Please cite as follows:
Chan, CKY (2015). "Dealing with Large Class", Engineering Education Enhancement and Research Asia (E3R Asia).

Dealing with Large Class

Introduction

Delivery of lectures is often inevitable due to large course enrollment, time and resources constraints. Lecturing in large classes can be difficult to engage students as it often poses a passive learning environment and experience to students particularly for engineering students who have long contact hours (Ekeler, 1994; Mulryan-Kyne, 2010). Engagement of students in large classes can be achieved through active learning (Biggs, 1989), as good interaction between the student and teaching contexts will encourage a deeper approach to learning and in turn, produce quality learning outcomes.

Students with different backgrounds, experiences and abilities may often find lectures difficult to follow particularly in a large class. In a large lecture hall, teacher cannot possibly attend to all the students' needs particularly with such as diverse student body and there is less opportunity for "student-teacher interaction". Thus, students often drift from lectures and lose focus. Also it is not an easy task for a teacher to figure out how much students actually understand in a large class lecture and to provide prompt feedback. Some teachers may interact with students by posing questions in class in order to encourage interactions and discussion, however, students are usually not fast to respond or initiate answers. This phenomenon is particularly true in Hong Kong, as study observed that Asians tend to be more passive in comparison to students from the west (Young & Lo, 2004).

References:

- Biggs, J. B. (1989). Approaches to the enhancement of tertiary teaching. *Higher Education Research and Development*, *8*(1), 7–25.
- Ekeler, W. J. (1994). The lecture method. In K. W. Prichard & R. M. Sawyer (Eds.), *Handbook of college teaching: Theory and applications* (pp. 85-98). Westport, CT.: Greenwood Press.
- Mulryan-Kyne, C. (2010). Teaching large classes at college and university level: Challenges and opportunities. *Teaching in Higher Education*, *15*(2), 175-185.

- Young, B., & Lo, I. M. C. (2004). Teaching large classes of engineering students. Retrieved from http://repository.ust.hk/dspace/bitstream/1783.1/1717/1/ti02_young_civl_paper.pdf

Problems with large classes

Reviews of the existing literature reported many pedagogical challenges of large class teaching, such as passive learning, teachers' inability to attend to students' need and difficulty to assess and to provide prompt feedback. The root of these difficulties often lies in a lack of teacher-student interaction in large classes.

Large enrollment courses usually take place in lecture theatres with significant physical distance between teacher and students, which creates an imaginary barrier and an impersonal atmosphere hampering student involvement and interaction (Geske, 1992). VanDeGrift, Wolfman, Yasuhara, & Anderson (2002) suggested several factors inhibiting student-initiated interaction in large classes, namely student apprehension, comment verbalization, feedback lag and single-speaker paradigm. Student apprehension refers to students' feeling of uneasiness when asked to speak up in a large class. This is particularly true when they are unfamiliar with the class material and even have problem expressing their difficulties in class. Students may also have a misconception that the opportunity to ask questions has passed once the lecturer move on to a new topic, resulting in feedback lag.

Large class teaching is often characterized by one-way communication which promotes teacher-centered learning, offering students minimum opportunities to express or discuss their opinions in class. Even if students do take the initiative to ask questions or make comments, there is limited time for them to do so one by one (i.e. single-speaker paradigm). As time is limited, teachers usually do not arrange any in-class activity in large lectures (Hoekstra, 2008). Therefore, there is no learning activity for students to evaluate the new concepts, and even apply their existing knowledge to what they have learnt (Alexander, Crescini, Juskewitch, Lachman, & Pawlina, 2009). In the learning environment of large lecture classes, it is difficult for students to maintain their concentration in a long period of time. The lack of interaction may result in a negative student learning experience and atmosphere. Furthermore, DeBourgh (2008) suggested that teachers generally do not receive any feedback from students in large classes, thus it is difficult for them to assess students' understanding until the summative process.

