

DEVELOPING RESPONSIBLE LEARNERS

SATYEN GAUTAM, SACHIN JANGAM, AND KAI CHEE LOH
National University of Singapore • Singapore 117585

As educators, we believe that education should be geared towards creating learners who take responsibility for their learning over and above responding to instructions. While traditional methods (lecture and tutorials) and incorporating cutting-edge technology in the classroom (e.g., use of animations) can facilitate efficient transfer of information, they may not necessarily create self-motivated responsible learners. The question to ask is what we as educators can do to overcome this challenge. While no single rule of thumb can solve this problem, educating students to recognize themselves as stakeholders instead of mere recipients of knowledge can be a productive, beneficial, and agreeable alternative for all. Stakeholders as defined by Nuseibeh and Easterbrook^[1] are “individuals or entities who stand to gain or lose from the success or failure of a system or an organization.” Research has shown that the day students feel that they are stakeholders, *i.e.*, they have ownership over their learning, is the day they would want to engage in academic tasks with more vigor and take responsibility for their learning.^[2-5]

Rather than bringing radical changes in classroom management, this project focuses on exploring instructional activities such as peer assessment, course review and content selection, and reciprocal peer teaching in giving students ownership over their learning, thus paving the way towards creating responsible learners.

WHY THESE INSTRUCTIONAL ACTIVITIES?

Peer Assessment

In recent years, peer assessment has been increasingly used as a method of engaging students in the improvement of their own learning in higher education.^[6-11] Peer assessment is the assessment of students' work by other students of equal status.^[12] As grading is an area of primary concern to students, we

anticipate that by giving students an opportunity to be part of grading, one can give them ownership. When learners have ownership over their learning, it can lead to greater engagement and intrinsic motivation for them to take responsibility for their learning.^[13]



Satyen Gautam is currently a senior lecturer in the Department of Chemical and Biomolecular Engineering, National University of Singapore (NUS). He earned his Ph.D. in chemical engineering from NUS in 2011. He teaches courses in kinetics, process design, and food technology, and is enthusiastic about the use of technology in teaching and learning and promoting student engagement in learning.

Sachin Jangam is currently a lecturer in the Department of Chemical and Biomolecular Engineering, NUS. He received his Ph.D. in chemical engineering in 2009 from Institute of Chemical Technology, Mumbai. His research interests lie in the area of heat and mass transfer, mainly drying. He is actively involved in pedagogical research, in particular active learning and use of technology in teaching.



Kai Chee Loh is currently an associate professor in the Department of Chemical & Biomolecular Engineering, NUS. He obtained his B.Eng. and M.Eng. in chemical engineering from NUS before going to MIT for his M.S. in chemical engineering practice and Ph.D. in biochemical engineering. In addition to his research interests in biological waste water treatment processes, he is passionate about teaching, particularly new techniques in pedagogy, including flipped-classroom and technology-enhanced methodologies.

Course Review and Content Selection

Learners become responsible when they can make academic choices and drive their learning.^[14] Allowing students to be part of course review exercises and incorporating topics of students' interest (content selection) can be effective ways to allow students to realize that their voice is heard.^[15] As defined by Mitra and Gross,^[16] student voice is systematic inclusion and empowerment of students in the decision-making process. This feeling of being recognized as "partners in learning" can motivate students to be responsible learners.

Reciprocal Peer Teaching

Reciprocal peer teaching is a form of cooperative learning and involves circumstances where students alternate roles as a teacher and student.^[17-20] Peer teaching requires students to review, organize, and consolidate existing knowledge, understand concepts, reformulate knowledge into new conceptual frameworks,^[21] and use appropriate methods to disseminate their learning to their peers. By placing learners "in the driver's seat," one can encourage students to take responsibility for their learning.

Besides helping learners become responsible for their learning, the aforementioned activities can enable students to develop skills that are transferable to the workplace and to other aspects of life.

- *Peer assessment can allow students to build mutual trust and confidence in one another.*
- *Course review and content selection can help students improve on their judgment and critical reflection skills.*
- *Reciprocal peer teaching can extend students' learning far beyond the given task. In words of Alpay, Cutler, Eisenbach, and Field,^[22] "the teaching experience can lead to the development of organizational, communication, and critical-thinking skills associated with the teaching process, as well as improved knowledge and technical skills through greater attention to and motivation for the subject matter."*

METHODOLOGY AND PROJECT OUTCOMES

Peer Assessment

Methodology

Peer assessment was conducted for the course Food Technology and Engineering in Semester 2 of AY 2015/16. Food Technology and Engineering is a 13-week, four-credit elective course (3 hr. of lecture and 1 hr. of tutorial per week). The course was taken by 61 Year 3 and 4 chemical engineering students. As part of the peer-assessment activity, students working in small groups (three to four students) were required to design rubrics for assessment, assess the presentations of peers, and provide constructive feedback.

