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Promoting Active Learning in Universiti Teknologi Malaysia: A Bottom-up, Top-down Approach

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Abstract **-** Being a leading technological higher education institute in the country, Universiti Teknologi Malaysia (UTM) is aggressively encouraging teaching staff to enhance teaching and learning to produce graduates who are relevant in today's highly competitive world. To achieve this goal, grassroots awareness and training campaign, followed by encouragements are rigorously made.

Active learning techniques, especially the Cooperative Learning (CL) and Problem Based Learning (PBL) are currently being promoted across all disciplines as well as levels of studies. This effort which was initiated by a group of enthusiastic teaching staff received a welcome endorsement from the highest level of university administrative key personnel. A special task force called CL-PBL Support Group was then set up to facilitate the promotion of CL and PBL practices across the board. At implementation level, faculty-based core groups were set up and trained to acquire and apply the necessary knowledge and teaching skills pertaining to these active learning approaches.

This paper describes strategies and efforts to convince and encourage the implementation of active learning techniques among teaching staff and administrators, especially those in the engineering and engineering-related faculties. Training and support provided to academic staff are also discussed. Finally, factors that influence the success of university-wide implementation will be included.

Keywords: Active learning; Cooperative learning, Problem-based learning, Engineering education

1. Introduction

Universiti Teknologi Malaysia (UTM) is the nation's foremost contributor of engineering graduates. Being a technology-based public university, the university's mission is to provide quality education for the masses, in line with the vision of the country. UTM is neither elitist, nor egalitarian. There are varieties of students from different academic and social backgrounds who meet the academic requirements pursuing engineering degrees and diplomas. Given a myriad of students entering the university, UTM is committed to provide quality education for all at the future technical manpower and leaders of Malaysia.

Since the 1990s, there have been a major movement to emphasise excellence in teaching at the undergraduate level in universities throughout the world. The concern to increase the quality of undergraduate education was aptly raised by the Boyer Commission in the United States in 1990s [1,2] and the Dearing Committee Report in the United Kingdom in 1997. Boyer [1] stated that:

> *"... what we have in many campuses today is a crisis of purpose. Far too many colleges and universities are being driven not by self-defined objectives but by the external imperatives of prestige. Even institutions that enrol primarily undergraduates – and have few if any resources for research – seek to imitate ranking research centres. In the process, their mission becomes blurred, standards of research are compromised, and the quality of teaching and learning is disturbingly diminished."*

In UTM, there are efforts to acknowledge the importance of teaching as much as research. To produce quality graduates, UTM had recently come up with attributes to reflect its graduates. UTM graduates shall have sound disciplinary and professional knowledge, high self-esteem and effective skills in communication, team-working, problem solving and lifelong learning. To achieve this ambitious goal, the university is aggressively encouraging active learning techniques, especially as cooperative learning and problem-based

learning, to enhance teaching and learning as well as generic skills of the graduates.

2. Active Learning

2.1 What is Active Learning?

Active learning is a class teaching and learning techniques that involves students in learning activities other than passively listening to lectures. The activities include speaking, discussing, reading, higher-level thinking, reflecting, etc.

Active learning has been shown to enhance learning [3, 4]; this is hardly surprising because learning is a naturally active process. Students from diverse learning styles can adapt to active learning because it gives the responsibility of organising what is to be learned in the hands of the learners. Active learning can be applied not only in small classes, but also in very large lecture halls with hundreds of students.

There are many subsets of active learning techniques. Cooperative learning and problem-based learning, in particular, are widely used in higher education.

2.2. Cooperative Learning

Cooperative learning (CL) is an active learning technique that involves the collaboration and interaction of students in teams under the following conditions [5]:

- Positive interdependence between team members to accomplish a task
- Individual accountability in completing their share of the work and mastering all material
- Face-to face interaction in at least part of the task
- Appropriate use of interpersonal skills, like communication, leadership and conflict management.
- Regular self-assessment of group functioning to identify any improvements that need to be made and maintain those that functioning well.

Other than enhance learning, CL induces generic skills, such as communication, interaction and interpersonal skills, teamwork and leadership skills, self-confidence and self-esteem, and higher-level thinking skills.

Cooperative learning can be applied to a class size of less than 100 students. It may be more difficult to monitor group functioning with very large classes, especially in undergraduate classes where the level of student maturity is still quite low. Since team activities are also carried out in class, a lecture-theatre setting is unsuitable. Instead, a classroom with flexible seating arrangement is needed.

2.3 Problem-based Learning

Problem-based learning (PBL) is a subset of cooperative learning. In PBL, a realistic problem is the starting point of learning, which engaged the learner to find a solution [6, 7]. Students collaborate in small teams to identify, find and construct knowledge on new concepts that they need to learn in order to solve the problem. PBL in the classroom in not only about giving and solving problems, but it is also "about creating opportunities for students to construct knowledge through effective interactions and collaborative inquiry" [8]. As such, it is not surprising that PBL is ranked on the highest end of student-centred techniques.

