to undergo short small-group discussions during the tutorial period itself, before getting a representative to share the group's answers with the class in the form of an informal presentation. In this paper, discussions led by tutors during tutorials are represented by TTLD, while the ad-hoc small group discussions during tutorials are represented by TSGD.

The impact of task requirements on tutorial discussions is neither immediate nor direct. There is one written test in the middle of the semester comprising 20% of the overall grade, and a final written examination at the end of the semester which comprises 40% of overall grade. The only direct assessment on tutorial discussions is 10% of the overall grade for students' participation, which is awarded at the end of the semester.

Data collected

A summary of number of bell rings and number of thoughts collected are shown in Table 1 while breakdown of these thoughts into various discussions are summarised in Table 2.

Table 1
Number of bell rings and number of thoughts

Class	PBL Sessions (rings/thoughts)				Tutorial Sessions (rings/thoughts)			
	Wk 1	**Wk 2**	**Wk 3**	**Wk 4**	**Wk 1**	**Wk 2**	**Wk 3**	**Wk 4**
3B14	2/32	3/42	3/42	4/88	4/92	3/72	2/48	2/43
3B06	3/38	3/64	3/54	4/89	3/72	3/71	4/98	3/67
Total	**449 thoughts**				**563 thoughts**			

Table 2
Number of thoughts classified into PSGD, TTLD and TSGD.

	Week 1			**Week 2**			**Week 3**			**Week 4**		
Class	PSGD	TTLD	TSGD	PSGD	TTLD	TSGD	PSGD	TTLD	TSGD	PSGD	TTLD	TSGD
3B14	32	46	46	42	48	24	42	48	0	88	0	43
3B06	38	72	0	64	24	47	54	49	49	89	67	0
SubTotal	70	118	46	106	72	71	96	97	49	177	67	43
Total thoughts : PSGD (449) , TTLD (354), TSGD (209) = 1012 thoughts												

DATA ANALYSIS

Categories of students' thoughts

The categories of students' thoughts were derived based on concepts acquired from three main studies, namely Peterson *et. al.* (1982), Bloom (1954), Bloom et al., (1956) and Geerligs (1995). Table 3 shows the coding categories of students' thoughts used for this study.

Peterson coded students' thought processes, in a classroom teaching environment using a stimulated recall interview method, into general cognitive strategies (e.g., attending, understanding), specific cognitive strategies (e.g., relating to prior knowledge), and teaching process (e.g., monitoring understanding). Bloom categorised students' thoughts into relevant and irrelevant thoughts, and subsequently formalised his work into the well-known taxonomy of educational objectives. The taxonomy classified the objectives into six levels: knowledge, comprehension, application, analysis, synthesis and evaluation. Geerligs used six sub-categories: task-related (include content, procedure, metacognitive), and off-task related (include task-irrelevant, miscellaneous/unclassified, and absence of thoughts).

Table 3

Categories for analyzing students' thoughts

Task-related categories (Relevant thoughts)	**Code**	**Description of categories / Examples of students' thoughts**
Content-related (passive)	CP	Thoughts concerning the subject under discussion in which the individual is simply following the idea or listening or repeating what he had just heard into his mind. He is doing a minimum of active thinking about the ideas, and passively noting what is being said. Examples: • repeating what the individual just heard in the discussion (e.g., what's in the annual report) • listening to the 3 audit approaches.
Content-related (reflective)	CR	Thoughts concerning the subject under discussion in which individual is experiencing more that passive thinking. This includes comprehension (understanding), application (using the information), analysis (examining with options), synthesises (combining two or more points/ideas), and evaluation (judging/valuing/questioning). The deliberation and/or questions pertain to *specific* content of the discussion. Examples: • but won't the audit work be "unfair and untrue?" • is that all that can be given by the company? How about the share price? Are auditors responsible to the members or directors?
Procedure-related	P	Thoughts about the subject related to the method of working with the question given by tutor, oneself, the group, and the discussion. Examples: • I should write down the page number of the textbook for future reference • in exam, how am I going to answer the question of risk-based auditing … • all right, finally done question 1 (i.e. the way tutorial discussion is progressing)
Metacognitive	Mt	Thoughts related to the monitoring of one's own *general* understanding of the subject under discussion. Examples: • audit! I don't think it's easy … • what the tutor said makes sense … • I don't really understand, should I get the textbook?
Off-task categories (Irrelevant thoughts)		
Task-irrelevant	Off	Thoughts not related to the subject under discussion. These thoughts are mainly personal outpourings. Examples: • thinking of lunch, what to eat … • house hunting, rent is going up these days … • whether my boyfriend has left the house yet …
Miscellaneous	Mc	Thoughts that are indecipherable, incomprehensible, or poly-interpretable. Also includes absence of thoughts. Examples: • blank • money (could be task-relevant or off-task thought)

