IJER Indonesian Journal of Educational Review
p-ISSN 2338-2017 | e-ISSN 2335-8407
Vol. 4, No.1 , July 2017, p 1-13

Available online at
http://journal.unj.ac.id/unj/index.php/ijer

COLLABORATIVE AND SELF-DIRECTED LEARNING PROCESSES: A CASE STUDY IN MALAYSIAN CHEMISTRY PBL LESSON

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Abstrack

Problem-based learning (PBL) provides students with the opportunity to conduct self-directed learning in collaborative groups, which are essential skills to meet challenges in the 21st century. This study aims to investigate the occurrence and types of collaborative and self-directed processes during problem analysis phase utilizing the FILA-MMS chart in Malaysia secondary school. Two out of five groups of students taught by a teacher in one PBL chemistry lesson was observed, audio-recorded and the verbatim were analyzed. The findings show that collaborative process and self-directed process occur in both groups. Collaborative processes occur by 79.1% and 78.9% in group 1 and group 2 respectively. Major collaborative processes observed in both groups are 'question and answer', 'co-construction' and 'sharing of ideas or information'. Self-directed processes occur by 18.3% and 12.9%. The main self-directed processes observed are 'monitoring' and 'directing'. This study shows that there is a lack of self-directed learning skills among students, such as planning, reflection, evaluation of understanding, and managing information and resources. To enhance these skills among students, future PBL teachers are suggested to emphasize and model planning, reflection and evaluation processes in their lessons.

Keywords: *problem-based learning, collaborative learning, self-directed learning, chemistry lesson, secondary school*

Student-centered active learning strategies have been promoted for decades in developed countries in response to the needs of 21st century education. Capacities and attitudes extending beyond content knowledge, such as higher-order thinking, problem-solving skills, self-directed learning, teamwork and communication skills, planning and organizing skills, self-management skills (Evensen, Hmelo, & Hmelo-Silver, 2000; Tan, 2003) have been emphasized on. What about Malaysia, a nation with the aspiration of achieving the status of developed nation in the year 2020?

Most Malaysian students are still practicing rote learning in the teacher-centered classes (Lim, 2007; Abu Hassan Kassim, 2003; Anuar Zaini, et al., 2003; Ng & Siow, 2003; Sharifah Maimunah, 2000). Students learning are in the form of passively accepting information from the teacher, copying notes, drill and practice,

and 'cookbook style' practical activities. In such a learning environment, students become passive and dependent learners. Students face difficulties in learning and working with other when they enter tertiary education. Most students entering university are not prepared for active learning as they come from a passive, spoon-fed and exam-oriented schooling system (Hussain & Berhannudin, 2009; Khairiyah, et al., 2009). There is a need to nurture students with the skills and capabilities to learn and collaborate with others since their schooling years. A transition from passive learning to actively engage in their own learning is the first step towards the development of well-rounded students. Thus, a learning environment providing real context learning and opportunity for students to work by themselves and among themselves has been designed and introduced into Malaysia secondary school.

Problem-Based Learning

Problem-based learning was developed by Howard S. Barrows and first implemented in McMaster University medical education in the 1960's (Barrows & Tamblyn, 1980). Medical students were not able to apply their knowledge in real clinical settings even though having passed the written examinations. PBL was thus developed to provide students with a learning environment that mirrored clinical practices, which could facilitate students' skills relevant to the real practice as well as promote deep learning. Various adaptations were made and PBL has been implemented across most disciplines, spread across the globe and was introduced into K-12 education (Tan & Mohammad Yusof Arshad, 2011).

PBL is a pedagogical approach centered on ill-structured real world problem, which stimulate the practice of information-gathering, reasoning and problem-solving skills, interpersonal and team working skills, as well as the acquisition of content knowledge, in the process of working out the problem in collaborative groups. Students are responsible for their own learning while the instructor's role is to facilitate students' learning process without imparting direct answers or knowledge.

There is limited research found about using PBL in Malaysia secondary schools even though there is an increase interest worldwide to implement PBL. Majority of Malaysia secondary school students as well as teachers have never come across PBL approach at schools (Faaizah & Halimah, 2007). Whether PBL is able to be implemented across Malaysia schools with large classes conducted by only one teacher remains a question. What will happen when teachers and students new to PBL experience PBL lessons? How will the learning proceeds? Are students able to work collaboratively and self-directly within their PBL groups and how does it occur? These are crucial issues to be found out in order to better design future PBL lessons across Malaysia schools.