Advocates of peer assessment, while associating it with a number of benefits, have reported skeptical perceptions of

students about the activity as well. Some students' concerns about peer assessment are: (i) inadequacy to assess the work of others^[23-24]; (ii) fairness of grading^[25-27]; and (iii) lack of participation by peers.^[25] Understanding the challenges and investigating ways to find possible solutions is crucial to the success of the activity. To help students develop an appreciation for the standards and criteria for assessment, it was decided that students should be directly involved in preparation of rubrics. Besides familiarizing students with assessment, it is expected that the rubric preparation exercise will give students a feel of having a "voice" in the classroom.

Students' skepticism of fairness of grading can be attributed to "over marking" or "under marking" by peers.^[26] To instill confidence in students of the assessment procedure, it was decided that: (i) assessment will be a joint responsibility involving both students and instructor; (ii) instructor's contribution to the overall marks will be higher than the students; and (iii) in situations where the marks assigned by the instructor and the students differ significantly, the instructor will adopt a suitable process to moderate the marks.

Students' third concern was about lack of participation by peers. Several researchers argue that peer assessment is a learning aid; participation by students in it should thus be voluntary. A contrary view is that student engagement can be further enhanced if a portion of the marks are assigned towards participation.^[28] To promote student engagement, it was decided that a small portion of the marks will be assigned towards student participation; assignment of marks will be dictated by: (i) quality of questions asked during Q&A session; and (ii) usefulness of feedback provided.

The activity began by organizing an informal discussion session to brief the students of the objectives, methodology, and expectations of the activity. The session also served as a platform to collectively discuss the framework of the assessment rubrics as well as the instructor-student contribution ratio to the overall marks. The collectively developed framework of the assessment rubrics is shown in Table 1. It was decided that a three-level rating scale will be used: "below expectations," "meets expectations," and "above expectations."

Post-discussion, student groups were given two weeks to design the rubrics. The rubrics submitted by the various groups were evaluated, analyzed, and assimilated into the final form by the instructor. The presentations, organized in the last teaching week of the semester, required each group to present on a topic of their choice. The presentation

TABLE 1
Framework of assessment rubrics

Major Criteria	Weightage (%)	Contribution
Content and organization	60	Team
Presentation style	20	Individual
Response to questions	20	Individual

session (15 min.) was followed by Q&A session (10 min.) and feedback session (5 min.) to complete the learning cycle. Assignment of marks for the group presentation was a joint effort with a 70:30 instructor-student contribution towards the overall marks. Group presentation accounted for 25% towards the overall marks for the course and included the following components:

- (i) Presentation preparation and delivery: 18%
- (ii) Rubrics preparation: 5%
- (iii) Participation in assessment: 2%

Project Outcomes

The finalized rubrics are shown in Table 2.

TABLE 2				
Finalized rubrics for group presentation				
Content and Organization (60%)				
Sub-Criteria	Attribute	Below Expectations	Meets Expectations	Above Expectations
<i>Breadth and depth of content (40%)</i>	Coverage of subject	Poor	Satisfactory	In-depth
	Evidence of research/literature review	Minimal	Adequate	Extensive
	Evidence of creative and critical thinking ability	No/minimal	Some	Significant
		(0-15)	(16-29)	(30-40)
<i>Organization (20%)</i>	Order of content	Lacks logical organization	Generally logical	Logical - enhances communication
	Transitions between major ideas	Disjointed	Adequate	Apt - clearly reflects relation of one idea to next
		(0-7)	(8-14)	(15-20)
Presentation Style (20%)				
<i>Delivery (10%)</i>	Voice	Not clear (mumbling, inaudible, mispronunciation)	Generally clear with little/no mispronunciation	Clear, appropriate modulation and pronunciation
	Pace	Too fast or slow at most times	Comprehensible	Right pace
	Body language	Lacks enthusiasm; some distracting gestures	Displays enthusiasm; few or no distracting gestures	Displays enthusiasm; adequately expressive
	Preparation	Mostly reading from slides	Some reading from slides	Seldom/no reading from slides
	Duration	Exceeds/falls short by 1 min. or more	Exceeds/falls short by less than 1 min.	Appropriate length
		(0-3)	(4-7)	(8-10)
<i>Ability to engage audience (10%)</i>	Eye contact	Little	Satisfactory	Good
	Use of visual aids and direct audience participation	None	Some	Good
		(0-3)	(4-7)	(8-10)
Response to Questions (20%)				
<i>Ability to answer questions (20%)</i>	Response	Answered some questions Response difficult to comprehend	Answered most questions Response understandable — could be better structured	Answered all questions Response clear and easy to comprehend
		(0-7)	(8-14)	(15-20)

