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INCORPORATING STUDENT FEEDBACK INTO CURRICULUM REVIEW ACCORDING TO OUTCOME BASED EDUCATION PHILOSOPHY

YIT YAN KOH[1], PERK LIN CHONG[2,*]

[1]Faculty of Engineering and Built Environment, University of Newcastle, Singapore
[2]School of Science, Engineering and Design, Teesside University, United Kingdom
*Corresponding Author: P.Chong@tees.ac.uk

Abstract

The conduct of the Engineering Programme in Malaysia and Singapore is much depending on the idea of Outcome-Based Education (OBE), which is an education philosophy that focuses on the graduate attributes or outcomes upon the completion of an engineering programme. Under such philosophy, the programme design is underpinned by the Programme Outcomes (PO) and the courses are driven by the Learning Outcomes (LO). For the case in the University of Newcastle, Australia (Singapore Campus), The Programme Outcomes (PO) of the engineering programme is first determined in the curriculum, for which the LO of the courses in the programmes are designed based on the PO stated. In addition, the students' achievements of such outcomes are measured upon completion of courses and programmes. As part of Continual Quality Improvement (CQI), these measurements are analysed and steps for improvements are taken. This paper presents a case study conducted for the teaching of the course of Thermofluids in the University of Newcastle, Singapore, where the LO measurement is used as an input for revising the course content. The measurement is taken across three years of study, based on the LO attainments of assessment components such as quizzes and assignments. The resulting LO attainments incorporating with student feedback (Start-Stop-Continue) will be used as an input to propose for the improvement of the course content. In addition, the paper also explores into the holistic side of the engineering education, where students feedback are also taken into consideration as part of the personal improvement in teaching so as to provide a well-rounded education to the students towards the attainment of LO and hence CQI process of the OBE.

Keywords: Continual quality improvement (CQI), Curriculum review, Learning outcome (LO), Outcome-based education (OBE), Start-Stop-Continue strategy.

1. Introduction

The curriculum review process plays a vital role in ensuring that the programmes in the higher education institutions are offered according to the accreditation standards and also address the needs of the professions.

The Engineering programmes, depending on the countries, are accredited by different professional bodies. The accreditation bodies include The Institution of Engineers, Australia (Australia), Institution of Engineers of Singapore (Singapore), Engineering Accreditation Council (Malaysia) and the Institution of Mechanical Engineering (United Kingdom).

The Outcome Based Education (OBE) system is defined as "organizing everything in an educational system around what is essential for all students to be able to do successfully at the end of their learning experiences" [1]. In other words, one would determine what kind of skills and knowledge that a student should possess after the graduation, and then only the courses and syllabus are build based on such determination.

According to Aziz et al. [2], the practice of OBE system in the Engineering Education in the region started since the beginning of the millennium , where the idea by Spady [1] has combined with Bloom [3] taxonomy to provide clearer guidelines in defining necessary LO in order to attain the stipulated PO. The OBE system that is practised in Malaysia/Singapore is illustrated in Fig. 1, where the PEO are designed based on the vision and missions of the institution. With the defined PEO, the programme outcomes are designed, together with the guidelines of the local accreditation bodies. With the clear definition of the PO, the LO are then designed for each course.

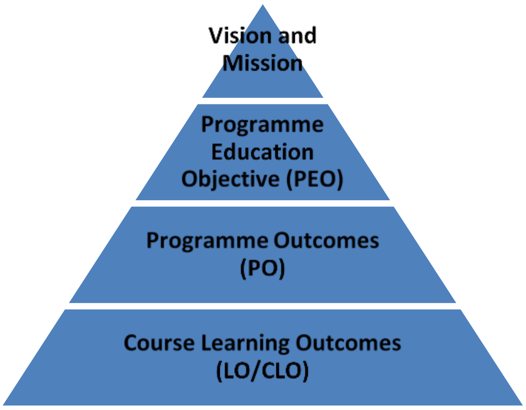

Fig. 1. The relationship of Course Learning Outcomes (LO), Programme Outcomes (PO), Programme Education Objectives (PEO) and Vision and Mission of the institution in an OBE model.