Collaborative Process

Collaboration is the mutual engagement of students in a coordinated effort to reach a common learning goal and solving a problem together (Roschelle & Teasley, 1995; Webb & Palincsar, 1996). Students are involved in the same task activities, share their tools and possess a comparable prior knowledge level. In the collaborative process, students all contributed in different parts of the learning.

Previous studies have shown that working collaboratively in small groups holds potential benefits such as promoting student learning and achievement, deep learning, critical thinking, transfer of learning, communication skills, problem-solving skills and organizing skills (Cheng and Warren, 2000; Cockrell et al., 2000; Hmelo-Silver, 2004; Van Boxtel, 2000). Evidence shows that working collaborative in small groups has undeniable positive effects. However, how does the collaborative process occur that brings about these effects?

Few researches have conducted qualitative analysis on actual student interaction to identify the learning process during collaborative learning. Mercer (1996) analyzed the quality of children talk in collaborative environment into three modes of talking and thinking: disputational talk, cumulative talk, and exploratory talk. Van Boxtel (2000) coded interaction between dyads at high school level into three categories of episodes: question, conflict and reasoning. Both conflict and reasoning are identify further whether it is individually constructed or co-constructed. Disputational talk and cumulative talk in Mercer (1996) are similar to conflict and co-construction in Van Boxtel (2000) respectively, while exploratory talk encompass both question and reasoning. Visschers-Pleijers et al. (2004) adopted the coding system of Van Boxtel (2000) to explore cognitive interactions between medical students in PBL tutorial groups of 5-7 students for reporting phase. Findings of the study show that cognitive interactions could be found in the tutorial groups and co-constructions are most easily elicit from the transcript. Visschers-Pleijers et al. (2006) adapted Van Boxtel (2000) coding scheme and the three types of learning-oriented interactions by Mercer (1996). The findings show that learning-orientated interactions accounted for 80% of the interactions, with cumulative reasoning, exploratory questioning and handling conflicts about knowledge accounting for about 63%, 10% and 7% of the interactions, respectively. Task involvement in the tutorial groups was high and relatively little time was spent on exploratory questions and handling conflicts about knowledge.

Yew (2009) examined a group of 5 college students' learning-oriented interaction in a complete PBL cycle, consisting of three phases: problem analysis, self-directed learning, and reporting. Episodic scheme by Van Boxtel (2000) was adapted and self-directed learning episodic codes were added on. Occurrence of all constructive, collaborative and self-directed learning activities were observed, with 53.3% of episodes being collaborative, 27.2% self-directed and 15.7% constructive. Major collaborative processes are question and answer, sharing of

information and co-construction.

Most of the studies of PBL learning interactions do not focus on the self-directed process, as in the study by Yew (2009). Self-directed learning is also a main characteristic of PBL and should be explored the interactions that will promote self-directed learning skills.

Self-Directed Process

Knowles (1975) defined self-directed learning as 'a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies and evaluating learning outcomes'. Students learn to identify deficits in their knowledge and what they need to learn, and demonstrate appropriate learning strategies such as goal setting, planning, monitoring and reflection on their progress (Hmelo- Silver, 2004; Zimmerman, 2002; Zimmerman, 1990).

Learning is a lifelong process and proceeds even after graduation. Thus, the skill to self-leam is a precious commodity that will ensure a person success in life. A high correlation between the usage of self-regulatory strategies and academic achievement has been proven by previous studies (Zimmerman 1990; Zimmerman and Martinezpons 1988).

Patterson (2002) listed six competencis required for student to become self-directed learners, which are selfassessment of learning gaps, evaluation of self and others, reflection, information management, critical thinking; and critical appraisal. In the coding scheme by Yew (2009), four self-directed process episodes are used: planning, evaluation of understanding, evaluation of resources, and monitoring of task progress.

In this study, the coding scheme is adapted from Yew (2009), with reference to numerous other studies and accommodated with the actual data obtained. The purpose of this article is to investigate whether self-directed learning process and collaborative process take place in PBL groups at Malaysia secondary school level, and the types of self-directed learning process and collaborative process that occur.