Using the finalized rubrics, students were jointly assessed by their peers and the instructor for the group presentation. An instructor-student contribution ratio of 70:30 was used for peer assessment. At the end of each presentation, detailed feedback was given orally to the presenters by both students and instructor. Comparison of the marks assigned by the instructor and the students showed good agreement; the difference in marks ranged from 0% to 12%. No definite marking pattern was observed; in several cases students' marks were higher than the instructor's, while for some the instructor gave higher marks.

On conclusion of the peer assessment activity, a student survey was conducted. The student responses are summarized in Table 3.

Some of the students' comments about peer assessment and suggestions for improvement are:

"Gives opportunity to voice out our opinions. We do not have to follow the requirements imposed on us by the lecturer...."

"Provides a valuable opportunity to experience the role of an assessor."

"Creates a collaborative learning atmosphere... Makes the entire learning process more fun and meaningful."

"While difficult to control, some students requested their friends to ask them pre-decided questions during Q&A session."

"Instead of being an individual contribution, 'Response to Questions' can be made a group contribution. The level of difficulty of the questions asked to individual members in the group may vary and thus assessing individual's ability to answer questions is difficult in the present set-up."

"Longer Q&A session would enable improved assessment...."

"Instead of giving an immediate feedback, the assessors can provide written/verbal feedback to the presenters a day or two after the presentation. This would give the assessors adequate time to reflect and provide more constructive feedback...."

The majority of the students responded favorably to each of the survey questions. Based on the survey results, it may be reasonably accurate to state that: (i) involving students in the rubric preparation exercise makes them feel empowered as well as provides them with a more concrete understanding of what is expected; and (ii) giving students an opportunity to be part of grading can enable them to see themselves as active builders of their own grades—providing them with intrinsic motivation to take responsibility for their learning.

Course Review and Content Selection

Methodology

To open up lines of communication between the students and instructor an in-class student feedback session was conducted at the end of Semester 2, AY 2015/16, for the course Food Technology and Engineering. The session began with an introduction to the objectives of the survey, which were:

- (i) Gauge students' perception about the course content and the adequacy of coverage of the various topics. The students were informed that topics in need of additional coverage will be supported with e-lessons (screencasts), while the less-relevant topics will be discussed in brief and/or substituted with new topics in future semesters.
- (ii) Identify, from the list, the topics that they think were apt to be introduced as e-lessons in future semesters. The idea was that these e-lessons will serve as additional learning material for the students.

TABLE 3
Responses to survey questions (No. of respondents: 61)

Question	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
Rubrics preparation exercise gave me a fair and equitable opportunity to use my voice and knowledge to decide on the key criteria students should be assessed upon.	26	66	7	1	0
Familiarization with rubrics prior to group presentation provided me with a clear understanding of the expectations and rendered the assessment process more transparent.	38	54	7	1	0
Peer assessment helped me to improve on my judgmental and critical reflection skills and elevated my role from a passive observer to a decision maker.	43	56	1	0	0
Peer assessment facilitated building a supportive and collegial classroom environment that promoted free exchange of opinions/ideas.	56	38	6	0	0
Peer assessment is an effective way of giving students ownership of their learning, paving the way towards developing responsible learners.	34	56	10	0	0

Post briefing session, the feedback was collected using the survey forms (Refer to Tables 4.1 and 4.2).

Project outcomes

Conducting the course review exercise gave students an opportunity to communicate their concerns and the instructor

an opportunity to reflect on the course syllabus. The feedback was both qualitatively and quantitatively assessed to evaluate students' suggestions. Food packaging—in particular innovations in food packaging—emerged as the sole topic that most students felt needed to be dealt with in more detail.

TABLE 4.1 Survey form for course review		
Instructions <ul style="list-style-type: none"> • If the topic is relevant to the course and has been addressed well, no action is required. However, if you feel that changes are required for a particular topic/sub-topic, kindly circle the topic/sub-topic and indicate one of the following: <ul style="list-style-type: none"> –Topic is relevant but can be covered in less detail: LD –Topic is relevant and should be covered in more detail: MD –Topic is not relevant and can be excluded from the syllabus: EX • Kindly provide your reasons/suggestions in the remarks column 		
Syllabus	LD / MD / EX	Remarks
Part 1: Food Process Engineering Low-Temperature Preservation Principle of low-temperature food preservation, temperature & thermophysical properties of food, refrigerated food storage, cooling and heating processes for foods, frozen food storage, effect of freezing on food, freezing process, freezing temperature depression, freezing time - - Part 2: Food Science and Technology Food Chemistry Classification, composition, nutrition, properties of lipids, proteins, carbohydrates, vitamins, and other minerals - -		
(Note: For illustration purposes, only select topics are listed)		