Contextual analysis

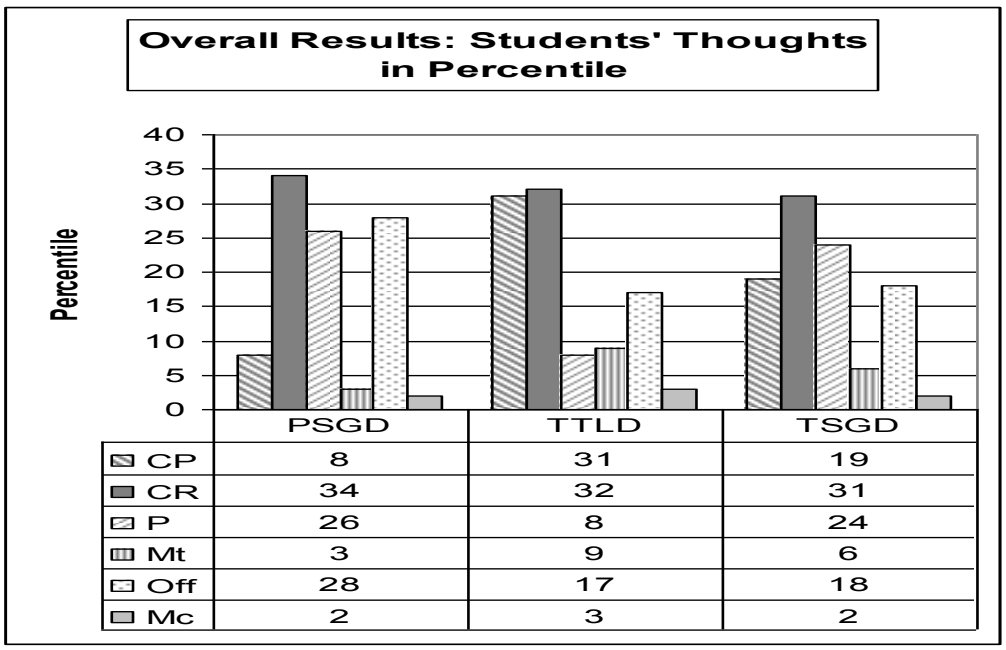
The researcher began the analysis process by reading the data as a whole and obtaining a general overview before significant aspects of the study were highlighted. Contextual analysis, as it is known, is a procedure which is increasingly being accepted for descriptive researches (Svensson, 1986; 1997). During this process, the "basis of the theme or perspective of the investigation" (Svensson, 1986, p. 36) is kept in view, and comparisons between all cases (in this case students' thoughts) are essential.

Students' thoughts were collated weekly, but coding of the 1012 thoughts was done together after collection of final set of data in order to achieve consistency. Each thought was scrutinised carefully, and similar thoughts were compared, before a code was assigned. When ambiguity arose, an elimination process was applied, in which the most unlikely categories for thought were eliminated one-by-one until only one category remained. Each set of students' thoughts was coded at least three times, and each time the coding was done with a different colour. The first set of data for class 3B06 (Week 1) was coded five times. The original coded thoughts, with colour indication, were then passed to an independent reviewer for a second opinion.