METHOD

This study used a qualitative approach of case study. The purpose is to obtain detailed insights into PBL groups' learning processes during problem-analysis step using FILA-MMS chart. A teacher and his form four chemistry class (Year 10) of thirty five students participated in this study. The class comprises of 21 female students and 14 male students with a mixture of different races. The students are divided into five groups with seven members each for the PBL lessons. Both the teacher and students are new to PBL. Students' verbal interaction was recorded using audio recorder placed at each group's lab bench. The researcher

participates as a passive observer. Two groups' audio-recording are randomly selected for transcription and analysis. The analysis focuses on the learning processes that occur in the group, namely collaborative process and self-directed process. Content analysis and constant comparative method are used. Coding scheme by Yew and Scmidt (2009) with reference to other studies was adapted for the purpose of this study.

Four (question and answer, co-construction, sharing of ideas or information, and conflict) out of the eight collaborative process in this study are simplified from the seven episodes in Yew and Schimt (2009). Basic question and answer, unanswered question and explanation initiated by question episodes are simplified under 'question and answer'. Elaborated and unelaborated conflict episodes are simplified to 'conflict'. At this initial stage of PBL implementation at secondary education, this study aims to obtain an overview of the learning process that occur and whether collaborative and self-directed processes are practiced. The types of questions and answers, and students' conflict will be further analysed in future studies. For self-directed process, all four episodes in Yew and Schimt (2009) are adapted into this study.

This study focus on the problem analysis phase utilizing the FILA-MMS chart (Figure 1). This chart has been adapted from FILA chart to integrate the multiple levels of chemical representation component into PBL. Table 1 show the explanation for each column in the FILA-MMS chart, which is inserted in the student's module.

Facts	Ideas			Learning Issues	Action Plan
	Macro	Micro	Symbolic		

Figure 1 FILA-MMS chart

Table 1 FILA-MMS Chart Explanation	
Column	Explanation
Facts	Information extracted from the problem scenario; grouped according to themes where possible.
Macro Ideas	Any ideas about the problem, based on facts identified; brainstorm; hypotheses - accepted without judgment, evolves over time. (Things you know about the information extracted and suggestions for possible solutions.)
Micro Ideas	Theory at particulate level (atoms, ions and molecules) and/or submicroscopic representation diagrams of chemical reaction or physical process involved (when applicable)
Symbolic Ideas	Equations of related reactions (when applicable)
Learning Issues	Things you need to know or find out to solve the problem; Phrased as questions; when answered should contribute towards solving the problem
Action Plans	Activities to be carried out to answer gaps in order to help solve the problem, e.g. conduct research, interview; questions/info to be sought from the parties in the scenario. (How to find the needed information.)

The problem scenario students encountered are: Lee loves soft drinks. A can of cola is the least he took every day. As days passed by, Lee found that his teeth have become sensitive to the extent that even eating ice-cream is an unbearable pain to him. You and your group are to help Lee understand what is happening to his teeth and advise him on his habit of "a can of cola a day".

RESULTS AND DISCUSSION

Findings show that both collaborative and self-directed processes occur in PBL groups in Malaysia secondary school large classroom. Table 2 shows the percentage coverage of verbatim and number of episodes for each of the collaborative and self-directed processes in both groups. Mean percentage coverage of verbatim, standard deviation and coefficient of variance are also included to give an overview as well as the differences between both groups. Percentage coverage of verbatim is chosen to show the percentage occurrence of collaborative and self-directed processes throughout students' verbalize interactions.

Table 2 Collaborative and self-directed processes shown in two groups during problem analysis

Learning rocesses	GROUP 1		GROUP 2		MEAN		
	Percentage coverage (%)	No. of episodes	Percentage coverage (%)	No. of episodes	Mean percentage coverage	SD (%)	Coefficient of variance
Collaborative							
Question and	23.64	26	33.48	29	28.56	6.96	0.24
Co-construction	18.03	5	17.09	7	17.56	0.67	0.04
information							
Conflict	10.68	6	5.92	5	8.30	3.37	0.41
Encouragement	0.89	2	1.45	4	1.17	0.39	0.34
Summarizing	9.79	1	0.00	0	4.89	6.92	1.41
Advocating effort	1.82	3	0.00	0	0.91	1.29	1.41
Peer teaching	0.00	0	8.55	2	4.28	6.05	1.41
Total collaborative	79.10	57	78.94	66	79.02	0.11	0.00
Self-directed Monitoring	7.83	7	4.47	7	6.15	2.38	0.39
Directing	3.84	8	5.15	12	4.49	0.92	0.21
Evaluation of understanding	0.88	1	1.85	4	1.37	0.68	0.50
Managing information and resources	1.72	1	1.44	1	1.58	0.20	0.13
Planning	3.28	1	0.00	0	1.64	2.32	1.41
Reflection	0.73	1	0.00	0	0.36	0.51	1.41
Total self-directed	18.29	19	12.90	24	15.59	3.81	0.24