The benefits of PBL are numerous. In addition to the benefits of CL, PBL also develops and enhance thinking and problem solving skills, information mining skill, and self-directed and lifelong learning skills.

PBL is characterised by the following features [7,8]:

- A realistic problem, which captures the students' interest, is the starting point of learning
- The problem challenges students' existing knowledge, attitudes and competencies, leading them to identify new knowledge (or learning issues) needed, and shortcomings that have to be corrected.
- The responsibility and direction of learning is assumed by the students; faculty members are only there to facilitate students' thinking, learning and group functioning to help them resolve the problem.
- Information mining from various sources, and utilization of evaluation to analyse what is really useful.
- The process of identifying learning issues and problem-solving is as important as acquiring new knowledge to arrive at the solution.
- Students learn in cooperative teams, where they need to interact and communicate to share knowledge, discuss their understanding and debate conflicting opinions.
- Synthesis of various knowledge and information to arrive at the solution.
- Reflection of the students' learning experience.

Undoubtedly, PBL requires the most radical change in mindset and implementation. However, the fact that it can develop and equip students with all the

attributes desired by the university and the board of engineers requires serious thought and commitment by the university to encourage and promote its implementation.

3. Important Factors

To ensure the success in making the reform, several important factors must be considered and addressed. Some of them are discussed below.

Administrators. Administrative support, both at the university level and the faculty level is crucial in promoting and sustaining the reform in teaching. Support from the university level can be in various forms, such as providing budget and funding for training and research, as well as promoting awareness among, and even enforcing, faculty administrators to provide support for lecturers who are implementing CL or PBL [6].

Lecturers. Lecturers will be reluctant to change from well-accepted practice to techniques that they are unsure of in terms of practicality and efficacy. Most dislike moving away from their comfort zones. There is also fear of backlash from students, which will result in poor teaching evaluations. A possible increase in workload, especially with PBL, is also a turn-off, especially since the current promotion exercise does not take efforts to improve teaching into account. Many will start to wonder about WIIFM – "what's in it for me?" Nevertheless, there are many lecturers who care, and are frustrated at the dichotomy in what they teach and what students actually learn. They are the ones who usually have the determination to work hard at improving their teaching.

Students. Students will also be reluctant to move away from their comfort zone. The highest resistance will normally be from those who have negative attitude, or are highly examination orientated. Students who resist active learning will just not participate or do what they are asked to do. In CL, students may resist working in teams. In PBL, resistance will be highest at the initial stage when students are asked to solve problems without lectures being given first. Their dissatisfaction may result in complaints that go to the faculty, or even university administrators. The administrators should not listen to one-sided accounts, but instead facilitate discussion with all parties present to clear-up matters.

Infrastructure. Proper infrastructure for student-centred, team-based techniques must be provided. Most classrooms have poor layout, with fixed chairs, or chairs that are welded together. This makes it difficult for students to work in teams during the class. There are also insufficient places for discussions, especially those with computers and internet access. For PBL, ideally, there should be one flipchart for each group in the classroom for better facilitation.

Class size. The number of students in a class should not be more than 60 for CL and PBL. Although it is still possible to conduct CL with less than 100 students, the facilitation will not be efficient with only one lecturer.

Knowledge and time. Dissemination of knowledge and training on active learning techniques is essential. Evidence of practicality and efficacy is also needed to convince lecturers. A suitable time frame must be given for the change to take place – no change can take place instantaneously. Those who have undergone training need to prepare and try the technique on students during the semester. Refinements need to be made before they can be confident of spreading the message to others. All these of course need time, patience and commitment.

Assessment. The current mindset in society towards education is highly examination orientated. This is deeply ingrained in learners and educators from pre-school right up to institutions of higher learning. The fact is, employers are actually more concerned with generic skills than grades. In a recent survey, employers ranked a grade point average of 3.0 or better at number 17 out of 20 in importance compared to other generic skills and values, with communication skill at number 1 [9]. Assessment of generic skills must be made on a continuous basis, rather than through examinations. If educators are serious about the importance of generic skills and personal development, then the assessment method must be changed from the over-emphasis in examinations. As such, professional and accrediting bodies should not impose regulations in fixing a high percentage of course evaluations on final examinations, which is currently practiced.

Keeping these factors in mind, a suitable model of implementation is designed to ensure a successful reform in teaching and learning in UTM.

3. Model of Implementation

3.1 Overview

A bottom-up, top-down approach is taken to promote CL and PBL. A gradual, non-drastic approach is taken to raise awareness and educate lecturers and students on the

techniques. This natural progression is essential in winning the hearts and minds, and thus the support of the academic community.

