The 4th International Research Symposium on Problem-Based Learning (IRSPBL) 2013

# Promoting Deep Learning with PBL

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**Abstract**

The challenge in medical education is to actively involve students in learning especially in a traditional curriculum. This study introduces active learning using the principles of PBL in lectures and tutorials. The use of both task-debrief lecture and PBL were found to promote deep learning especially the latter. Deep learners were more receptive to both changes compared to surface learners who found PBL more effective in influencing their approach to learning. Despite the changes in learning approach, the student performances on case-vignette questions were not improved. The complexity of learning and the way student approaches assessment are indicated.

*Keywords:* Deep learning, PBL, Task-debrief lecture, Assessment

## 1. Introduction

University today is organically link to society and with this comes societal expectations and accountability. The needs of society and the industries have to be at the centre of a university's activities, leadership training, citizenship, competencies and others. All universities aspire for excellence in teaching, scholarship and research. For example, within the Objects of the University of Notre Dame Australia is " the provision of an excellent standard of teaching, scholarship and research". How does one measure excellence in teaching? Examination results? External ranking? Graduate attributes? Employment records?

Excellence in teaching ultimately has to be translated to "excellence in learning". There are several teaching learning models that discuss the factors that influence student learning. From their studies of educational productivity in numerous countries, Fraser, Walberg, Welch and Hattie (1987) conclude that learning is dependent upon three variables – student aptitudes (ability, development and motivation), instructions (quality and quantity of teaching) and the environment (home, classroom and peers). This is not inconsistent with Entwistle and Tait's (1989) "heuristic model" of the teaching-learning process in Higher Education which shows the complexity of the whole environment within which learning occurs (Figure 1) and John Biggs' 3-P model which states that learning outcomes are a result of the interactions of the teaching and learning contexts with the student approaches to learning (Figure 2). According to Biggs (1989), both student and teaching presage factors interact to produce an approach to learning, which produces the desired outcome of deep learning, independent learning, critical thinking and life-long learning. Lizzio, Wilson and Simons (2002) establish direct and indirect effects of good teaching on three educational outcomes (GPA, satisfaction and self reported development of problem solving and collaboration) by testing the relationship between student's chosen learning strategy and their perceptions of good teaching practices. These graduate attributes (eg. problem solving, teamwork, deep learning and critical thinking) align well with the current needs of the Biomedical Science industries, requiring students to be Biomedical Scientists rather than technologists.

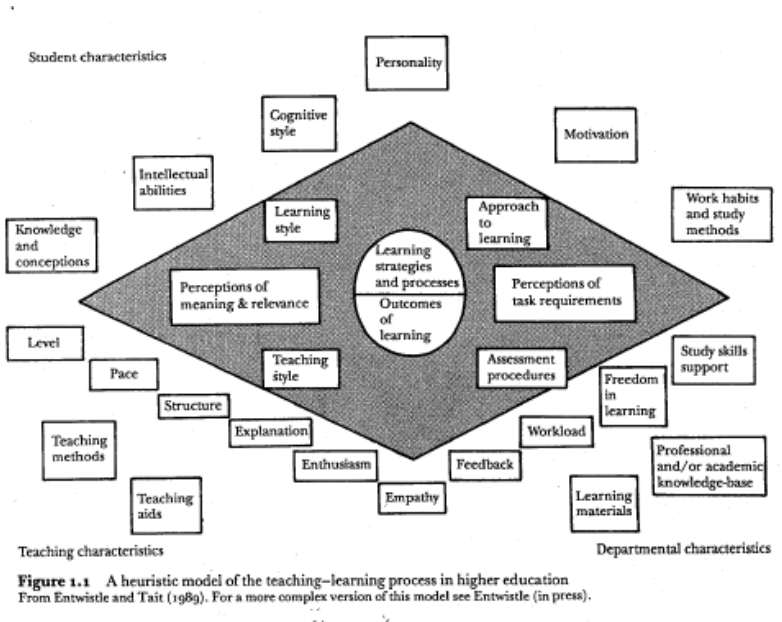


**Figure 1.1** A heuristic model of the teaching–learning process in higher education
From Entwistle and Tait (1989). For a more complex version of this model see Entwistle (in press).