References:

- Alexander, C. J., Crescini, W. M., Juskewitch, J. E., Lachman, N., & Pawlina, W. (2009). Assessing the integration of audience response system technology in teaching of anatomical sciences. *Anatomical Sciences Education*, *2*(4), 160-166.
- DeBourgh, G. A. (2008). Use of classroom "clickers" to promote acquisition of advanced reasoning skills. *Nurse Education in Practice*, *8*(2), 76-87.
- Geske, J. (1992). Overcoming the drawbacks of the large lecture class. *College Teaching*, *40*(4), 151-154.
- Hoekstra, A. (2008). Vibrant student voices: Exploring effects of the use of clickers in large college courses. *Learning, Media and Technology*, *33*(4), 329-341.
- VanDeGrift, T., Wolfman, S. A., Yasuhara, K., & Anderson, R. J. (2002). *Promoting interaction in large classes with computer-mediated feedback system*. Seattle: University of Washington.

Ways to manage and engage large classes

1. Online learning management system

Online learning management system such as Moodle, Blackboard and the Integrated Virtual Learning Environment (IVLE), consists of various functions which facilitates large class teaching. Since engineering students tend to be active learners, who do not learn effectively in learning environment which require them to be passive (Felder & Silverman, 1988), online learning management systems acts as a platform for them to participate in active learning through participation in discussion forums and online quizzes.

Discussion forums allow teachers and students to share their ideas and interact with each other beyond classroom. VanDeGrift & colleagues (2002) agreed that discussion forum helps to overcome factors inhibiting student-initiated interaction in large classes (e.g. student apprehension and comment verbalization), since students can post their opinions and raise their concerns on the forum without having to speak up physically in front of fellow classmates. They can also raise questions after 'digesting' lecture materials and organizing their thoughts without having to worry about missing a chance to ask questions after the lecture or having difficulty expressing themselves.

Online quizzes allow students to work at their own pace. The instant feedback feature in online quizzes allows teachers to monitor student performance, enabling them to adjust teaching content according to the needs of students. Advanced online quizzes can even cater for students at different levels and with today's digital generation, students can readily use their mobile phones to work on their online quizzes.

It is however important to note that in order to engage and motivate students in class, teachers need to design their curriculum, their choice of tools and their assessment creatively to suit the diverse body of students as discussion forum, online quizzes or online learning management system are only tools to assist the teachers, but it is what the teachers do affect the ways students learn.

Example of good practice 1: Using IVLE to teach a large class of Mathematics and Engineering Students (National University of Singapore)

At the National University of Singapore (Tan, 2004), a mathematics professor used the University's Learning Management System, known as the Integrated Virtual Learning Environment (IVLE) to facilitate his teaching of a large class of engineering major (over 1500 students) and mathematics major students (over 200 students). He employed the discussion forum/ chat room, online quiz, survey and multimedia (webcast) tools within the IVLE, which allowed him to be "closer to the students who may otherwise feel ignored in a class of over 200." He found that the discussion forum particularly suitable for large class sizes, as it allows "silent majority" to voice themselves, and cultivates "a habit of discussion". Utilizing the discussion forum to deal with diverse ability among students, he posted additional questions to challenge higher ability students, offering bonus points for constructive comments. He observed that higher ability students assisted lower ability students in the forum, suggesting that the forum does facilitate the teaching of diverse students.

The online assessment tool was used to tackle the issue of feedback in large class teaching. The auto-marking function reduced significant amount of workload on the teacher and also allowed both teachers and students to obtain prompt feedback on student performance. Many of the eLearning tools discussed can also be found in Moodle – the HKU learning management system, thus, I suggested that teachers who are trying to address some of the issues in large class teaching to read the paper. It is important for teachers to make informed decisions, as quoted from the paper:

"After all, a tool is just a tool. The effectiveness of the tools depends on how they are being used. This in turn depends on the amount of effort a lecturer puts in to design the courseware using the tools. Is it worthwhile? Is it necessary? I leave the answer to individual lecturers."

Example of good practice 2: Using Blackboard to teach large engineering classes (University of New South Wales)

Watson (2011) introduced an engineering professor's using a blended approach (see Fig. 1 below) to teach a large class of first year engineering students (approximately 700 students) in an Engineering Materials and Chemistry Foundation course at the University of New South Wales. The face to face component of the course consists of an hour and a half lecture conducted weekly and a laboratory session conducted fortnightly. Utilizing the Blackboard Learning Management System, the online component of the course consists of online tutorials with quiz, laboratory reports and exercises, self-testing, online group work and resources.