From Figure 2, it can be seen that most of the students' verbal interactions (79.02%) depicts collaborative processes while self-directed processes only occurs by 15.59%. Previous studies (Visschers-Pleijers, Dolmans, de Leng, Wolfhagen, & van der Vleuten, 2006; Yew & Schmidt, 2009) also reported higher collaborative process than self-directed process. Collaborative process is content-learning-oriented while self-directed process sets up the framework and direction for the content-learning. Yew and Schimdt (2009) reported that a group of five polytechnic students from a Singaporean PBL institute shows 69.0% of constructive and collaborative process, while self- directed process occurs at 27.2%. In this study, students show comparatively high occurrence of collaborative process but a lower self-directed process.

High percentage of collaborative process reflects the characteristic of PBL: student collaboration in small groups. Even though Malaysian students are used to passive learning environment, they have the potential to adapt to the new active learning environment of PBL. From the observations, it is found that even though students dislike the idea of 'teacher not teaching', they like the opportunity for them to talk (discuss) during class time.

In comparison with 27.2% of self-directed process shown by experienced PBL students (Yew & Schmidt, 2009), Malaysia secondary students show a lack of self-directed learning process even though they managed to complete their task. Long-term immersion in spoon-feeding environment hinders the students' metacognitive skills and ability to plan, set goals, manage resources, reflect and evaluate their own learning. These have always been conducted by the teacher and students only responsibility is to receive and act according to the teacher's direction. Thus, both groups plunge into the task at hand without proper strategies and stop at completion of the task without reflection and evaluation. Students' weaknesses in self-directed learning should be look upon on. Modeling of self-directed learning strategies by the teacher could help students to better understand and implement the strategies.

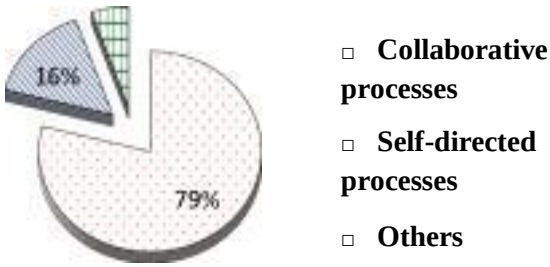

Figure 2 Average percentage coverage of learning processes in collaborative groups

Both collaborative and self-directed learning are important learning processes in PBL, which with repeated practice will promote students' collaborative skills and self-directed learning skills. The results show that these processes accounted for more than 90% of students' verbatim in their group during problem analysis. This implies that the students' interaction focused mainly on the learning task: analyze the problem using FILA-MMS chart. This chart has served its purpose as a tool to aid students in analyzing the problem systematically and keeping students on task.

Collaborative Process

In addition to four collaborative process adapted from Yew and Schmidt (2009), four additional collaborative processes arise from the data of this study: advocating effort, peer teaching, encouragement, and summarizing. Advocating

effort is also a collaborative learning behaviour observed in other studies (Johnson & Johnson, 1996; Nor Fariza Mohd Nor, Afendi Hamat, & Mohamed Amin Embi, 2012). Peer teaching, encouragement, and summarizing are behaviours or activities occurring in collaborative environment, as found in Gillies and Ashman (2003).

Three major collaborative processes occurred in both groups are question and answer (28.56%), coconstruction (17.56%) and sharing of ideas or information (13.35%). Conflict (8.30%) and encouragement (1.17%) could also be observed in both groups. The coefficients of variance show that the percentages of these processes in both groups interaction did not vary much. This implies that question and answer, co-construction, sharing of ideas or information, conflict and encouragement are common and natural learning processes that occur in collaborative groups, even in Malaysia context. On the other hand, summarizing and advocating effort only occurred in group 1 while peer teaching only occurred in group 2.