Figure 1. The heuristic model of the teaching-learning process (Entwistle and Tait, 1989). This model identifies the framework and the complexity of factors including teaching and departmental characteristics influencing student learning outcomes.

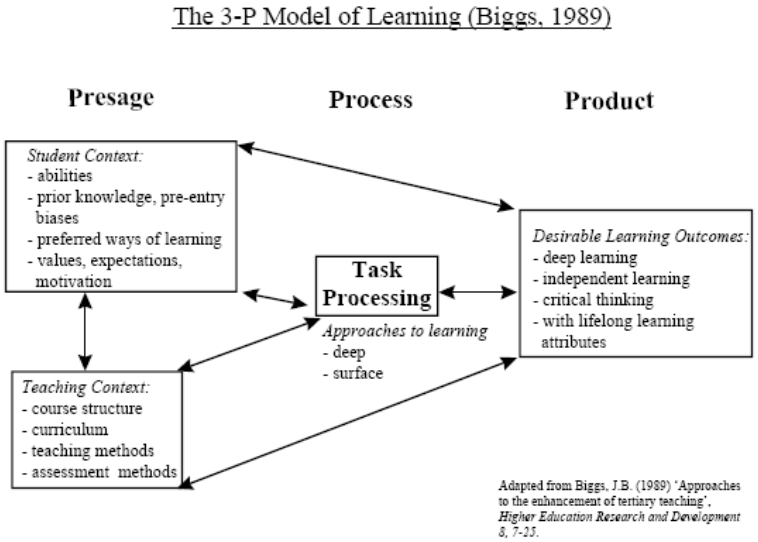


Figure 2. The 3P model of teaching and learning (Biggs, 1989) which shows the interactions of student approaches to learning with the teaching and learning contexts to produce the learning outcomes.

Based on these educational models, Universities must provide the contexts that promote deep approaches to learning and discourage surface learning if they aspire to achieve excellence in teaching and learning and produce graduates that meet the demands and challenges of the changing society and the industries.

## 2. Context of Research and the Research Questions

The Bachelor of Biomedical Science at the University of Notre Dame Australia is a 3-year undergraduate program. A successful completion of 24 units is required for the award of the degree. The standard mode of instruction for each unit is a 2-hour lecture followed by a 2-hour tutorial or practical session. This is practically a traditional curriculum as per mode of delivery, lectures followed by tutorials. Biomedical Science is a rapidly advancing field, especially in areas of genetics and molecular biology. The human body by itself is already complex. Often, the teaching faculties are overwhelmed by the vast amount of information and their expert knowledge and "the best approach" is to deliver them didactically through lectures. This mass "transfer of information" invariably creates rote learning and surface learners. Tutorials and practicals are more interactive (questions and answers session, test practice and hands-on activities) but albeit, insufficient to promote deep learning.

The distinction between deep and surface learning is in the depth of involvement, commitment, interaction and application. Entwistle (1990), as cited in Raaheim et.al. (1991), categorises three approaches to learning – deep, surface and strategic. Essentially, a deep approach is characterised by active engagement with the subject matter, seeking real meaning and interests. Deep learners have the ability to represent problems, integrate information, generate inferences and are problem solvers. A surface approach is characterised by memorisation of information, reproduction of facts, syllabus bound and often a lack of interest. Surface learners lack the domain-specific knowledge, fail to self-question and they spend minimum time on problem solving. A strategic approach is characterised by a student who tend to excel in assessed work with focus on effective organisation, time management and self-regulation in study (Table 1). These three approaches are of course abstractions and students may manifest a combination of these approaches to learning. What teaching strategies can be implemented to promote deep learning among students? This is the key issue and is the fundamental question of this research project.