2. Curriculum Review Process

The curriculum review process is an essential part of all academic institutions ranging from post-graduate levels in the university [4, 5]. The curriculum review that is carried out by the institutions is said to be done based on the objectives of setting clear expectations, maintaining open, consistent communication, incorporating multiple levels of leadership, engaging various groups of stakeholders, and implementing through actionable items [6]. The curriculum review process has been a part of the Continuous Quality Improvement for the programme towards the success of OBE. The review process takes place at the course level and the programme level to ensure that the programme is delivered the up-to-date and relevant subject knowledge to the students.

The curriculum review is not only commonly seen in engineering programmes [2, 7], but also in other programmes such as medicines and pharmacy [8, 9]. For the case of Engineering in the region, the curriculum review process has been embedded as part of the CQI process of OBE. Take Singaporean Engineering Education for example [10], the curriculum review process has been defined as part of the loop of the review processes of LO, PO and PEO, as shown in Fig. 2. Assessments of attainment of LO, PO and PEO are conducted, and analysed, and improvement strategies are implemented as part of the CQI process. The relationships of LO, PO and PEO are then analysed to ensure the consistency and relevancy of the process among these OBE components.

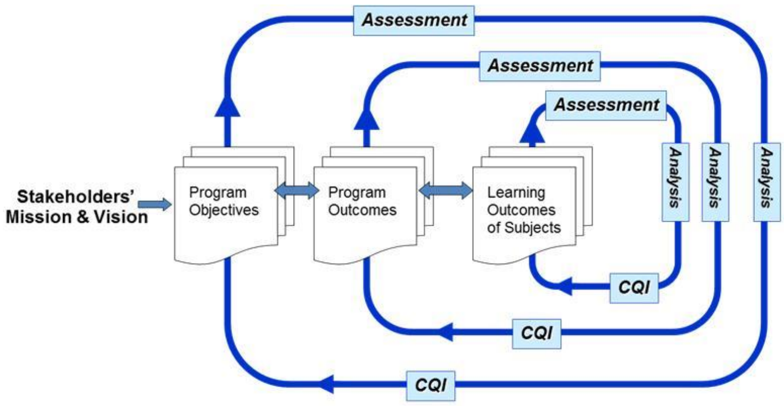

Fig. 2. The flowchart of a CQI process of a typical Malaysian Engineering Programme.

Successful implementation of CQI in the educational setting is challenging, which required efforts of academic and students, including their willingness to participate in a variety of surveys and frequent meetings [11]. Furthermore, the CQI process can be time consuming and held back by bureaucratic structure, which can eventually deter the improvement process. In this paper, the aim is to demonstrate the implementation of CQI in curriculum review, even though there is a challenge in execution. Essentially, the CQI process focuses on the innermost loop of Fig. 2, where the assessment and analyses of attainment of LO are discussed and improvements are suggested based on the results of analyses.

3. Implementation of OBE

This section focuses on the implementation of OBE for the course offered in the Bachelor of Engineering (Honours) (Mechanical Engineering) in the University of Newcastle (Singapore Campus). The course that is taken into consideration is Thermofluids, which is offered to the level 2 students. In addition to this, the analyses are done across the observation of 4 offerings of the course, namely Trimester 3 2013 (T3-13), Trimester 2 2014 (T2-14), Trimester 1 2015 (T1-15) and Trimester 1 2016 (T1-16).

The course is divided into two major components, namely Thermodynamics and Fluid Mechanics. This course serves as the first course towards Transport Phenomena and Applied Engineering Thermodynamics at level three. The LO of the course is briefly described as following

LO1. *Apply thermodynamic principles related to power and refrigeration cycles.*
LO2. *Apply appropriate material models in thermodynamic analysis.*
LO3. *Perform calculations demonstrating their knowledge on the concepts of reversibility and irreversibility.*
LO4. *Apply basic equation of fluid statics to compute the pressure variation in incompressible liquids and gases.*
LO5. *Perform calculations demonstrating their knowledge of fluid forces on immersed objects.*
LO6. *Apply the mass and momentum (linear and angular) conservation laws for the solution a variety of flow problems.*
LO7. *Derive and apply Reynolds transport, Navier-Stokes, Euler's and Bernoulli equations with an understanding of the physical meaning of each term as well as constrain/limitations for each equation.*
LO1 - LO3 focus on the Thermodynamics while LO4 - LO7 focus on the fluid mechanics.