RESULTS AND DISCUSSIONS

Overall results

Overall results are reported in Figure 1. Reflective content-related thoughts (CR) score highest for all three activities at 34% for PSGD, 32% for TTLD and 31% for TSGD. The result shows that approximately one-third of students' thoughts are reflective content related for all three activities (PSGD, TTLD and TSGD). This is an encouraging finding as it indicates that students are active thinkers for all three activities.



	PSGD	TTLD	TSGD
CP	8	31	19
CR	34	32	31
P	26	8	24
Mt	3	9	6
Off	28	17	18
Mc	2	3	2

Figure 1: Overall results: Students' thoughts in percentile

However, the other two-thirds of students' thoughts for each activity show different thought patterns. In PSGD, although reflective content-related thoughts (CR) recorded the highest score, off-task thoughts (Off) took second place at 28% and were followed by procedure-related thoughts (P) at 26%. Content-related (passive) thoughts (CP) recorded 8% while metacogitive-related (Mt) and miscellaneous thoughts (Mc) were at 3% and 2% respectively. In TTLD, instead of off-task thoughts (Off), content-related (passive) thoughts (CP) took the second place at 31%, followed by off-task thoughts (Off) at 17% and metacognitive-related (Mt) at 9%. Procedure-related thoughts (P) and miscellaneous thoughts (Mc) were at 8% and 3% respectively. Finally for TSGD, procedure-related thoughts (P) constituted 24% while content related (passive) thoughts (CP) were 19%. Off-task thoughts (Off) were recorded at 18% while metacogitive-related (Mt) and miscellaneous thoughts (Mc) were at 6% and 2% respectively.

What do these percentages suggest? Looking at the results of PSGD alone, the hypothesis that students' thoughts during PBL small-group discussions are inclined towards reflective content-related and not passive content-related appears to be true. PSGD recorded 34% of CR thoughts as compared to only 8% of CP thoughts. CP thoughts are basically passive listening and mentally repeating what students heard. However, it is also important to highlight the high percentage of Off thoughts in PSGD. During compulsory PSGD, each group discussed given problems with minimum supervision. The tutor moved around from one group to another, within the class, during the 1 hour 50 minutes session, and so was not with each group all the time. The instructional settings for PSGD in this study were unstructured in terms of both problem analysis and physical set-up of discussions, unlike the Seven Jump Approach (Schmidt and Moust, 2000) and the Southern Illinois University model (Barrows *et al.,* 1991). The physical presence of the tutor is important at least during compulsory discussions. It would be better for PBL tutors to meet individual groups for a shorter discussion period rather than meeting all groups simultaneously for a longer period. Barrows (1988) recommended that the role of PBL tutors should be structured, and the student-tutor ratio must be kept small so that tutors are able to maintain students' cognitive and metacognitive behaviours.

Another related issue pertaining to the structuring of the PBL curriculum is the conscious incorporation of students' reflection time within the PBL process. Students' reflection is one of the general principles in the development of students' process skills and must be incorporated as one of the components of the assessment of process skills in the PBL curriculum (Woods, 2000). Off-task thoughts are significantly high for PSGD (28%), as compared to the other two activities, TTLD (17%) and TSGD (18%). In analysing details of the off-task thoughts in PSGD, a variety of topics emerged from day-dreaming, personal concerns to immediate personal plans such as where to have lunch. Without close tutor supervision in PSGD, students are easily distracted, unless they are driven by intrinsic motivation all the time during discussions.

Although reflective content-related thoughts are high in TTLD (at 32%), the proportion of passive content-related thoughts is equally high. At 31%, it clearly supports the basic assumption of a pedagogical view of "learning from the teacher" as the teacher is deemed to be an expert in the discipline and students learn by adding new knowledge to existing knowledge (Ramsden, 1992). This confirmed that the didactic and unilateral mode of teaching (e.g., Kozma *et. al.,* 1978) causes students' passive content-related thoughts.