Table 1. Categories of approaches to learning

| | |
|---|---|
| **Deep approach** | Intention to understand<br>Vigorous interaction with content<br>Relating new ideas to previous knowledge<br>Relating concepts to everyday experience<br>Relating evidence to conclusions<br>Examining the logic of the argument |
| **Surface approach** | Intention to complete task requirements<br>Treating task as an external imposition<br>Unreflectiveness about purpose or strategies<br>Focus on discrete elements without integration<br>Failure to distinguish principles from examples |

| | |
|---|---|
| | Memorizing information needed for assessments |
| **Strategic approach** | Intention to obtain highest possible grades<br>Gear work to perceived preferences of teacher<br>Awareness of marking schemes and criteria<br>Systematic use of previous papers in revision<br>Organizing time and effort to greatest effect<br>Ensuring right conditions and materials for study |

The importance of deep learning to the overall development of graduates cannot be overemphasised as they relate to leadership and competencies. The 3P model as well as the heuristic model of teaching and learning identifies several variables in the process of learning, amongst them, prior knowledge, ways of learning, motivation, teaching methods and assessments. The role of each of these variables varies. This study looks at some of these variables in relation to the fundamental question "can changes in the teaching strategies influence the learning approaches adopted by Biomedical Science students ?" Answers to this question will be used to improve teaching practice.

The participations of this project are year 3 Biomedical Science students enrolled in the unit of Reproductive Biology. The limitation of this study is in the class size (30), which unfortunately is insufficient for conclusive statistical analysis as per empirical research. Nevertheless this study attempts to contribute to the research in teaching-learning activities by investigating the following research questions.

1. What proportion of the students utilise a deep approach to learning?
2. Is there a relationship between student demographic profile and the approach to learning?
3. How effective are the changes made to the teaching strategies in promoting deep learning?
4. Is student's prior approach to learning a factor in the outcomes of the changes made?
5. Is there an improvement in the student assessment results?

## 3. An Overview of the Methodology

### *3.1. Changes to the teaching strategies*

#### *3.1.1. Lectures*

The normal lectures were replaced by task-activities and a debriefing session (task-debrief lecture) for 4 consecutive teaching weeks. This effectively changed the delivery, from teacher-centred to "partial" student-centred learning. Activities included in the revised format were:

1. Identification of Prior Knowledge. Students were given a list of major topics of the lecture and asked to write down what they know.
2. Knowledge Construction. After they have identified their prior knowledge, students, in groups of 3 or 4, were asked to construct what they can learn from the resources given (diagrams, models) and identify areas that they want to learn or need to find out (learning issues).
3. Students then present what they have learned from Knowledge Construction and identify any learning issues that need to be addressed.
4. Debriefing. The lecturer then "completes" the lecture by building on what the students have constructed, "filling in the gaps" and discuss the learning issues with reference to different clinical contexts.

#### *3.1.2. Tutorials*

The normal tutorial comprises activities at different stations (gross anatomy, virtual microscopy and self-assessment). This was replaced by case-based problem-based learning (PBL) where students "brain-storm" a clinical trigger to identify the learning issues. The clinical trigger (eg. a lady with heavy menstrual bleeding) represents "the problem" the students need to solve while learning the basic sciences of Reproductive Biology. They then research the learning issues and report to the group to finally "put the cases together". This was done in a group of 10 students, for a period of 4 teaching weeks.

#### *3.1.3. Assessment*

There are two assessments in this unit, an in-course assessment and an end-of-semester assessment, each comprising multiple choice questions (MCQs) and short answer questions (SAQs). The in-course assessment was changed to align with the changes made to the lectures and tutorials. Case-vignette questions were introduced in the MCQs and SAQs which previously comprised

mainly of direct-questions. Questions were asked based on "case scenario" in these questions, as a way of examining and integrating key concepts ( higher level thinking skills) and thus were better questions for detecting deep approaches to learning than direct (recall)-questions.