Instead of summarizing the main points of their discussion, group 1 round up their discussion by taking turns in restating all the points they have previously discussed and written down. This shows a low level of cognitive process and summarizing skill. Yet, restating all the discussion points also play a synchronizing role in collaborative groups. This ensures that members do not miss out any points and all of them have a similar piece of work that represents their group. In comparison with group 2, group 1 at least made an effort to summarize their discussion. Group 2 stops right at task completion and ends with a round of applause for themselves. As a result, students show inconsistency within their groups during classroom discussion (Tan & Mohammad Yusof Arshad, 2013).

Peer teaching in group 2 indicates a difference in the mastering of prior knowledge between the students and the presence of high-ability student in the group. Collaborative environment provides opportunity for high-ability students to give help to their peers, which will further promote their own learning (Gillies & Ashman, 2003).

Example (peer teaching 1)

R: H_3PO_4 plus $CaCO_3$. $CaCO_3$ is calcium carbonate.
R: But you going got to balance the equation.
F: Calcium carbonate
R: CO3 calcium carbonate. Equal together. Ah, you know how to do it.
R: Can you write the equation first? You might (inc.).
F: H3PO4
R: Wait. Leave some space, because you might need to plus the number.
F: H3PO4 plus?
R: Plus $CaCO_3$. Because it reacts with your teeth.
F: wait wait wait. Ah, wait.

Example (peer teaching 2)

S: H3PO4 plus CaCO3, you get Ca3(PO4)2, plus H2O plus CO2 . Okay?

R: Okay.

S: Here got H_3. Here got H_2 only. Your most common multiple is 6. Here times 3, here times 2.
You got $(PO_4)_2$, okay? So PO_4, done. Then/

R: Ca

S: Ah, Ca you got 3. So times 3 here. This one done also. Then you got 3 CO_3. 3 CO_3 means you got 3 C and 9 O.

R: Okay.

S: 9 O right... So here, you need 3 O. Your H/

L: (inc.) one ah?

S: Your H settle already, yes. You need 3 O, here you last 6 O la. Okay. You got 3 C here. If times 3, okay, you got 6 O, balance already la.

Both episodes of peer teaching are related to the construction and balancing of equations, which are topics previously taught in the same academic year. Students peer teach their members step by step by explaining and/or demonstrating on paper. During peer teaching episodes, only few members participate in the verbal interactions while others listen on. On the other hand, advocating effort in group 1 shows the need to encourage members to contribute, which indicates a more similar distribution of knowledge level among members.

Self-Directed Process

In addition to the four self-directed process in Yew and Schimdt (2009), two other processes arise from the data of this study, which are reflection and directing. Patterson and and Crooks (2002) stated that reflection is one of the competencies required to become a self-directed learner. Reflection on the learning process is also an important component of learning (Jossberger, Brand-Gruwel, Boshuizen, & van de Wiel, 2010). De Grave (1996) also included the reflection process at the task level of meta reasoning in his coding system.

Two major self-directed learning processes observed in both groups are monitoring (6.15%) and directing (4.49%). Students are ignorant about learning strategies, such as planning, evaluation of understanding, reflection, and managing information and resources. Students are new to the PBL environment and are not used to direct their own learning, thus the only processes observed are monitoring of time and task progress, and directing or requesting members for action related to PBL process or moving toward task completion.

Even though directions and instructions from the teacher are deemed to be unfavorable in a PBL setting, appropriate directive behaviors in collaborative groups are needed to keep the group on task, and progress toward task completion. Directive verbal interaction such as *"Okay, lets continue*" when the group 2 deviated from task helped the group to get back on track. Another example is when

group 2 was stuck in the conflict on which column to be filled in with the formulae, directing interaction *"Carry out with paper. Tell you what. Carry out with paper. Show me the paper."* directs the group to continue with the task rather than staying stagnant. *"Okay, enough*" are frequently observed in group 1 to indicate that the points discussed for that particular column is enough and they should move on to another part. This kept the group moving and completing the task in the given time.

Students were able to complete their problem analysis using FILA-MMS chart. However, the quality of their collaborative work could be improved with elaborated reasoning (Yew & Schmidt, 2009) and self-directed learning strategies should be learnt and implemented to improve their collaborative work.