The LO of the course is designed based on the Graduate Profile Statements, where the course builds students' capacity with reference to the Engineers Australia Stage 1 Competency Standards for Professional Engineers (Graduate Attributes). As such, each outcome is mapped to the assessment, and also Graduate Profiles Statements.

The assessments of this course are divided into two components: quizzes and written assignments. Two quizzes of 40% each contribute to 80% of the total course marks, while written assignment contributes to another 20% of the course marks. Quiz 1, conducted during the middle of the course, covers all topics in Thermodynamics, while Quiz 2, conducted at the end of the course, covers all topics in Fluid Mechanics. Each quiz consists of four structured-type questions, where students are required to answer all four questions in the 2-hour duration. The written assignments are structured-type questions that require the show of working steps in the process of obtaining answers. There are six assignments, consisting of three thermodynamic-based assignments and three fluid mechanics-based assignments.

In a nutshell, the implementation of OBE for Thermofluids course is concentrated on the extent to which the students have achieved the stipulated LOs [12, 13] as mentioned in the previous section. The aim of this section is to present a method for assessing the attainment of LOs. The key step is to map the coursework assessment components with the corresponding LOs as shown in Table 1. For simplicity, all mapped LO carry the same weightage.

Table 1. Mapping of LOs and assessment components (Q: Quiz, A: Assignment).

	Q1 (40 %)	Q2 (40 %)	A1 (3.33 %)	A2 (3.33%)	A3 (3.33 %)	A4 (3.33 %)	A5 (3.33 %)	A6 (3.33 %)
LO1	15%			3.33%				
LO2	10%	2%	3.33%					
LO3	15%				3.33%			
LO4		10%				1.66%		
LO5		8%				1.66%		
LO6		10%					3.33%	
LO7		10%						3.33%

For each student, a particular LO is said to be achieved if his/her LO mark is equal to or greater than the target set as 50%. As an example, when computing LO2 attainment for Student X, the LO2 is mapped with Quiz 1, Quiz 2, Assignment 1, and the mark allocations are 10, 2 and 3.33 respectively as shown in Table 1. In term of LO2 attainment, suppose the Student X obtains 6 marks in Quiz 1, 2 marks in Quiz 2 and 2 marks in Assignment 1, the calculation procedures are as follows:

LO2 Marks = 6 + 2 + 2 = 10 marks

Maximum Possible LO2 Marks = 10 + 2 + 3.33 = 15.33 marks

$$\text{LO2 Attainment} = \frac{LO2\ Mark}{Maximum\ Possible\ LO2\ Mark} \times 100\%$$

$$= \frac{10}{15.33} \times 100\% = 65.23\%$$

Therefore, the LO2 of Student X is considered achieve, as it has exceeded the target set at 50%.

In this case study, the Key Performance Index (KPI) of LO attainments is set as 70%. The KPI is measured in such a way that the percentage of student number meeting the target of 50%. For instance, suppose there are 9 out of 37 students obtain at least 50% of LO2 attainment, which indicates that only 9/37 = 24.32% of students achieve LO2. In this case, the KPI of 70% has not been met.

Throughout the remaining of the subsections, the analyses of LO attainment will be carried out in 4.1. The observation of student performance in different cohort will be discussed in 4.2.

3.1. Analyses of the LO attainment

Figure 3 illustrates the attainment of Learning Outcome (LO) in different cohorts of students. For each student, a particular LO is said to be achieved if his/her LO mark is equal to or greater than the target set as 50%. For LO1, the students in the cohorts of T3-13 and T2-14 have not met the Key Performance Index (KPI) set as 70%. This reflects that most of the students have difficulty in performing calculations on the thermodynamic cycles. For the students at the cohort T2-14, the LO1 attainment is particularly low, which is just about 48% attainment. This has prompted to slow down the delivery pace in subsequent cohorts (T1-15 and T1-16), and the improvement of LO1 attainment have exceeded the KPI of 70%. Similar pattern to LO1 attainment, LO2 attainment has been improved through slowing down the pace of delivering the related topics.