### *3. 2. EVALUATION*

#### *3.2.1. Situational Analysis*

Students were asked to indicate their agreement or disagreement to a series of statements that relate to their approach to learning (surface or deep) from which a 5 point Likert scale was scored (from 1 = strongly disagree to 5 = strongly agree). The statements were derived from the categories of "approaches to learning" by Entwistle (1990). Demographic profiles of the students were also obtained.

#### *3.2.2. Changes to teaching strategies*

The effectiveness of the changes to the teaching strategies was evaluated by a questionnaire survey and an assessment. Students were asked to evaluate their experiences of the changes made to the lectures and tutorials, using the same Likert scale and any additional comments. The statements were specifically designed to evaluate how the changed teaching strategies may have affected the student's approach to deep learning. An item analysis was performed to compare performances of direct questions with case vignette questions in the in-course assessment.

## 4. Results and Reflection

### *4.1. Research Question 1 and 2*

1. What proportion of the students utilise a deep approach to learning?
2. Is there a relationship between student demographic profile and the approach to learning?

The questionnaire addressing question 1 contained 10 statements. Four statements related to surface learning and 6 to deep learning. A total score of 16 and above must be obtained from the 4 surface learning statements for a student to be categorised as a surface learner and 24 and above from the deep learning statements to be a deep learner. These scores corresponded to the Likert scale of "in agreement with the statement".

Based on the above criteria, 11/30 students were surface learners and 13/30 deep learners. Six students were non-classified as they had not met the total score for either surface or deep learning and no students were classified as both surface and deep learners. The different approaches to learning did not appear to relate to either the gender, student origin, age (school leavers or mature-age) or employment status (Table 2). Mature-age students are students who have left schools for at least a year prior to enrolment at the University.

Table 2. Demographic profiles of surface and deep learners (numbers indicate the number of students).

| | Male | Female | School leavers | Mature-age* |
|---|---|---|---|---|
| Surface Learner | 5 | 6 | 9 | 2 |
| Deep Learner | 6 | 7 | 9 | 4 |
| Neither | 3 | 3 | 4 | 2 |
| TOTAL | 14 | 16 | 22 | 8 |

* *students who have left schools for at least one year*

| | Local | International | Work | No employment |
|---|---|---|---|---|
| Surface Learner | 8 | 3 | 9 | 2 |
| Deep Learner | 9 | 4 | 10 | 3 |
| Neither | 4 | 2 | 5 | 1 |
| TOTAL | 21 | 9 | 24 | 6 |

### *4.1.2. REFLECTION*

The total score used to identify the different approaches to learning is arbitrary but given the small number of questions, it is felt that the responses must at least be "in agreement with the statement". Entwistle (1990) categorised three approaches to

learning – deep, surface and strategic and only two were used in this study. There seems to be an equal number of deep and surface learners in the student cohort. Six students were neither deep nor surface learners and none utilised both surface and deep learning. On reflection, there could be more statements to discriminate between deep and surface learners. This may account for the 6 students who were neither deep nor surface learners. They could also be strategic learners but unfortunately this group of students are not identified in the questionnaire during Situational Analysis and warrants further study.

While there appears to be no distinct relationship between the different learning approaches and the demographic profiles, this must be interpreted cautiously given the number of students (30) in this study. Biggs (1987; 1993) for instance, argued that the extent to which students have gained life experience, their prior academic ability and general intelligence may influence their learning approaches. In particular, as students get older their tendency to adopt a deep approach increases whereas their surface approach decreases and students with lower intelligence are more likely to adopt a surface approach. Again, rote study (memorisation) has been the norm in several educational systems such as the Chinese education, and students growing up in that system will invariably inherit surface learning. Even the current Western Australian school system, where progression depends on satisfying the requirements of the local Examination or School Board, does not appear to promote deep learning.