CONCLUSION

The occurrence of collaborative and self-directed process in Malaysian PBL classroom and the function of FILA-MMS chart to promote on task behavior support future implementation of such PBL lessons in Malaysia. To enhance collaborative and self-directed learning skills, future PBL teachers are suggested to perform demonstrations and modeling the competencies of these skills. Collaborative and self-directed learning skills do not develop overnight. However, quantity (occurrence) would subsequently being developed into quality (skills) in the long run.

REFERENCES

Abu Hassan Kassim. (2003). Pengajaran-Pembelajaran Kimia Di Sekolah Menengah: Ke Manakah Arah Tujunya? (Teaching and Learning Chemistry in Secondary School: Where Is It Heading?). *Paper presented at the Seminar Memperkasakan Sistem Pendidikan, Puteri Pan Pasific, Johor Bahru, 19-21 October 2003.*

Anuar Zaini, M. Z., Low, W. Y., Wong, Y. L., Fatimah, H., Lim, C. T., & Daniel, E. G. S. (2003). *Factors Associated with Child Growth and School Performance Amongst Primary School Children*. Paper presented at the CEDER Seminar, Asia-Europe Institute, University of Malaya, 24 March 2003.

Barrows, H. S., & Tamblyn, R.M. (1980). *Problem-Based Learning: An Approach to Medical Education.* New York: Springer Publishing Company.

Cheng, W., & Warren, M. (2000). Making a Difference: Using Peers to Assess Individual Students' contributions to a Group Project. *Teaching in Higher Education*, 5(2), 243-255. doi: 10.1080/135625100114885 Cockrell, K. S., Caplow, J.A. H., & Donaldson, J. F. (2000). A Context for Learning: Collaborative Groups in the Problem-Based Learning Environment. *The Review of Higher Education*, 23(3), 347-363. *Educational Psychologist*, 25(1), 3-17. doi: 10.1207/s15326985ep2501_2

Zimmerman, B. J. (2002). Becoming a Self-Regulated Learner: An Overview. *Theory Into Practice*, 41(2), 64-70. doi: 10.1207/s15430421tip4102_2

Evensen, D.H., & Hmelo, C.E. (2000). *Problem-Based Learning: A Research Perspective on Learning Interactions.* Mahwah, New Jersey: Lawrence

Erlbaum Associates.

Faaizah Shahbodin, & Halimah Hj. Badioze Zaman. (2007). *C2HADAM: Hybrid PBL Multimedia and Web Based Courseware for Science*. Paper presented at the International Conference on Science & Mathematics Education (CoSMEd) 2007, SEAMEO RECSAM, Penang, Malaysia, 13-16 November 2007.

Gillies, R. M., & Ashman, A. F. (2003). Cooperative Learning: The Social and Intellectual Outcomes of Learning in Groups. *London and New York: Routledge Farmer.*

Hmelo-Silver, C. (2004). Problem-Based Learning: What and How Do Students Learn? *Educational Psychology Review,* 16(3), 235-266.

Hussain Othman, & Berhannudin M. Salleh. (2009). *First Year Students First Year PBL Experience in a Large Class.* Paper presented at the International PBL Symposium 2009, Republic Polytechnic, Singapore, 10-12 June 2009.

*Johnson, D. W, & Johnson, R. T. (1996). Cooperation and the Use of Technology. In D. Jonassen (Ed.), Handbook of Research for Educational Communications and Technology: A Project of the Association for Educational Communications and Technology***.** *New York: Macmillan.*

Jossberger, H., Brand-Gruwel, S., Boshuizen, H., & van de Wiel, M. (2010). The Challenge of Self-Directed and Self-Regulated Learning in Vocational Education: A Theoretical Analysis and Synthesis of Requirements. *Journal of Vocational Education & Training,* 62(4), 415-440. doi: 10.1080/13636820.2010.523479

Khairiyah Mohd Yusof, Syed Ahmad Helmi Syed Hassan, & Zaidatun Tasir. (2007). *Inducting First Year Engineering Students into Problem-Based Learning.* Paper presented at the International PBL Symposium 2007, Republic Polytechnic, Singapore, 7-9 March 2007.

Knowles, M. S. (1975). *Self-Directed Learning: A Guide for Learners and Teachers*. Toronto, ON: The Adult Education Company.