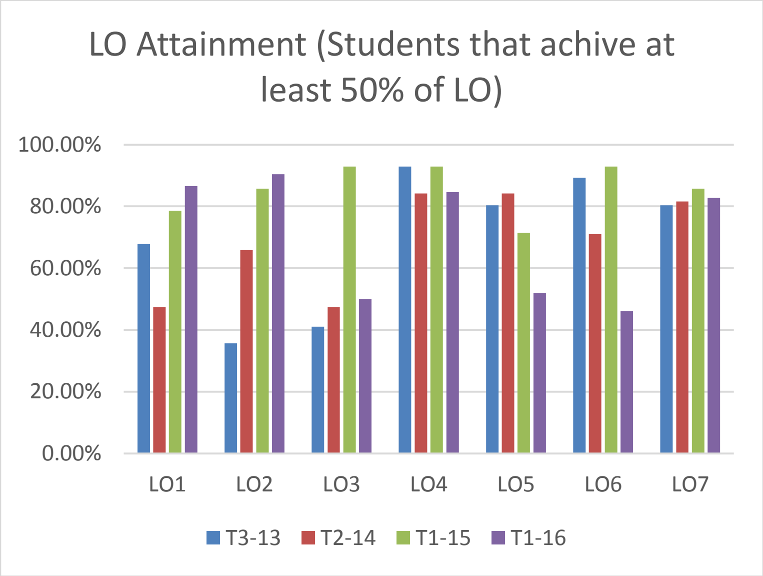

Fig. 3. LO Attainment of the students for different cohorts.

For LO3 attainment, the achievement is consistently low, except the outlier of T1-15 cohort. This shows that most of the students have difficulty to grasp the difficult concepts of reversibility and irreversibility. Therefore, it is suggested the indicative contents and assessment components that aligned with LO3 need to be reviewed. Some changes might be necessary in order to improve the attainment of LO3.

From LO4 to LO7 attainments, most of the cohorts have met the KPI of 70%, except the T1-16 cohort does not meet the KPI on LO5 and LO6 attainments. This could be due to the questions with high taxonomy level have been imposed on the exam, where the students do not have sufficient practice. This can be addressed by adjusting the difficulty level of the tutorials without revising the course syllabus.

Throughout the LO attainments of the 4 cohorts as shown in Fig. 3, most of the learning outcomes attained the KPI of 70%, which suggests that most of the indicative contents are well aligned with the LOs and have been helpful for the students. However, most of the cohorts perform poorly in the attainment of LO3, which is less than 50%. Therefore, it is necessary to review the contents that are related to LO3.

3.2. Observation of the performance of students

The relatively lower LO achievements for LO1 - LO3 may be due to the following observations: Quiz 1, which covers the Thermodynamics, is scheduled during the trimester period, and students have no study break before the quiz. In other words, a student may have just learned the topic and in less than a week they are put to test on the taught topic. On the contrary, Quiz 2, which covers Fluid Mechanics, is scheduled during the examination period, and students have a week a study break before the quiz, and hence students were able to perform in the quiz better. Table 2 shows the distribution of the Quiz 1 and Quiz 2 and the relative performance of students of the two quizzes.

Table 2. Comparison of students' performance of Quiz 1 and Quiz 2 in relation to the conduct of the quizzes in the period of the trimester.

Trimester	Teaching (first half including 1 week term break)	Quiz 1 Week	Teaching (second half)	Study break week	Quiz 2 week	% better performance	% worse performance
T3-13	1 - 6	6	8 - 13	14	15	84.21	15.79
T2-14	1 - 7	7	8 - 13	14	15	73.68	26.32
T1-15	1 - 7	7	8 - 13	14	15	35.71	64.29
T1-16	1 - 7	7	8 - 13	14	13	56.86	43.14

Looking into Quiz 2, when the quiz is scheduled after the study break, it can be seen that the amount of student who would perform better than the earlier quiz is much more than those who perform worse than the Quiz 1. One exception case is on the T1-15 batch, where there are only 14 students in the class, and most of them are re-moduling the course, which the performance is said to be just below average. In T1-16 trimester, the quiz is brought forward to the end of teaching weeks, that is, week 13, and it is seen that the number of students who would perform better in Quiz 2 is reduced to 56.86%.