TABLE 4.2 Survey form for content selection		
From the list below, identify topic(s) you find suitable to be introduced as e-lessons in future semesters.		
	Topic	Put a tick if you find the topic suitable
1	<u>Sanitization of Fresh Produce Using Ultrasound</u> Highlights: Basic concepts; pros & cons of ultrasound technology; sanitization of fresh produce	
2	<u>Manufacture of Sunflower Oil</u> Highlights: Composition and nutritional aspects; manufacturing process (types of sunflower seeds, cold pressing of sunflower seeds, refining process); packaging (packaging techniques, shelf life of sunflower oil in different types of packaging)	
3	<u>Flavors and Encapsulation</u> Highlights: Aspects of flavoring science; use of edible coatings in foods; flavor application using coating technology; regulatory and safety aspects in flavor processing	
4	<u>Cereals: Nutrition & Technology</u> Highlights: Nutritional value (health benefits & implications of consuming cereal, minerals and vitamins in cereal, natural form vs. processed form); manufacturing process (raw ingredients, processing steps, types of coatings, quality control); packaging (types of packaging, packaging materials and their properties, storage conditions)	
-	---	
15	<u>Coffee: From Beans to Cup</u> Highlights: History of coffee; processing of coffee cherries (dry and wet method); milling (hulling, polishing); blending of coffee beans; roasting; grinding and brewing coffee; decaffeination; packaging and storage	
Other topic(s) that you think can be included in the course syllabus and/or introduced as additional learning material:		
(Note: Students were provided with a total of 15 topics. For illustration purposes, only five topics are listed)		

To address students' concerns, two e-lessons (screencasts) titled "third-generation packaging" and "self-heating food packaging" were prepared. The e-lesson on third-generation packaging introduces students to three new packaging techniques, namely edible packaging, active packaging, and intelligent packaging. The e-lesson on self-heating food packaging discusses the different types of self-heating food packaging products and the pros and cons of each.

Out of the 15 topics listed in the survey form for content selection, three topics that received the highest student votes were selected for e-lesson preparation. The three topics are: manufacture of sunflower oil, sanitization of fresh produce using ultrasound, and food flavoring and encapsulation. The e-lessons on these three topics serve as additional learning material for the students.

Five undergraduate students, who previously took the elective course and participated in the survey, assisted the instructor in preparing the e-lessons. It may be noteworthy that preparation of e-lessons by the senior students for future use by their juniors is another form of peer teaching (although not reciprocal in nature). The e-lessons are now available

for students' use via the IVLE (Integrated Virtual Learning Environment) platform. The links to the e-lessons are listed in Table 5 (Log-in credentials - Username: chbenus; Password: elessons2015).

O'Banion^[29] championed the notion that it is important to engage learners as partners in the learning process. To the question "Course review and content selection are useful activities and should be carried out for other courses," 86% of the students replied in the affirmative. The positive response establishes the usefulness of these activities in giving students a voice and as a meaningful way of furthering student-faculty partnership in education.

Reciprocal Peer Teaching

Methodology

Reciprocal peer teaching was conducted for the course Good Manufacturing Practices in Pharmaceutical Industry in Semester 2 of AY 2015/16. Good Manufacturing Practices in Pharmaceutical Industry is a 13-week, four-credit elective course (3 hr. of lecture and 1 hr. of tutorial/seminar per week). The course was taken by 45 Year 3 and 4 chemical engineering students.

As part of this "students teaching students" activity, students (working in groups of five) were required to teach on a topic assigned by the instructor. The assigned topics pertained to analytical techniques used in the industry to analyze the quality of protein-based biologics. The activity began with an informal discussion session in Week 1 of the semester to brief the students

on the objectives, methodology, and expectations of the activity. Each group was required to review the literature and submit the scope of their presentation within 2 weeks of topic assignment.