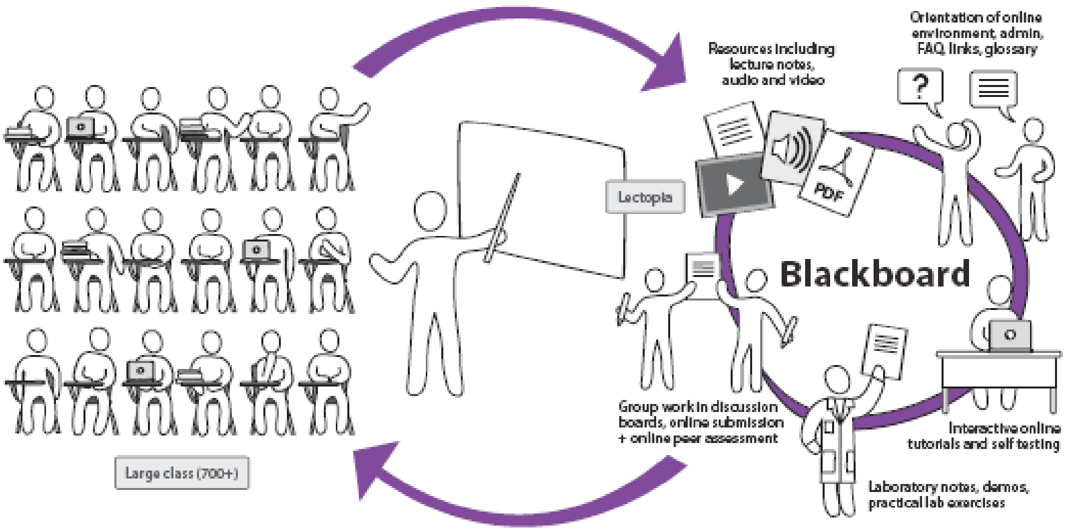

Fig. 1: Blended learning using Blackboard (Watson, 2011)

It was emphasized that the online component was exceptionally helpful and efficient in facilitating the teaching of the course. Firstly, lecture and lab materials posted on the Blackboard prior to the class allow students to prepare, enabling the teacher to make better use of lecture/lab time in engaging students in more interaction and productive work

Secondly, the Blackboard facilitates group work in large class. In a large class, it is often difficult for students to coordinate with each other and to meet face-to-face. The Blackboard helps to resolve this problem by acting as a platform for students to form learning community with their peers, allowing them to interact and participate in discussion online. Discussion board or forum also allows teachers to provide timely feedback to questions or concerns posted by students, increasing teacher-student interaction despite limited face-to-face time during lectures.

References:

- Felder, R. M., & Silverman, L. K. (1988). Learning and teaching styles in engineering education. *Engineering Education*, *78*(7), 674-681.
- Tan, V. (2004, December). *Using IVLE to teach large classes - A personal experience*. Paper presented at the Teaching & Learning in Higher Education Proceedings, Singapore.
- VanDeGrift, T., Wolfman, S. A., Yasuhara, K., & Anderson, R. J. (2002). *Promoting interaction in large classes with computer-mediated feedback system*. Seattle: University of Washington.
- Watson, K. (2011). Using online environments to teach large classes. Retrieved from http://tv.unsw.edu.au/files//unswPDF/CS_Largeclasses_LTTO.pdf

2.) Student Response System (Clickers)

Student response systems (also known as Clickers) are one of the innovative tools used to enhance interactive learning and student engagement in large classes. These instructional devices allow every student to respond to voting or multiple choice questions, presented on PowerPoint slides within a time limit. As students respond to the question anonymously, it eases students' feeling of uneasiness and boosts their confidence, even they give a wrong answer. Responses collected from the individual keypads are transmitted to a base station which records and processes the results. The summary of student responses generated by the system allows teachers to assess students' understanding and engage them in an active discussion on the quiz results. In another words, with the aid of student response systems, large classes become more dynamic rather than static.