On top of that, the performance of LO3 generally seems to be lower than LO1 and LO2. The content of reversibility and irreversibility are covered just before the Quiz 1, and students are generally having less than 1 week to familiarise with the content. Furthermore, the abstract concept of reversibility and irreversibility is difficult to grasp, which leads to the relatively low performance in Quiz 1.

As of the course structure, Quiz 1 and Quiz 2 cover different topics and therefore the instructor is obligated to follow. Both of the quizzes cover complex problem solving, where critical analysis and high mathematical skill are required to be demonstrated. The students are required to answer 4 long questions within 2 hours. Therefore, it is likely that the students do not have sufficient time to complete all the questions.

Looking into the performance of LO4 - LO7, which is in the Fluid Mechanics, students are performing relatively better in these areas. In addition to the observation mentioned in the previous discussion that students are generally having more time in the preparation for assessment, the lecturer's specialisation in the area would probably one of the contributing factors to the better performance.

Students are generally weak in the derivation of the equations and concepts, however the students still perform well in LO7 (exceed 80%) due to the fact that they have sufficient learning time. Therefore, student learning time is one of the key considerations in curriculum review.

It is noted that the measurement of LO attainments is merely based on the student academic achievement without consideration of student learning experience. In the next section, the feedback mechanism will be described, which allows the student learning experience to be captured.

4. Feedback Processes

In terms of classroom teaching, feedback is said to be a mechanism to drive the improvement among students, leading to better and more effective learning experience. In other words, this is an important element in promoting formative learning among students [14]. The feedback, as described by Ramprasad [15]:

> "*Feedback is information about the gap between the actual level and the reference level of a system parameter which is used to alter the gap in some way*"

The statement provides a clear picture of the idea of feedback, and the outcomes of providing the feedback, which is to close the gap between the actual level and reference level.

The curriculum review conducted by Hsih et al. [8], included students in the review process based on the belief that "*as consumers of education, students have the right and responsibility to be involved in curricular reform and communicate their ideas freely*", in which, there are also institutions who involve students directly in obtaining their feedback in the curriculum review process. On the other hand, Eluu [16] also reported on the involvement of student feedback to assist on the curriculum review undergraduate religion/education programme, which shows the importance of getting stakeholders' input in order to improve the curriculum, leading to better attainment of students' learning outcomes.

In addition to providing feedback to students to help them improve themselves, the educator should also humbly receives the feedback from students, and improve his/her teaching from the feedback. In various institutions of higher learning, various formal methods have been adopted to provide feedback to lecturers, such as Student Evaluation of Courses (SEC), Student Feedback on Courses (SFC) and Student Feedback on Teaching (SFT), which are put in place in the author's institution. It is recognised that the student feedback through the SFC alone may not be enough to collect sufficient information leading to the executable plans to improve the curriculum [17]. Hence, other feedback mechanisms, including peer observation of teaching, or student forum to collect information on teaching quality, are taken into consideration during the process of the curriculum review.

Feedback collected from these mechanisms are important, once analysed, it provides suggestions for the lecturer to close some of the gaps in their teaching and improve the teaching methods. Here, a very important factor in teaching and learning experience improvement is to be highlighted: change. In this regard, one should observe the response to students' need and observe how the change made by the educator will help students to improve their learning. As mentioned by Shagoury and Power [18],

> *"Observing students closely, analysing their needs, and adjusting the curriculum to fit the needs of all students have always been important skills demonstrated by fine teachers"*

Race [19] proposed the idea of feedback is best described by the Ripple on the Pond Model, that illustrates the importance of the process and adopted as the guideline to receive the feedback from students. Depicted in Fig. 4, the model address four main concepts, namely

- Wanting/Needing

  - Something that arises from the inner part of the mind, as a motivation to move
- Doing
  - Act of carrying out the idea
- Digesting
  - Process of think back of the plan and reflection
- Feedback
  - External response obtained

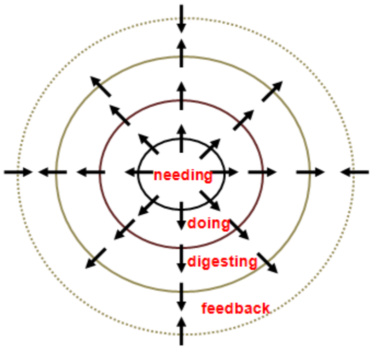

Fig. 4. Ripple on the pond model, proposed by Race [19].