*4.2. Research Question 3*

3. How effective are the changes made to the teaching strategies in promoting deep learning?

Both changed teaching strategies (to lectures and tutorials) appear to have some influence on the students' approach to learning. Students felt that the introduction of activities prior to lecture debriefing promote their attention, listening, motivation, reflective thinking, use of prior knowledge, meaning to the lectures and problem-solving (mean score of 3.5 and above) but not in areas of discovery, understanding, fun or communication (Figure 3). Problem-based learning however received more "in agreement" responses and appears to be a better strategy in promoting deep learning. All areas were promoted - attention, listening, motivation, reflective thinking, discovery, understanding, prior knowledge, meaning to the lectures, fun, communication and problem-solving (mean score of 3.5 and above) (Figure 4).

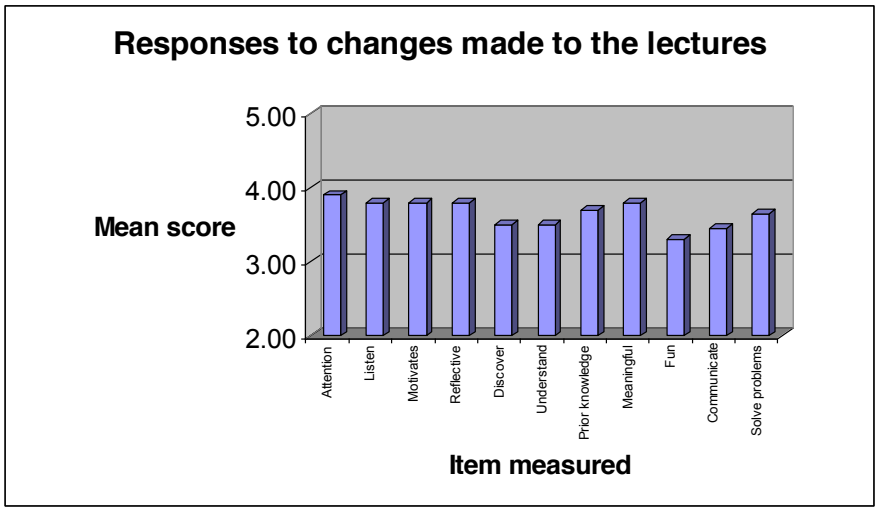


Figure 3. Students' responses to changes made to the lectures. The y-axis corresponds to the Likert scale of 2 = Disagree 3 = Not sure 4 = Agree 5 = Strongly agree. Number of respondents = 30.

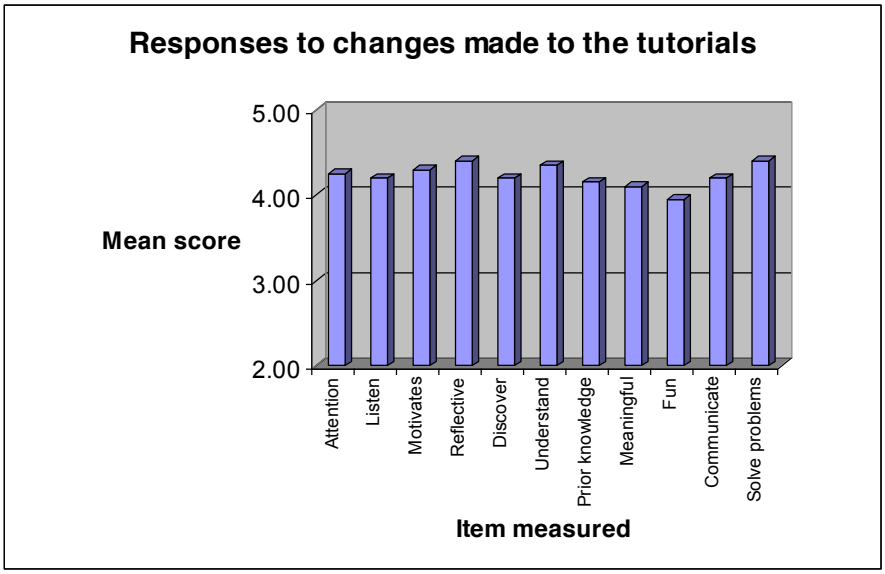


Figure 4. Students' responses to changes made to the lectures. The y-axis corresponds to the Likert scale of 2 = Disagree 3 = Not sure 4 = Agree 5 = Strongly agree. Number of respondents = 30.