As reported by many, Clickers have already had proven successes fostering peer interaction and student-to-teacher interaction in large classes (Chan, Tam, & Li, 2011). However, although clickers can provide significant pedagogical benefits to both teachers and students, the individual keypad is a big drawback as it is costly and creates logistic problems (Dunn, Richardson, Oprescu, & McDonald, 2013). This issue is minimized with the use of mobile devices (see section on mobile learning).

References:

- Chan, C. K. Y., Tam, V. W., & Li, C. Y. V. (2011). A comparison of MCQ assessment delivery methods for student engagement and interaction used as an in-class formative assessment. *International Journal of Electrical Engineering Education*, *48*(3), 323-337.
- Dunn, P. K., Richardson, A., Oprescu, F., & McDonald, C. (2013). Mobile-phone-based classroom response systems: Students' perceptions of engagement and learning in a large undergraduate course. *International Journal of Mathematical Education in Science and Technology*, *44*(8), 1160-1174.

Supplementary resources:

- Caldwell, J. E. (2007). Clickers in the large classroom: Current research and best-practice tips. *Life Sciences Education*, *6*(1), 9-20. Retrieved from http://lifescied.org/content/6/1/9.full.pdf
- Herreid, F. C. (2006). “Clicker” cases: Introducing case study teaching into large classrooms. *Journal of College Science Teaching*, *63*(2), 43-47. Retrieved from http://www.sciencecases.org/clicker/herreid_clicker.asp
- Siegel, J. A., Schmidt, K. J., & Cone, J. (2004). INTICE – Interactive technology to improve the classroom experience. Retrieved from http://www.ph.utexas.edu/~ctalk/bulletin/intice.htm
- van Dijk, L. A., van den Berg, G. C., & van Keulen, H. (2001). Interactive lectures in engineering education. *European Journal Engineering Education*, *26*(1), 15–28.

3.) Mobile Learning

Overcoming the drawbacks of clickers in terms of cost and logistics, real-time quizzes can also be conducted with the help of mobile technologies. Students in this generation are born with mobile devices and multimedia technology, they are often known as the “digital generation” (Chan, 2013). As universities become increasingly populated with the “digital generation", designing in-class exercises or assessment that can utilize these portable devices can make a large lecture more engaging.

Example of good practice 1: Mobile Quiz Platform (The University of Hong Kong)

At the University of Hong Kong (HKU), the Department of Electrical and Electronic Engineering developed a Mobile Quiz Platform (Fok & Tam, 2010) in 2007 that facilitates in-class assessment in large classes. Through the Mobile Quiz Platform, students can use their PDA or gaming device like NDS or PSP to answer a set of quizzes delivered from the server. The quizzes can be readily administered during lecture hours and the quizzes are marked instantly and results can be displayed on a score-board in real-time. Results can be readily shown graphically so that the teacher can gain information on students' level of understanding and common mistake made.

Example of good practice 2: iClass (The University of Hong Kong)

More recently, a new mobile learning tool – the iClass (Fok, 2012) was developed by the Department of Electrical and Electronic Engineering and the Centre for the Enhancement of Teaching and Learning in the University of Hong Kong to deal with the challenges of large class teaching. This tool enables teachers to conduct interactive classes through mobile devices, such as iPhone, iPad, tablet PCs and Android devices. While serving a similar function as the traditional classroom response system, summary of student responses to multiple-choice questions can be shown in a bar-chart, pie-chart or even a tag-cloud format. iClass also allows students to respond to the questions and discussion topics posted by the teacher using their mobile devices. In addition, iClass also has many unique functions. For example, it allows students to present their ideas immediately in class by drawing pictures, entering keywords and allowing peer grading and commenting in real-time. It also supports an editable e-book for students to work on worksheets and submit them online. Through wireless networks, students can send their work to the lecturer's computer screen in real-time for sharing with peers or for immediate feedback. They may also share their work on social networking application such as Facebook.