Addressed by Race [19], a number of ways of feedback are obtainable from students to drive the change of the lecturer, namely reading body language, coursework, informal comments, peer feedback, self-reflection, structured questionnaires, open-ended questions and stop, start, continue method. In this paper, the last method of feedback collection is adopted and is termed by the author as the Start-Stop-Continue (SSC) strategy. This SSC strategy has been chosen based on the simplicity and effectiveness of the strategy in obtaining the feedback from the students. In addition, due to the nature and the design of the feedback format, students are also able to freely comment on anything on about the lecturer in a relaxed mood, leading to better lecturer-student interaction.

Universities conduct the curriculum review process to ensure the continuous improvements of the conduct in the programme. In engineering, the feedback obtained to improve the programme are in various ways, for instance, through the performance measurement [20, 21], or through the feedback from the industry for the state-of-the-art technologies required in the programme [22, 23]. These approaches are used to ensure that the revised curriculum is more relevant to students in their learning and the connection with the readiness of the outside world, and at the same time, to ensure that the programme objectives that have been set in the design of the programme are met at the end of the course.

4.1. Feedback collection through Start-Stop-Continue Strategy

To receive student feedback, using open-ended questionnaires might be particularly appropriate to obtain a good idea of students' learning experience [24]. However, using Start-Stop-Continue feedback mechanism produce greater depth than free text entry [25, 26]. The feedback session is conducted at the end of the semester, and the feedback collected are used as the reference for improvement for the coming semester. In the SSC strategy, instead of asking the questionnaire-type feedback, students are required to fill in the SSC form, as shown in Fig. 5.

START	STOP	CONTINUE	COMMENTS / ACTION PLANS

Fig. 5. The example of an SSC form.

The form is divided into four columns, namely “Start”, “Stop”, “Continue” and “Comments/Action Plans”, which are explained as follow:

***“Start”* -** This is the column for students to fill in the feedback on anything that they feel that the lecturer has not done in this course, but he should **START** doing this to improve their learning.

***“Stop”* -** Throughout the first half of the course, if students feel that the lecturer is doing something that does not help in their learning, and they feel that the lecturer should **STOP** doing that to improve their learning, they will comment on this column.

***“Continue”* -** The column is provided to students to comment on anything that the lecturer has been doing in the class, and they feel that the lecturer should **CONTINUE** doing this to enhance their learning experience of the subject.

***“Comments/Action Plans”* -** This is an extra column that is created to provide lecturer with some information on students’ action plan so that he can make necessary adjustments in his teaching to help them in making learning possible. Here students will propose their action plan to the lecturer and make the lecturer aware of their plan. Hence, the lecturer will be able to provide necessary assistance to the students when they need help with the basic understanding of their study plan. On the other hand, students are also free to comment on anything they feel about the lecturer and the course, and from here the lecturer will be able to improve himself from the comments.

4.2. Analyses of feedback

The feedback from the student through the Start-Stop-Continue strategy is collected and analysed. The “Start” feedback is obtained to show that things that the lecturer needs to start doing so as to make sure that students have better learning experiences. Table 3 shows the responses of students obtained throughout the trimesters.

Table 3. Selected "Start" comments for teaching Thermofluids from 2013 to 2015.