In TSGD, CP thoughts were recorded at 19%, lower than in TTLD, even though both are part of the same traditional tutorial process. This seemed to indicate that "discussions", whether in a PBL environment (PSGD) or a traditional system (TSGD), do not allow students to listen passively. Students are "forced" to think and talk during discussions.

According to Marton and Saljo (1976), students adopting surface-level processing focus on unrelated parts, isolated words and sentences and usually with the aim of meeting the demands of assessment, while a deep processing approach focuses on analysing and reflecting concepts learned. From the high percentages of reflective content-related thoughts reported in this study, it seemed appropriate to deduce that deep approach learning was present in all three activities. However, with an equally high percentage (31%) of passive content-related thoughts in TTLD, it also seemed that out of the three activities, TTLD was most likely to encourage surface learning approach.

A similar impression may be obtained when details of the procedure-related (P) thoughts are compared. Overall findings showed that P thoughts were distinctly high for unstructured discussions at 26% for PSGD and 24% for TSGD, as compared to 8% for TTLD. Detailed analysis of P thoughts in PSGD and TSGD was done, and is tabulated in Table 4 as follows:

Table 4
Detailed analysis of procedure-related (P) thoughts

Nature of Procedure-related thoughts	**Activity**	**Total thoughts/Activity**	**Occurrences (% based on overall)**	**Total**
Presentation of answers / reports	PSGD	449	24 (5%)	26%
Management of resources	PSGD	449	12 (3%)	
"Working with oneself" / group / tasks	PSGD	449	***70 (16%)***	
Arrangement of meetings	PSGD	449	8 (2%)	
Physical environment	TSGD	209	1 (1%)	24%
Presentation of answers	TSGD	209	***25 (12%)***	
"Working with oneself" / group / tasks	TSGD	209	21 (10%)	
Tutors' management of discussions	TSGD	209	1 (1%)	

A high percentage of 16% for PSGD was on "working with oneself/group/tasks". Examples of such P thoughts include prioritising workload within oneself, co-ordinating work with team members in terms of work delegation and meeting deadlines, as well as interpersonal skills in managing team members. The occurrence of P thoughts linking to the presentation of answers and reports, which indicates the need to meet the demand of the assessment, is relatively low (5%). On the other hand, in TSGD, the percentages were 10% and 12% respectively. Although the difference in the percentages between PSGD and TSGD is marginal, the distinct difference in the percentages in PSGD itself may indicate that students are more inclined to deep processing. While the results may tend to show that PBL small-group discussions encourage deep learning, they also show that the traditional tutorial discussions do not discourage deep processing in learning.

Results by weekly pattern

A weekly comparison for each of the activities were done to see if there were any distinct patterns of students' thoughts, and to see whether the characteristics of these activities were shown through these patterns.

The result for PSGD shows students' thoughts being affected by different stages of the PBL process. Figure 2 shows that students' thoughts throughout the four weeks correspond to various PBL stages as reported earlier. Students' thoughts in Week 1 show high percentages for CP, P and Off thoughts. Since this is the first week of discussion, students are expected to do problem identification, problem inquiry and identification of learning goals. The high CP thoughts indicates that in identifying learning issues, students need to comprehend, analyse and evaluate data given in the problem. Similarly, during their first week, they need to delegate tasks, identify the sources of information required, as well as discuss how to meet assessment requirements, which is shown in the high percentage of P thoughts. The Off thoughts were equally high. This may be due to students who were not pressured to work on the problem and were still "talking-away" during discussions.