References:

- Chan, C. K. Y. (2013). Use of animation in engaging teachers and students in assessment in Hong Kong higher education. *Innovations in Education and Teaching International*.
- Fok, W. (Ed.). (2012). *The new era of e-learning: Mobile learning & interactive class for the new curriculum*. Hong Kong: University of Hong Kong.
- Fok, W. W. T, & Tam, V. (2010). Assessment by mobile quiz platform. Assessment Resources@HKU, University of Hong Kong. Retrieved from http://ar.cetl.hku.hk/load_article.php?id=85

4.) Small-group strategies

Allocating a small percentage of class time to small-group work can make a large difference in making a conventional lecture more engaging and productive for student learning (Cooper & Robinson, 2000). In what is called the "bookends procedure" (see Fig. 2), a lecture may begin with an engagement activity (e.g. ask students to list at least three insights that they gained from a reading assignment and at least one question), which aims to promote "advanced organizing" of what the students know and to trigger their curiosity. Following the engagement activity will be a 10-12 minutes lecture. Some group work, such as think-pair-share (Lyman, 1981), which takes approximately 3 to 4 minutes will sometimes be used between short lecture periods (Smith, 2000). Finally, guided reflection (i.e. 5-6 minute summary) will be used as the final bookend activity, encouraging students' reflection on important concepts learnt and ideas which they are unclear about (Smith, 2000).
Examples of good practice in the use of one-minute paper and a variation of think-pair-share, known as the "ConcepTest" (Mazur, 1997) to deal with large classes in science/engineering are presented below.

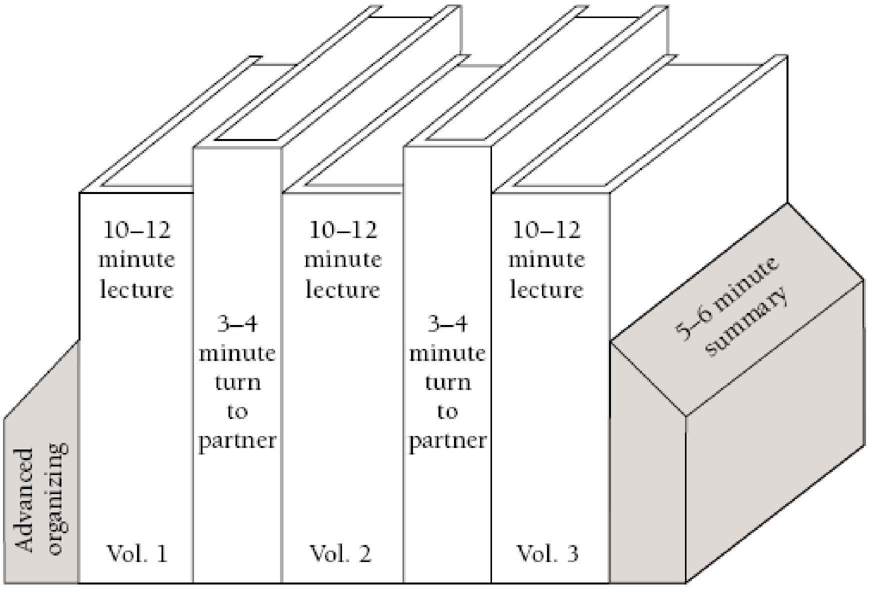

Fig. 2: Bookend Procedure (Smith, 2000)

Example of good practice 1: ConcepTest (University of Wisconsin-Madison, University of Colorado Boulder)

ConcepTest was first developed by a Harvard physics professor, Eric Mazur (1997). It involves a classroom-wide vote-discuss-vote cycle built around a question focusing on a key concept identified by the teacher, as illustrated in Fig. 3 (Ellis, Landis & Meeker, n.d.).