Ref.	T3-13	T2-14	T1-15	T1-16
i	*"Teach from the basic"*			
ii	*"Giving past year papers"*	*"Past Year Papers"*		
iii	*"Put all lecture notes on BlackBoard"*	*"Upload lecture slides before lecture"*	*"Releasing solutions before the lectures for self-learning"*	
iv	*"Different teaching approach to different students. Some students just need hints to do a problem, while others need to be shown an example etc…"*			
v	*"Give more difficult example"*		*"Introducing tougher example for better understanding"*	
vi		*"More Break ☺"*		
vii		*"supplementary work solutions"*		
viii		*"More illustrations and other media to engage students' attention"*		
ix		*"Summary of topics learnt"*		
x		*"Make lecture more interesting and not boring by telling jokes every now and then"*		

The idea of collecting "Start" feedback is to check what is lacking on students' perception, and that what a lecturer need to start working on. It can be seen that initially students are more concern with the conduct of the teaching as well as the provision of the teaching materials. However, as time changed, the concerns shifted to other behavioural feedback, such as "*More Break ☺*", "*Ignoring late comers*", and "*To be more patient*". The feedback reveals that they are also concern and more open to inform the lecturer about the behavioural issues that are affecting their learning.

In addition to this, the practice also serves as checking for improvement of teaching practice, that if the same feedback is provided every trimester, that means the lecturer has not been putting much effort in making the learning environment better for students. For example, item *iii* and item *xii* are seemed to be repeated every trimester for 2013, 2014 and 2015. Notwithstanding the repetition, the feedback is different from one year to another. For item *iii*, students are concern with the materials on the BlackBoard, the learning management system that used in the university. Such concerns have shifted from uploading the material (instead of giving hardcopies to students in the class), to upload the materials before the lecture. This was then changed to having the solution on the BlackBoard before the lecture. One can see the improvement that has been taken place, and shifting the concern on the student to the better learning experience to requesting a better service. Despite the request to have more difficult questions and having questions that are similar to the examinations, students seem to perform better as the years' progress (shown in Table 4), which is comparable to the LO attainment that is shown in Fig. 3.

Table 4. The comparison of the class mean for the four trimesters.

Trimester	Class mean
T3-13	60.32
T2-14	61.26
T1-15	65.08
T1-16	62.47

The "Stop" comments are collected to observe the practices that needed to stop so as to assist students to learn the course with least frustration. The idea of having such comments is to take note of the behaviour or practice that may affect students' learning experience. Ideally, such comment should not be appearing in the next round of practice to make sure that students' feedback has been taken into consideration and not repeated. Table 5 shows some of the selected comments in the "Stop" column.

Looking at the comments, it can be seen that some improvements have been made to improve the learning. In addition, such system also provides a good feedback on some of the teaching or assessment approach that may affect students' understanding and may not be effective in their learning. This can be seen on the trying out the essay assignments, in-class assignments and part of the assignments questions are given in the class, that is shown in items *i* and *v*. Students finds these assessments for the first course in Thermofluids does not help much in their learning and hope that this can be replaced with other types of assessments. The comments were taken note and changes are made, leading with no repeated feedback in the following trimesters.

However, there are also personal behaviours that will take a longer time to improve, for example, talking too fast, that will take a while to get used. One of the ways to improve this was informing students to slow the lecturer down immediately when they are not able to follow the lecture. The method showed some of the improvements, as every time when the lecturer as going too fast some students would start to inform the lecturer to slow down, leading to the better conduct of the lecture.

Summarising the "Continue" comments, the following feedback is collected:

- Good lectures overall
- Explanation of crucial concepts and giving examples
- Being approachable when replying to emails promptly
- Animatedly teaching
- Giving various types of questions
- Humorous and mentoring
- Treating everyone the same

From the comments, it is observed that students, regardless of cohort, are looking for an instructor who is approachable, interactive, and able to make use of technology to enhance students' learning experience. Hence, it is important that one should consistently look into how he/she can adapt himself/herself into the technology or innovative teaching to ensure maximum learning experiences.

Table 5. Selected "Start" comments for teaching Thermofluids from 2013 to 2015.