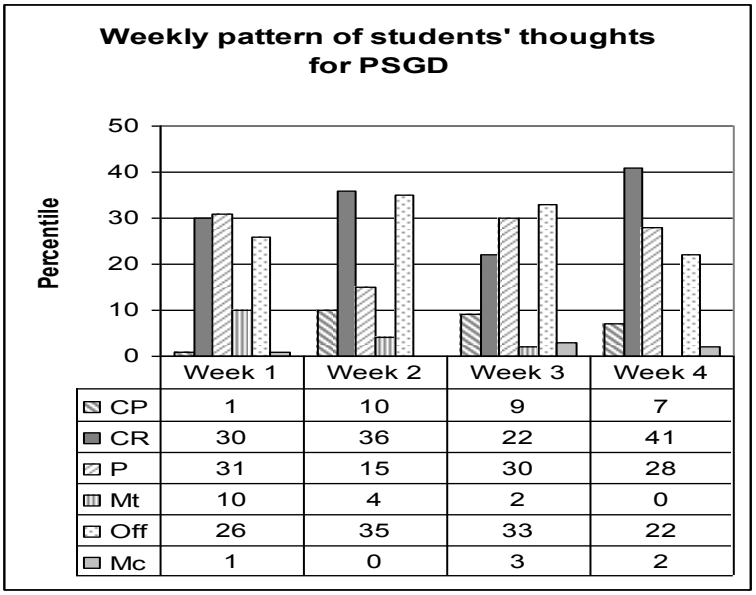
In Week 2, P thoughts decreased as students had settled down with procedure-related tasks. CP thoughts were still high as students were still actively scrutinising the problem through research and analysis, discussions or peer teaching. However, some students were still engaged in non-task activities since Off thoughts were still high. In Week 3, P thoughts doubled, as students were getting ready for submission of the group report as well as presentation. However, Off thoughts were still high. In Week 4, CR suddenly increased tremendously, indicating either that students were working very hard, or that those who had not been working were rushing through the work to meet the approaching deadline.

There is no clear pattern for TSGD as shown in Figure 3. Off thoughts clearly exceeded other thoughts in Week 1, while P thoughts and CR distinctly exceeded other thoughts in Week 3 and Week 4 respectively. The rest of the thought categories were indistinguishable in terms of percentages. Tutorial processes (TSGD) usually included a variety of activities such as discussions, mini-presentation, case studies, simulations or games (Brown and Atkins, 1988). In this study, TSGD comprised mainly the tutor's explanations of concepts, discussions and mini-presentations. Tutor's explanations of concepts and discussions resulted in 53% of passive and reflective content-related thoughts, while preparation for mini presentations gave rise to 24% of procedure related thoughts (Figure 1). Similarly, Figure 3 confirmed that the mixed nature of TSGD gave rise to a mixed weekly pattern.

A similar pattern for CP, CR and Off in TTLD over all four weeks is shown in Figure 4. CR and CP exceeded other thought types for all four weeks. They were consistently followed by Off thoughts. CR, however, exceeded CP for Week 2, 3 and 4.

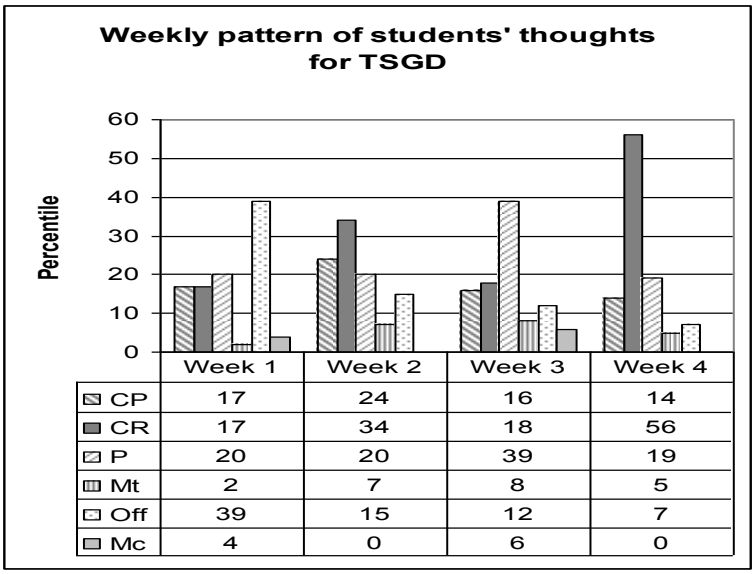
Results showed that tutor-led discussions encouraged both passive and reflective content-related thoughts, mainly because TTLD has a unidirectional mode of communication (Kozma *et. al.,* 1978) which is instructor-centred. As a whole, TTLD produced the lowest percentage of off-task thoughts (17%) and a very small percentage of procedure-related thoughts (8%). The lowest level of off-task thoughts was due to the structured settings of TTLD, and since students were not involved in discussions, procedure-related thoughts were insignificant. It is also interesting to note that the weekly patterns for TTLD are similar (Figure 4). In the opinion of the researcher, this again is due to the highly structured settings.