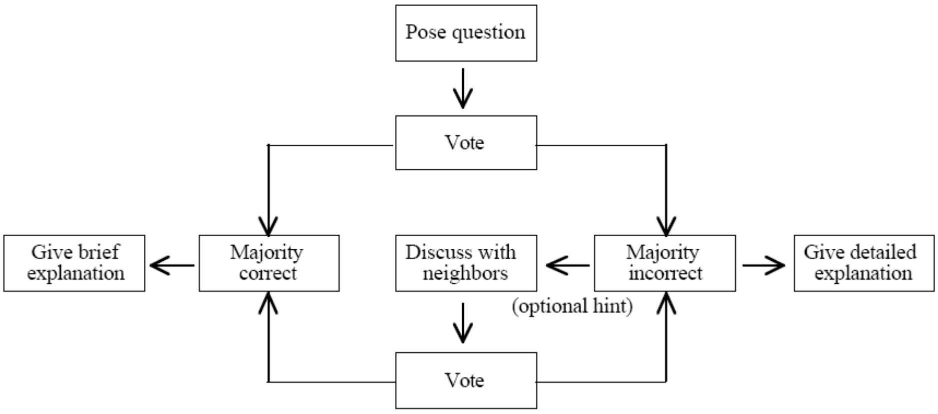

Fig. 3: Vote-Discuss-Vote cycle in ConcepTest (Ellis, Landis & Meeker, n.d.)

ConcepTest was adopted in a large chemistry class with more than 100 students at the University of Wisconsin-Madison (Ellis & colleagues, 2000). The Vote-Discuss-Vote cycle in ConcepTest is usually initiated under the teacher's explicit instructions, by posing to the class a topic question that would triggers discussion and negotiation among students. Within the cycle, students are repeatedly prompted to think and discuss about possible solution(s) to the topic question; not only does this process encourage students to think critically about their own ideas, but it also engages them in persuading and sharing ideas with others.

Generally, the teacher's key role in the cycle is to observe the interaction among students and direct the class as a whole, towards understanding of a problem; the teacher's intervention should be proceed in the interest of active and dynamic class interaction.
As high quality concept questions are difficult and time consuming to construct, Professor John L. Falconer and his colleagues at the Department of Chemical Engineering, University of Colorado Boulder, developed a library of ConcepTests for chemical and biological engineering courses (http://www.learncheme.com/). This library of ConcepTests forms a basis for the development of the AIChE Concept Warehouse (Brooks et al., 2012), which aims to create a community of learning focusing on concept-based instruction.

Example of good practice 2: One Minute Paper (North Carolina State University)

At North Carolina State University, the Department of Chemical Engineering, Felder (1992) proposed the use of one-minute paper to engage students in large class, whereby students were asked to note down anonymously in small groups or as individuals their answer to one or two questions, within a strict time frame of a minute or two before the end of the lecture.

Below presents the list of questions suggested by Felder (1992):
a.) What are the two most important points brought out in class today?
b.) What were the two muddiest points in today's class?
c.) What would make this material clearer to you?
d.) Make up a question about an everyday phenomenon that could be answered using material presented in class today. (Optional: One or two of your questions will show up on the next test.)

It was suggested that answers to these questions will provide prompt feedback to teachers on students' understanding of concepts taught, thus allowing them to address student difficulties in the next class, informing pedagogical adjustments. In addition to overcoming the problem of a lack of feedback in large classes, the one-minute paper is also beneficial to students as it encourages them to reflect on what they have learnt in class prior to leaving the classroom.

References:

- Brooks, B. J., Gilbuena, D., Falconer, J. L., Silverstein, D. L., Miller, R. L., & Koretsky, M. (2012, June). *Preliminary development of the AIChE concept warehouse*. Paper presented at the 119th ASEE Annual Conference and Exposition, San Antonio, TX. Retrieved from http://www.engr.uky.edu/~aseeched/papers/2012/4310.pdf
- Cooper, J. L., & Robinson, P. (2000). Getting started: Informal small-group strategies in large classes. *New Directions for Teaching and Learning*, *2000*(81), 17-24.
- Ellis, A. B., Cappellari, A., Lisensky, G. C., Lorenz, J. K., Meeker, K., Moore, D., Campbell, K., Billmann, J., & Rickert, K. (2000). How chemistry ConcepTests are used. Retrieved from http://www.jce.divched.org/jcedlib/qbank/collection/conceptests/
- Ellis, A. B., Landis, C. R., & Meeker, K. (n.d.). ConcepTest CAT. Retrieved from http://www.wcer.wisc.edu/archive/cl1/flag/extra/download/cat/contests/contests.pdf
- Felder, R. M. (1992). How about a quick one? Chemical Engineering Education, *26*(1), 18-19. Retrieved from http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Columns/Quickone.html
- Lyman, F. T. (1981). The responsive classroom discussion: The inclusion of all students. In A. S. Anderson (Ed.), *Mainstreaming Digest* (pp. 109−113). College Park, MD: University of Maryland Press.
- Mazur, E. (1997). *Peer instruction: A user's manual*. Englewood Cliffs, NJ: Prentice Hall.
- Smith, K. A. (2000). Going deeper: Formal small-group learning in large classes. New *Directions for Teaching and Learning*, *2000*(81), 25-46.