Ref.	T3-13	T2-14	T1-15	T1-16
i	*"giving so many essay assignments"*			
ii	*"Going too fast"*	*"Talking very FAST"*		
iii	*"being a horror film (shout) lol*"*			
iv	*"The interpolation for all questions in the quiz"*			
v	*"Give assignment question at 8.30am in the morning"*			*"Giving in-class assignments"*
vi		*"Erasing example questions on the board too fast"*		
vii		*"Giving too many examples, but fewer examples that are more related to examinations"*		
viii		*"Too strict with marking?"*	*"Setting hard questions for quiz papers"*	
ix			*"Using projector with screen up. Reflective glare on whiteboard is bad for students"*	
x				*"Assume people know everything"*

* lol means "laughing out loud"; a modern internet slang

5. Strategies for Improving the Performance

Throughout the discussions in previous sections, it has been found that improving the LO3 attainment is the key step to improve the overall performance. In doing so, it is suggested to impose more tutorial questions that are related to the LO3 and prolong the time span on delivering the topics. On the other hand, the delivering time span that related to other LOs will be shortened and may lower down the others LO attainments. Therefore, simply put more effort into an individual LO3 may not address the root cause of the problems.

In addition to having more tutorial questions, conducting Peer Assisted Study Session (PASS) [27] can also be considered in the strategy of improvement. PASS is a series of weekly learning sessions for students taking the identified traditionally difficult courses. PASS provide a platform to all students who wish to enhance their understanding and grades of the course. In the practice of PASS, the attendances to the PASS sessions are on the voluntary basis. In other words, students are not forced by the lecturer to attend the sessions, and they have the freedom to choose to attend these free sessions. Some students uses this sessions as an opportunity to get together with their friends to compare notes, to discuss important concepts, and to develop study strategies of the course. Each session is guided a PASS leader, who has previously taken and excelled in the course.

To provide a long-term improvement, the idea of enabling the students to focus on one area (either Thermodynamics or Fluid Mechanics) was proposed to the faculty and it was taken into the consideration in the programme review. From 2018, the course Thermofluids will be discontinued and the course has been replaced by two basic courses, namely Thermodynamics and Fluid Mechanics 1. Such arrangement will be able to help students to focus better on the area. In addition, it will also help to solve the problem where students are going through the assessments without complete understanding and preparation as what students are facing in the Thermodynamics section in the current course.

While splitting the thermofluids into two separate courses, which involves restructuring the other courses in the similar subject area in order to balance the stipulated total credit hours. Similar OBE to CQI process has been implemented for other courses. Without a doubt, it is rather time-consuming in terms of measuring the LO attainments, collecting student feedback and discussions among faculty members. Nevertheless, this gives a firm foundation for making major changes on the courses, which can avoid the future uncertainty that leads to unnecessary iterative changes of the course.

6. Conclusions

The curriculum review process based on OBE has been presented throughout the paper. The review process is based on the LO attainments of 4 cohorts of students, which demonstrates that the proposed change of the curriculum is based on profound data rather than intuitions between lecturers and students. With the data support of LO attainments, the shortfall of the curriculum have been explicitly reflected and necessary improvement has been made. Nevertheless, over obsessing on addressing the low LO attainments would tend to lose the overall expectation of the curriculum, particularly when maintaining both the standard of certain indicative contents and an appropriate amount of delivery time. In conclusion, taking consideration into student learning conditions, LO attainments provide a good indication on how to make an appropriate improvement.

A good student learning experience does not rely on curriculum improvement only but also other humanistic factors to provide a holistic engineering education for the students. In such a case, the contribution of a lecturer is important to achieve this. The improvements of a lecturer can be achieved through official feedback systems that are set by the university. However, there are also some informal feedback systems, for example, the Start-Stop-Continue feedback strategy that is adopted in this paper, has been proving the usefulness of informal feedback system to provide a more realistic, and constructive feedback to the lecturer to improve on his/her teaching.

Hence, the combination of both practice is said to be able to provide a holistic engineering education to students to provide a better learning experience in the learning of engineering. Furthermore, such learning experience can be further combined with the understanding of students' learning preference so a lecturer can cater his/her teaching based on students' learning preference, or provide additional assistance to students with the minor learning preferences to help them understand the course better.

As the preparation for future improvements, the measurements for the attainment of LO will be taken again when the individual courses are put in practice to observe the performance of LO attainment among students. In addition to this, the comparison of the performance of the courses will be taken in relation to the conduct of PASS sessions to look into the efficiency of the conduct of PASS sessions towards the improvement of class performance.

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