Figure 2
Weekly pattern of students' thoughts for PSGD



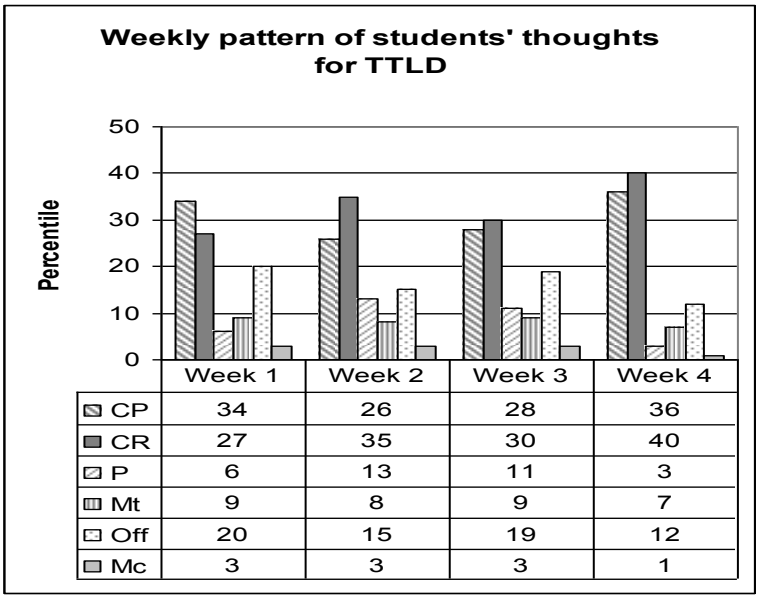
	Week 1	Week 2	Week 3	Week 4
CP	1	10	9	7
CR	30	36	22	41
P	31	15	30	28
Mt	10	4	2	0
Off	26	35	33	22
Mc	1	0	3	2

Figure 3
Weekly pattern of students' thoughts for TSGD



	Week 1	Week 2	Week 3	Week 4
CP	17	24	16	14
CR	17	34	18	56
P	20	20	39	19
Mt	2	7	8	5
Off	39	15	12	7
Mc	4	0	6	0

Figure 4
Weekly pattern of students' thoughts for TTLD



	Week 1	Week 2	Week 3	Week 4
CP	34	26	28	36
CR	27	35	30	40
P	6	13	11	3
Mt	9	8	9	7
Off	20	15	19	12
Mc	3	3	3	1

Yet another area to look at is the activation of prior knowledge. Based on Norman and Schmidt's review (1992), it is claimed that PBL encourages activation of prior knowledge which will help students in their learning and absorption of new knowledge. Does the data collected for this study show any indication of activation of prior knowledge? Strictly using contextual analysis, students' thoughts in this study were examined for indication of using prior knowledge. Much pain was taken in data analysis to compare student's thoughts with the content of discussions as well as the questions given to students by the tutor. A total of 4% (22 thoughts) from the tutorial discussions, and 5% (23 thoughts) from the PBL discussions, were deemed to indicate activation of students' prior knowledge. The difference in percentages was marginal for both instructional settings. Some of the thoughts that reflected the activation of prior knowledge are presented below:

- stock split … what is it? … sound familiar but can't quite remember the actual meaning
- liquidity … more inflow will improve liquidity …
- interest rates cheaper during recession!
- why shares increase? Bank's industry recover easier than other industry…
- how can OUB finance its investing activities with a negative cash flow from operating activities?