5.) Peer assisted mentoring/learning

Peer-assisted mentoring or learning is the employment of postgraduate students to mentor undergraduate students; where the mentors (postgraduate students) are responsible for supporting and facilitating the undergraduate students (Kehoe, 2007). Peer-assisted mentoring or learning helps facilitate the teaching of large classes because it sub-divides large classes into smaller and more manageable groups which improve students' interactivity and gives mentors better opportunities to provide timely and constructive feedback (UCD Teaching & Learning Resources, n.d.).

Example of good practice: Peer-assisted mentoring in a 'Creativity in Design' module (University College Dublin)

At the University College Dublin, School of Architecture, Landscape and Civil Engineering, peer-assisted mentoring was introduced to the "Creativity in Design (CVEN10040)" module, which is a core module for all first year engineering students (approximately 250 to 300 students) (O'Neill et al., 2011). The studio sessions were managed by students from the Structural Engineering with Architecture ME programme, who took an 'Innovative Leadership' module in their 5th year. In this 5th year module, the postgraduate students were trained in terms of leadership, project management, teamwork and facilitation skills. A total of five postgraduate students were assigned to facilitate the studio sessions, with 12 to 13 teams of undergraduate students, each team consisting of 5 members. During the studio sessions, the postgraduate students would facilitate undergraduate students work by providing formative feedback, managing group interaction and encouraging participation. This initiative not only helped to engage students in a large class, but also helped strengthened the relationship between postgraduate and undergraduate students. There have been many studies (Andrews & Clark, 2011; Yates et al., 1997) suggesting that students tend to understand and listen to their peers more than their teachers, as they felt they are more related to their peers.

References:

- Andrews, J., & Clark, R. (2011). Peer mentoring works! How peer mentoring enhances student success in higher education. Birmingham, UK: Aston University.
- Kehoe, D. (2007). *Developing your people: 25 action-based articles showing you how to develop your people through coaching and mentoring*. North Ryde, NSW: McGraw Hill.
- O'Neill, G., Galvin, A., & UCD staff. (2011). Assessment: Five UCD case studies of first year assessment (concept/enquiry modules), University College Dublin Teaching and Learning Resources. Retrieved from http://www.ucd.ie/t4cms/casestudiesffa.pdf
- UCD Teaching & Learning Resources. (n.d.). Large group teaching strategies – Peer-assisted mentoring. Retrieved from http://www.ucd.ie/teaching/resources/teachingtoolkit/largegroupteachingstrategies/

- Yates, P., Cunningham, J., Moyle, W., & Wollin, J. (1997). Peer mentorship in clinical education: Outcomes of a pilot programme for first year students. *Nurse Education Today*, *17*(6), 508-514.

Supplementary resources:

- Maheady, L. (1998). Advantages and disadvantages of peer assisted learning. In Ehly, S. & Toppings, K. (Eds.), *Peer assisted learning* (pp. 46-67). Mahwah, NJ: Lawrence Erlbaum Associates Inc.
- Nafalski, A, Berk, M., & Cropley, A. (2001, September). *Peer assisted learning for electrical engineering students*. Paper presented at the Australian Universities Power Engineering Conference (AUPEC), Perth, Australia. Retrieved from http://itee.uq.edu.au/~aupec/aupec01/098_NAFALSKI_AUPEC01paper1.pdf