Lim, T. C. (2007). Hubungan Antara Pendekatan Pengajaran Guru Dengan Pendekatan Pembelajaran Pelajar Mata Pelajaran Kimia Tingkatan Empat (The Relationship Between Teachers′ Instructional Approach and Students' Learning Approach of Form Four Chemistry Subject). *(Master Degree), Universiti Teknologi Malaysia, Johor Bahru, Malaysia.*

Mercer, N. (1996). The Quality of Talk in Children's Collaborative Activity in the Classroom. *Learning and Instruction,* 6(4), 359-377. doi: http://dx.doi.org/10.1016/S0959-4752(96)00021-7

Ng, S. B., & Siow, H. L. (2003). *Creating a Thoughtful Classroom: Teaching Profile of Science Teachers in Malaysia Secondary School*. Paper presented at the International Conference on Science and Mathematics Education, University of Malaya, Kuala Lumpur, 14-16 October 2003.

Nor Fariza Mohd Nor, Afendi Hamat, & Mohamed Amin Embi. (2012). Patterns of Discourse in Online Interaction: Seeking Evidence of the Collaborative Learning Process. *Computer Assisted Language Learning,* 25(3), 237256. doi: 10.1080/09588221.2012.655748

Patterson, C., Crooks, D., & Lunyk-Child, O. (2002). A New Perspective on Competencies for Self-Directed Learning. *Journal of Nursing Education,* 41(1), 25-31.

Roschelle, J., & Teasley, S. D. (1995). The Construction of Shared Knowledge in Collaborative Problem Solving. In C. O'Malley (Ed.), *Computer Supported Collaborative Learning* (pp. 69-97). Berlin: Springer.

Sharifah Maimunah Syed Zin. (2000). *Current Trends and Main Concerns as Regards Science Curriculum Development and Implementation in Selected States in Asia: Malaysia*. Paper presented at the International Workshop on the Reform in the Teaching of Science and Technology at Primary and Secondary Level in Asia: Comparative References to Europe, Beijing, China, 27-31 March 2000.

Tan, O. S. (2003). Problem-Based Learning Innovation: Using Problems to Power Learning in the 21st Century. *Singapore: Thomson Learning.*

Tan, Y. P., & Mohammad Yusof Arshad. (2011). *Problem-Based Learning: Implementation Issues In Malaysia Secondary Schools Science Classroom*. Paper presented at the International Conference on Science & Mathematics Education (CoSMEd) 2011, SEAMEO RECSAM, Penang, Malaysia, 15-17 November 2011.

Tan, Y. P., & Mohammad Yusof Arshad. (2013). *FILA-MMS Chart in Chemistry PBL Lesson: A Case Study of Its Implementation During Problem Analysis*. Paper presented at the International Research Symposium on Problem-Based Learning, Putrajaya, 2-3 July 2013.

Van Boxtel, C., Van der Linden, J., & Kanselaar, G. (2000). Collaborative Learning Tasks and the Elaboration of Conceptual Knowledge. *Learning and Instruction*, 10(4), 311-330. doi: http://dx.doi.org/10.1016/S0959-4752(00)00002-5

Visschers-Pleijers, A. J. S. F., Dolmans, D. H. J. M., de Leng, B. A., Wolfhagen, Ineke H. A. P., & van der Vleuten, Cees P. M. (2006). Analysis of Verbal Interactions in Tutorial Groups: A Process Study. *Medical Education*, 40(2), 129-137. doi: 10.1111/j.1365-2929.2005.02368.x

Visschers-Pleijers, A. J. S. F., Dolmans, D. H.J.M., Wolfhagen, I. H.A.P., & Van Der Vleuten, C. P.M. (2004). Exploration of a Method to Analyze Group Interactions in Problem-Based Learning. *Medical Teacher*, *26*(5), 471-478. doi:10.1080/01421590410001679064

Webb, N. M., & Palincsar, A. S. (1996). Group Processes in the Classroom. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of Educational Psychology* (pp. 841-873). New York: Simon & Schuster Macmillan.

Yew, E. H. J., & Schmidt, H. G. (2009). Evidence for Constructive, Self-Regulatory, and Collaborative Processes in Problem-Based Learning. *Advances in Health Sciences Education*, 14(2), 251-273. doi: 10.1007/s10459-008- 9105-7

Zimmerman, B. J. (1990). Self-Regulated Learning and Academic Achievement: An Overview.

Zimmerman, B. J., & Martinez-Pons, M. (1988). Construct Validation of a Strategy Model of Student Self- Regulated Learning. *Journal of Educational Psychology*, 80(3), 284-2.