Topic	URL
Third-Generation Packaging	https://breeze.nus.edu.sg/p4zpsr8xou7/
Self-Heating Food Packaging	https://breeze.nus.edu.sg/p80jeku7791/
Manufacture of Sunflower Oil	https://breeze.nus.edu.sg/p4k4bekniue/
Sanitization of Fresh Produce Using Ultrasound	https://breeze.nus.edu.sg/p9o38pog68t/
Food Flavoring and Encapsulation	https://breeze.nus.edu.sg/p2iqsx17v2n/

Question	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
Responsibility to teach peers motivated me to garner in-depth knowledge on the assigned subject.	57	34	9	0	0
Reciprocal peer teaching exercise served to enhance my organizational and communication skills.	57	41	2	0	0
Reciprocal peer teaching facilitated creating a conducive learning environment where students could learn not only from the instructor but also from each other.	36	46	18	0	0
Instructor gave adequate guidance/feedback to support learning.	75	25	0	0	0
Reciprocal peer teaching is an effective way to help students recognize themselves as partners in learning—paving the way towards developing responsible learners.	41	50	9	0	0

The scope was reviewed by the instructor and suitable feedback was provided. On acceptance of the project scope, each group received an additional four weeks of preparation time. The teaching sessions were organized from Week 8 until Week 12. The teaching session (25 min.) was followed by Q&A session (10 min.) and feedback session (5 min.) to complete the learning cycle. Peer teaching accounted for 30% of the overall marks for the course and comprised the following components:

- (i) *Teaching material preparation and delivery: 27%.*
- (ii) *Participation in assessment: 3% (Tasks included asking quality questions and providing constructive feedback to peers).*

To test the effectiveness of peer teaching, topics covered in peer teaching were tested in the quiz and accounted for 10% of the overall quiz marks. The questions took the form of multiple-choice questions.

Project outcomes

Most of the student groups exhibited an above-average performance for peer teaching. Making use of PowerPoint presentations, animations, props, whiteboard, and interactive quizzes, the student groups used different instructional tools to make the teaching sessions interesting and facilitate understanding of the concepts.

The quiz, conducted on the culmination of the course, comprised two sets of questions. The first set of questions assessed the students on topics covered in peer teaching and accounted for 10% of the quiz marks; the remaining 90% came from the topics taught by the instructor. The results suggest that the students' average scores were higher for questions on topics taught by the instructor; the average scores for the two sets of questions differed by less than 15%.

On conclusion of the activity, a student survey was conducted to evaluate students' perception of reciprocal peer teaching. The student responses are summarized in Table 6.

Some of the students' comments on peer teaching and suggestions for improvement are:

"Allows students to be in charge and responsible for their own learning."

"Preparing on the assigned topic on my own allowed me to gain an in-depth understanding of the subject..."

"Interactive environment... Gives a feeling of making a contribution."

"Peer teaching showed me the importance of presenting materials in a comprehensive yet simple and understandable manner."

"The teams which taught in the later weeks got an opportunity to learn from the mistakes of the earlier teams and thus had some advantage over their counterparts."

"Scope of some topics was very vast; presentation thus seemed rushed at times..."

"My learning was limited owing to information overload. Instructor needs to emphasize to the students not to overload too much information to the audience. The presenters get sufficient time to prepare the topic so they may have wealth of information. However, they need to remember that the audience is listening to the content for the first time."

"It being our first experience, technically intensive topics could be substituted with less complex topics. Even after extensive research, it was difficult for me to understand the topic completely and thus could not effectively teach my peers."

"A copy of presentation slides, if made available prior to the teaching session will make it easier for the student audience to follow as well as prepare notes..."

"Rehearsal sessions prior to actual classroom teaching can make peer teaching more worthwhile..."

As educators, we need to realize that student responsibility doesn't just happen. We need to nurture it. If we want students to take responsibility for their learning, we must first give them responsibility. As evident from students' responses, placing students in the teacher's seat gave students an opportunity to experience responsibility and contribute towards their peers' learning, and in the process learn to become responsible learners.

Lower average scores of the students for questions on topics covered in peer teaching, however, necessitate some changes in the methodology adopted. As suggested by the students, rehearsals prior to actual classroom teaching could prove beneficial. In words of Race, Brown, and Smith,^[28] "Mark-free rehearsal opportunities help students get the hang of what is required of them and also build in an opportunity for students to get interim feedback at a stage when there is time to bring about improvements."

CONCLUSION

The present research shows that instructional activities — peer assessment, course review and content selection, and reciprocal peer teaching — were well-received by many students and served to give opportunities to the students to use their voice and knowledge to contribute and make meaningful decisions. As educators, however, we need to acknowledge that students often tend to be generous in their responses. The student surveys should thus be regarded as "initial means" to assess the project outcomes; future studies will employ additional means to further assess the benefits and shortcomings of the instructional activities.

Also, while this approach of giving students ownership over their learning holds promise, the authors feel that a collective approach involving more instructors and spreading out such activities over the entire period of students' stay in the university is essential towards "completely" achieving the goal of creating responsible learners.

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