The bottom-up model consists of student-centred lecturers who form a central committee, called the CL-PBL taskforce or support group, to facilitate the promotion of CL and PBL to all levels of the academic community in UTM. At the faculty level, faculty representatives form a core-group to give closer guidance and/or mentoring. The taskforce and core group members were given training workshops by outside experts; they were then expected to plant the initial seeds of change. Task force members also went for visits to observe PBL in action in institutions of higher learning in Kuala Lumpur and Singapore. Implementations of CL and PBL by the task force and core-group were gathered and documented for evidence and information-sharing.

In the top-down execution, the deputy vice chancellor for academic affairs and the Teaching and Learning Unit of UTM plays an active role in promoting CL and PBL to the executive level of the university, the deans, deputy deans, head of departments and lecturers. The deans of all faculties are being reminded from time to time to ensure variations in teaching techniques used in the courses offered. Funding was made available to support training and visits for CL and PBL. A RM20,000 grant has been made available to develop training packages for CL and PBL. The deputy VC for academic affairs has also promised that lecturers in the initial implementation stage of CL and PBL will not be penalised for low student evaluations. Rewards and incentives are also being worked out for innovations and excellence in teaching, though there has been nothing concrete yet.

There are efforts to involve stakeholders, especially the industries. From dialogues and discussions, it is hoped that corporate bodies can assist by giving funding in terms of awards and grants, or at least assist in giving data and problems for PBL.

3.2 Short Term Plans

The short term plan covers a period of one to two years. This is difficult and uncertain period where the taskforce and core-group are moving against the tide to plant the initial seeds of change – the major tasks at this stage will be to introduce, convince and train.

The four series of workshops held on PBL had been sufficient for the central and faculty core-groups to implement CL and PBL, although there will be more training in the near future. Meetings are held to update and share information and ideas as pioneers in the university. A review is also conducted to ensure that only those who are interested to implement and promote CL and PBL are in the central and faculty core-group. If necessary, the support group may be enlarged to include others who are interested.

Educating administrators, lecturers and students on CL and PBL will be the major focus. Road shows on CL and PBL are held at all faculties to create awareness on the need for change in the teaching and learning techniques, and what is active learning, CL and PBL. Evidence of implementations and outcomes in the form of students' performance and response were also shared during the road shows. Other than road shows, technical papers and articles are written to disseminate information on the techniques and implementations.

Support at various levels must be made available. A portal is currently being planned to provide ready references, forms, and a forum for lecturers interested in CL and PBL. The task force and faculty core-groups are also available for support. Training on CL and PBL must also be conducted on a regular basis at the university and faculty level. Co-teaching and/or mentoring with experienced lecturers are encouraged. A crucial support from the faculty is to allow lecturers implementing CL and PBL to choose the suitable subject, time slot and classroom. To ease the burden of lecturers in terms of the increased workload, especially in the initial stages of implementation, student tutors or teaching assistants should be assigned to them.

No matter how necessary any reform may be, sufficient incentive must be given to provide motivation for the effort. Various forms of incentives can be given, which includes salary, promotions, merit in performance evaluation, release time, professional development opportunities, awards, grants and other material support, such as laptop computers for developing teaching material. Rewards and incentives do not have to be limited to the university, but also from government, professional bodies and industries.

3.3 Medium Term Plans

In the medium term, most lecturers will have received training and are comfortable with active-learning techniques, especially CL and PBL. Students will also be familiar and are able to receive the benefits of the techniques.

A regional reference centre on active learning, with emphasis on CL and PBL, will be set up, especially for engineering and technical courses. With input from the support group and interested lecturers, a UTM-style framework for PBL will be established by the centre. Other than providing support for UTM students and

lecturers, support services will also be given to other institutions in the region.

At the faculty level, a framework of PBL implementation will be established. The aim of the university is to have 10% of the total contact hours experienced by students to use PBL. Proper planning must be made so that students are not over-loaded in a semester. A maximum of two subjects using PBL per semester for a student should be imposed.

At this stage, the possibility of infusing PBL in curriculum design will be investigated for certain courses. Relevant subjects will be integrated to be covered using PBL. This will breakdown compartmentalisation and overlapping of subjects and encourages a multi-disciplinary approach.

3.4 Long Term Plans

Long term plans will mostly evolve around sustaining the reform in teaching and learning. Activities at the faculty level will be monitored to keep up with the changing needs of lecturers, especially in training and development. The incentives for those involved must also be maintained.

At this level, the awareness campaign will not be limited to institutions of higher learning. Documentation on active learning, especially PBL, will be made to the public. Books, brochures and articles for newspapers and magazines will be written to enhance education in the nation.

Research and innovation to improve engineering education will be on-going. A possible area that can be explored is the innovation and development of engineering curriculum with PBL.