*4.2.1. Reflection*

The statements in the survey addressing question 3 were all related to deep learning (eg. "they motivate me to listen & understand", "they make me think & relate to previous experience" and "I learn to solve problems"). They were intentionally designed to answer the question "can changes made to the teaching methods promote deep learning among students?"

It appears that both changes made to delivery have influenced the students' approach to learning and towards deep learning. This is a positive sign and suggestive of an effective intervention. What is interesting is the impact of the changes made. PBL has a greater influence than the task-debrief lectures in promoting deep approach to learning (Figure 5). This is not surprising, giving the fact that PBL is more student-orientated. While there appears to be an apparent change in the students' approach to learning in tutorials and lectures, this does not necessarily imply that the students' learning characteristics have changed. The translation of the perceived changes to a longer term effect may require a longer term intervention and reinforcements.

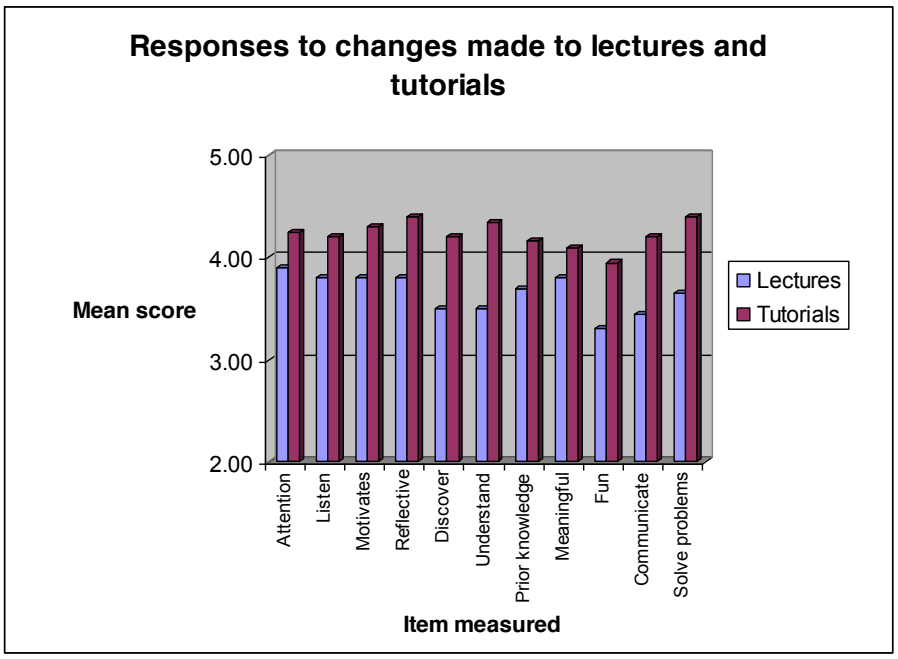


Figure 5. Students' responses to changes made to the lectures and tutorials. The y-axis corresponds to the Likert scale of 2 = Disagree 3 = Not sure 4 = Agree 5 = Strongly agree. Number of respondents = 30.

The greater impact of PBL is probably related to the nature and the clinical context of the activities. Bonanno et al. (1998) found that changes made to the learning environment which included the use of group problem solving exercises (like the present PBL), group presentations and group assignments resulted in students increasing their deep learning approach. Meanwhile, Ball

(1995) on the other hand found that applying problem based learning strategies and real life exercises can promote deep learning approaches among students.