The initial impression is that the results do not support Norman and Schidmt's suggestion. However, one possible drawback of the current study is that data were collected only during the four weeks of compulsory PBL discussions with the tutor's presence. In addition to the compulsory discussions, additional small group meetings ranged from 0 to 11 discussions per group during the four weeks of PBL curricula. It is also important to note that data collected for this study are only snapshots of the students' thinking process. They do not reflect students' continuous thinking process. Further studies could be done to reach a more concrete conclusion.

FURTHER STUDIES

The main limitation of this study is due to the adoption of the thought sampling process whereby the thoughts gathered are "snapshots" of the overall process. It would be useful for future study if the thought sampling process could be followed by focus interviews. Even if it is not possible to conduct the focus interviews for all the small groups, it would be good to interview at least two of the groups.

It would also be possible for a similar study to be conducted as a case study, in which the researcher could follow one small group throughout the complete tutorial and PBL small group discussions. These would include the official as well as the unofficial discussions where students meet without tutors. Thereafter, focus interviews could be conducted for the group. It is hoped that the trend of thoughts could be monitored in stages, and might be more beneficial in explaining the thought processes, as compared to the content of the thoughts.

Another way to further enhance the research study is to compare the students' thoughts using learning journals, analyzing them at various intervals. If students actually used these journals as their reflection tools, their thoughts during the discussions should be somewhat in line with reflections in their journals.

CONCLUSION

The study has achieved its main objective of understanding students' thought patterns in different instructional settings. The different patterns of students' thoughts in the PBL small group discussions and traditional tutorial discussions, which were found in this study, prove that instructional settings are important and are able to influence students' covert behaviours. The different pedagogical assumptions as well as the different characteristics of these instructional settings, caused tutors to play different roles, and these factors affected students' thoughts pattern.

In PBL small-group discussions, the study shows that the different stages of the PBL process cause different student thought patterns. The initial findings from this study are an encouraging start for PBL practitioners to reflect on the importance of good implementation, as well as the role of each of the PBL stages in meeting the overall objectives of the PBL process. The high percentage of off-task thoughts in all four weeks of PBL small-group discussions is rather disturbing and may need to be addressed by PBL practitioners. It is recommended that PBL small-group discussions need to be relatively structured, as in the Maastricht model (Schmidt and Moust, 2000).

It seems that students' thoughts are influenced by the expectations presented to them. In addition to the effect of the PBL stages on their thoughts, the unstructured nature of the PBL discussions leads to dissimilar weekly thought patterns. This shows that, in my opinion, students' thoughts can be encouraged to move toward desired outcomes, and there are two factors that can assist in this; namely structured PBL tutorials and a structured role for the PBL tutors. The structured PBL tutorials would not only ensure that students obtained clear guidelines, but also help them to be disciplined and work on the given problems consistently. The structured role of the tutor and the small student-tutor ratio would allow closer supervision, especially in the transition period from traditional to PBL curricula. Finally, due to the limitation of the study gathering only "snapshots" of students' thoughts, it could not confirm whether PBL encourages the activation of prior knowledge.

REFERENCES

Barrows, H.S. (1988). *The Tutorial Process*. Illinois: Southern Illinois University School of Medicine.

Barrows, H.S., Macrae, H.M and Brower, C., executive producer, (1991). *The Tutorial Process in Problem-Based Learning*. [Video recording – Tape 1: 58 minutes, colour, NTSC; Tape 2: 31 minutes, colour, NTSC]. Illinois: Southern Illinois University, U.S.A., Board of Trustees.

Bloom, B.S. (1951). Some results of a study of conscious thought processes in classroom situations. Unpublished paper presented at the American Psychological Association Meeting, Chicago: Illinois, 31 August. Cited in Bloom, B.S. (1954) The thought process of students in discussion. In S.J. French (ed.), *Accent on Teaching*, pp. 23-46. New York: Harper & Brothers.

Bloom, B.S. (1954). The thought process of students in discussion. In S.J. French (ed.), *Accent on Teaching*, pp. 23-46. New York: Harper & Brothers.