All the activities will be monitored and coordinated by the active learning centre. It is hoped that the centre can bring about excellence in engineering education throughout the region.

4. Discussion

The move to promote the implementation of CL and PBL is still at the initial stage. The CL-PBL taskforce is currently at the half-way point of the short term plan. Thus far, the core groups in several faculties, such as the Chemical and Natural Resources Engineering Faculty, the Mechanical Engineering Faculty, the Electrical Engineering Faculty, the Diploma Learning Centre and several other non-engineering faculties have applied CL and PBL in several classes. While there are room for improvements in the implementations, there have been many benefits and positive changes in students observed by lecturers. Students are mostly supportive and appreciative of the move to implement CL and PBL, and have reported a significant increase in generic skills [10].

On the lecturers' side, many in the original core-group were initially reluctant to implant the change in teaching technique, especially PBL, due to many uncertainties. However, after some initial evidence of implementation presented by the taskforce, more have tried, and many more have made commitments to implement PBL in the 2004/05-2 semester.

The awareness campaign to all lecturers is currently on-going. Road-shows are conducted at the request of faculties, and the concept of CL and PBL are introduced at numerous training, even the required ones under SSM, for lecturers. From the road-shows, the taskforce had received feedback from lecturers that some of them have actually started implementing active learning and CL techniques in their classes. Experience obtained from giving presentations in different faculties have also given exposure and enriched the knowledge of the taskforce members to the different perspectives and problems faced by lecturers.

In promoting CL and PBL at the grassroots level (mainly by word of mouth) by the core-group, most found it easier to convince younger lecturers. Nevertheless, there had been senior lecturers who were initially sceptical, but somehow turned around and at least agreed with the idea of the need for active learning in the classrooms. Mentoring lecturers in PBL are also taking place in some faculties.

On the whole, the move towards encouraging lecturers to adopt CL and PBL seemed rather sluggish, especially in the initial stage. This is because time is needed for those initiating the change to be trained, implement and gain experience in the techniques. Time is also needed for others to be convinced and prescribe to the change. This is aptly worded by Niccolo Machiavelli [9]:

> *"There is nothing more difficult to carry out, nor more doubtful of success, nor more dangerous to handle, than to initiate a new order of things."*

The CL-PBL taskforce and core groups are well aware of the effort, patience, determination and resilience required to successfully promote university-wide implementation of CL and PBL. Nevertheless, with clear intention, goals and plan of action, coupled with support from the highest level of university key personnel, the taskforce and core-groups are optimistic that a well-coordinated university-wide implementation of CL and PBL will materialise in the near future.

5. Conclusion

CL and PBL, which are active learning techniques, are currently being aggressively promoted in UTM to enhance the quality of engineering graduates. A bottom-up, top-down approach is taken to ensure a successful outcome.

Through training and awareness campaigns, the techniques are slowly but surely gaining the support of lecturers from all faculties. Although there are undoubtedly more to be done, the university is aiming towards a proper coordination of CL and PBL implementation in all faculties to yield graduates with the desired attributes for the 21st century.

References

[1] Boyer, E. Scholarship Reconsidered: Priorities of the Professorate, Princeton University Press, 1990.

[2] Boyer Commission on Educating Undergraduates in the Research University for the Carnegie Foundation for the Advancement of Teaching, *Reinventing Undergraduate Education: A Blueprint for America's Research Universities.* URL: http://notes.cc.sunysb.edu/Pres/boyer.nsf

[3] Ruhl, K. L., Hughes, C. A., & Schloss, P. J., "Using the pause procedure to enhance lecture recall", *Teacher Education and Special Education, 10*, 14-18, (1987, Winter).

[4] Khairiyah M. Y. and Mimi H. H., "Cooperative Learning in Process Dynamics and Control Course for Chemical Engineering Undergraduates", 7th Triennial AEESEAP Conference Proceedings, pp.115-121, 2003.

[5] Felder, R. M., and Brent, R., "Cooperative Learning in Technical Courses: Procedures, Pitfalls, and Payoffs", *ERIC Document Reproduction Service*, ED 377038, 1994.

[6] Duch, B. J., Groh, S. E. and Allen, D. E. *The Power of Problem-based Learning*, Stylus Publishing, Virginia, USA, 2001.

[7] Boud, D. and Feletti G. *The Challenge of Problem-Based Learning*. New York: St. Martins' Press, 1997.

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

[9] Coplin, B. *The Know-how You Need to Succeed: 10 Things Employers Want You to Learn in College*, Ten Speed Press, Berkeley Toronto, 2003.

[10] Khairiyah MY, Mimi HH and Azila NMA, "A First Attempt at Problem Based Learning in Process Dynamics and Control Course for Chemical Engineering Undergraduates at Universiti Teknologi Malaysia", 5th Asia Pacific Conference on Problem-based Learning, Kuala Lumpur, Mar 2004.