### *4.3. Research Question 4*

4. Is student's prior approach to learning a factor in the outcomes of the changes made?

This is more difficult to determine given the number of students (11 surface learners and13 deep learners). It appears however that surface learners are more influenced by PBL while deep learners are influenced by both task-debrief approach to lectures (prior-knowledge and knowledge construct) and PBL, with PBL being slightly more effective in promoting deep learning. The rest of the students (non-categorised) were mainly influenced by PBL (Table 3).

Table 3. Prior learning approach and impact of changed teaching strategies.

| | No. of students |
|---|---|
| SURFACE LEARNERS | 11 |
| Task-debrief lecture promotes deep learning | 3 |
| PBL promotes deep learning | 8 |
| | |
| DEEP LEARNERS | 13 |
| Task-debrief lecture promotes deep learning | 5 |
| PBL promotes deep learning | 8 |
| | |
| Non-classified | 6 |
| Task-debrief lecture promotes deep learning | 1 |
| PBL promotes deep learning | 5 |

#### *4.3.1. REFLECTION*

While deep and surface approaches characterise the way students engage with a task, they do not describe how the students develop the respective approach to learning. The latter is more difficult to address. Biggs (1989) developed the presage, process and product model that describes the process of student learning (ie. the 3P Model of Student Learning). Multiple factors interact to produce the learning outcome. Also students may use both deep and superficial learning to complete a task and to obtain the best outcome.

The results obtained in this research while preliminary support the influence of prior learning approach in developing the process of deep learning. As stated, multiple factors are invariably involved in the way students approach learning.

### *4.4. Research Question 5*

5. Is there an improvement in the student assessment results?

Based on item analysis of all the questions (MCQs and SAQs) in the in-course assessment, the total percentage scores obtained for the SAQ direct-questions were significantly higher than case-vignette questions but not in the MCQs (figure 6). The total percentage score for the SAQ direct-questions (5) is 65.22 % and the case-vignette questions (5) 35.78 %. In the MCQs, the percentage scores for the direct-questions (5) is 72.98 % and the case-vignette questions (35) 67.27 %.

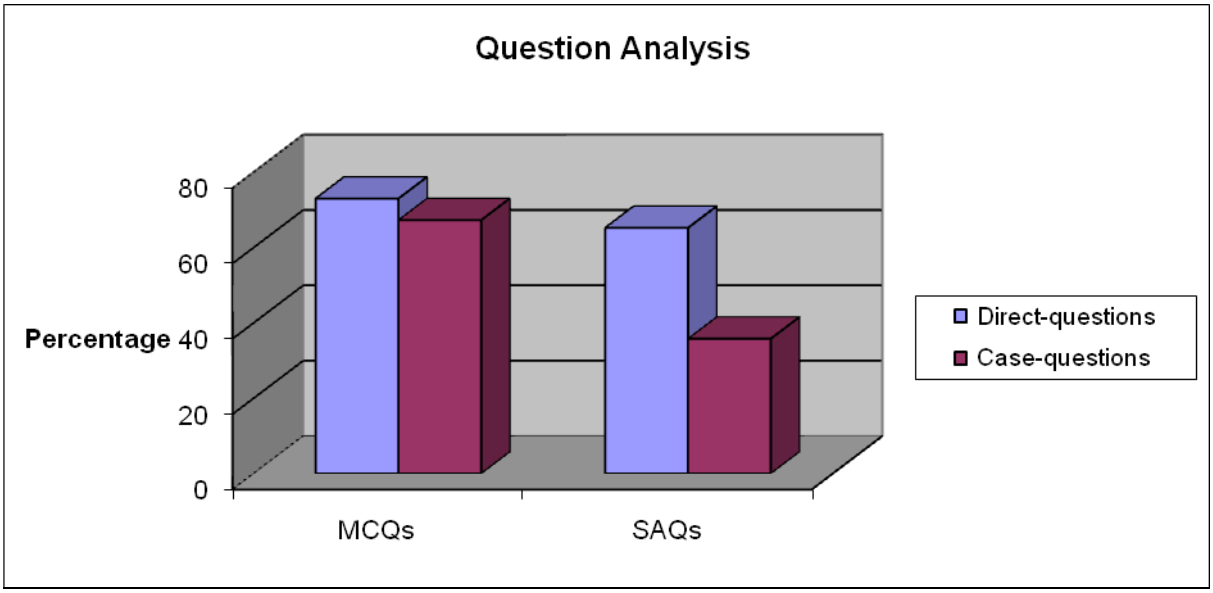

Figure 6. Total percentage mean score for MCQs and SAQs : direct-questions and case-vignette questions