Bloom, B.S., Engelhart, M.D., Furst, E.J., Hill, W.H. & Krathwohl, D.R. (1956) *Taxonomy of Educational Objectives: Handbook I: Cognitive Domain.* New York: David McKay.

Bereiter, C. and Scardamalia, M. (2000). Commentary on Part 1: Process and Product in Problem Based Learning Research. In D.H. Evensen, and C.E. Hmelo, (eds.), *Problem-Based Learning: A Research Perspective on Learning Interactions, pp. 185-195.* New Jersey: Lawrence Erlbaum Associates.

Brown, G. and Atkins, M. (1988). *Effective Teaching in Higher Education* London: Routledge.

De Grave, W.S., Boshuizen, H.P.A, and Schmidt, H.G. (1996). Problem-based learning: cognitive and metacognitive processes during problem analysis, *Instructional Science, 24*, 321-341.

Geerligs, T. (1995). Students' thoughts during problem-based small-group discussions. *Instructional Science*, *22*(4), 269-278.

Hmelo, C.E. (1998). Problem-based learning: Effects on the early acquisition of cognitive skill in medicine. *The Journal of the Learning Sciences*, *7*(2), 173-208.

Hmelo, C., Gotterer, G.S. and Bransford, J.D. (1997). A theory-driven approach to assessing the cognitive effects of PBL. *Instructional Science*, *25*, 387-408.

Kozma, R.B., Belle, L.W. and Williams, G.W. (1978). *Instructional Techniques in Higher Education.* New Jersey: Englewood Cliffs.

Marton, F. and Saljo, R. (1976). On qualitative differences in learning: Outcome and process. *British Journal of Educational Psychology*, *46,* 4-11.

Moust, J.H.C., Schmidt, H.G., de Volder, M.L., Belien, J.J. and de Grave, W.S. (1987). Effects of verbal participation in small group discussions. in J.T.E. Richardson, M.W. Eysenck, and D.W. Piper, (eds.), *Student Learning: Research in Education and Cognitive Psychology,* pp. 147-154 . Milton Keynes: Open University Press.

Norman, G.R. and Schmidt, H.G. (1992). The psychological basis of problem-based learning: A review of the evidence, *Academic Medicine*, *67*(9), 557-565.

Pedersen, S. and Liu, M. (2003). The transfer of problem-solving skills from a problem-based learning environment: The effect of modelling an expert's cognitive processes. *Journal of Research on Technology in Education*, *35*(2), 303-320.

Peterson, P.L., Swing, S.R., Braverman, M.T. & Buss, R. (1982). Students' aptitudes and their reports of cognitive processes during direct instruction. *Journal of Educational Psychology*, *74*(4), 535-547.

Ramsden, P. (1992). *Learning to teach in higher education.* London: Routledge.

Schmidt, H.G. and Moust, J.H.C. (2000). Factors affecting small-group tutorial learning: A review of research. In Evensen, D.H. and Hmelo, C.E. (eds.), *Problem-Based Learning: A Research Perspective on Learning Interactions,* pp. 19-52. New Jersey: Lawrence Erlbaum Associates.

Svensson, L. (1986). Three approaches to descriptive research. In Ashworth, P. and Giorgio, A. (eds.), *Qualitative Research in Psychology: Proceedings of the International Association for Qualitative Research*, 23-47.

Svensson, L. (1997). Theoretical foundations of phenomenography. *Higher Education Research and Development, 16*(2), 159-171.

Webb, N.M. (1980). Group process: The key to learning in groups. *New Directions for Methodology of Social and Behavioral Science*, *6,* 77-87.

Webb, N.M. (1991). Peer interaction and learning in small groups. *International Journal of Educational Research*, *13,* 21-41.

Woods, D. (2000). Helping your students gain the most from problem-based learning. In O.S. Tan, P. Little, S.Y. Hee, and J. Conway, (eds.), *Problem-based Learning: Educational Innovation Across Disciplines*, pp. 12-36. Singapore: Temasek Centre for Problem-Based Learning.