*4.4.1. Reflection*

In previous year's in-course assessment, students tended to perform better in direct-questions than case-vignettes. The present results are consistent with this and do not show a change in the performances of the students despite the introduction of active learning in the delivery of the unit. The lower score of case-vignette question is typical of the previous year's delivery and this is more apparent in the SAQs. MCQ is an objective assessment and may not evaluate comprehension as well as SAQ.

Does this mean that the changed teaching strategies have not succeeded in promoting deep approaches to learning or that assessment is a separate entity altogether from learning approaches? Unfortunately, this cannot be answered at this stage, as it is not possible to separate the results of the deep and superficial learners as the questionnaire survey was completed anonymously. The relationship between deep learning and performances at examination is still unclear, although there is evidence suggesting that "the use of deep and strategic learning styles in the final year of medical school predicts better performance in the final examination, but the same measures at the time of selection for admission to medical school do not predict examination performance" (McManus et al, 1998)

## 5. Overall discussion

The results of the present study suggest that student participation in the teaching learning activities is essential in promoting deep learning. This has long been recognised (Entwistle, 2000) and is the reason for the current paradigm shift from teacher-centred to student-centred learning. The student presage (approaches to learning) and the learning environment are important contributing factors, as stated in Bigg's 3 P model of Learning. There are indications from the results of the present study to show that student's approach to learning influence the way they respond to changes made to the mode of lectures and tutorials. A strategy that is more contextual and student-directed (such as PBL) is more effective in promoting deep approaches to learning, even to surface learners. What was observed with PBL was the initial enthusiasm shown by the students as they read the clinical triggers and this somehow was lacking with the changes made to the lectures. Asking the students to search their prior knowledge and later construct knowledge appears like a chore to some students. On reflection, any changes made must be "interacting, interesting and trigger enquiries" to initiate deep learning. It was also observed that all students participated in the PBL discussion, away from the lecturer who now functions as a facilitator and is not a dominant figure. The dominance of lecturer still exists in the lecture despite the changes made. Interestingly, there are few deep learners who do not respond to the changed teaching strategies in lectures. The way students view the teaching learning activities may be an important factor. Deep learners for instance may not want to engage as deep learners if they view the lectures as "information gathering" for examinations.

Whether or not the changes obtained in the present study can be translated to long term effect is uncertain. This may be difficult as students' approaches to learning are often developed and perfected over a long period of time at school. Students often continue their mode of learning even when they enter Universities. Learning mode at school may be regarded as a model by students of successful learning at university as their academic performances have been proven by school examination and the Curriculum Council. Established habits of learning do not dissipate overnight when transit from one institution to another. Is there a tendency for students to become surface learners as they progress through their University studies?

These reservations pose a greater challenge for Universities to provide the context that promotes deep learning and cultivate students' analytical and conceptual thinking skills. Deep learning is important in the development of both cognitive (mastery of concept, applications, etc) and non-cognitive (critical thinking, metacognition, etc) effects of higher education. The promotion of

deep learning is thus important and is an agenda for all Universities, not just to promote teaching excellence but also to align with the current industry needs. This above study illustrates an example of how this is being done in the lectures and tutorial sessions. The outcomes of these two teaching interventions in promoting the graduate attributes (problem-solving, reflective thinkers, etc) are congruent with the demands of the present Biomedical Science industries.

**Acknowledgement**

The author acknowledges Mr Shaun H.P. Tan, Bachelor of Commerce, for the data analysis.

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