Course Design and Development: Focus on Student Learning Experience

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Abstract

Learning is not an outcome and, as a process, is more than just taking classes. It is a transformation journey a student walks through, and experiences picked up along the journey contribute gradually to student competence development. Competence, what companies are looking for from graduates, cannot be handed directly and will not be built unless the learning process is properly designed, developed and executed. This research work aims to present a process for course design and development, focused on embedding learning experience into a course. Bloom's Taxonomy is utilized for identifying learning outcomes. Kolb's Experiential Learning Cycle is introduced for planning learning activities for ease of learning. Last, but not least, a recently developed LOVE model is applied for the selection of teaching and learning methods for offering a diversified learning experience. An existing project-based learning engineering postgraduate course on Product Design and Development is assessed to illustrate the proposed process for course design and development.

Keywords: Bloom's Taxonomy, Kolb's Experiential Learning Cycle, LOVE model, Course Design and Development, Learning Experience.

1 Introduction

Learning is not an outcome. It is a process that creates neither knowledge nor skills nor competence. In fact, it is a process that creates an experience unique to individual students. It is a transformation journey an individual student walks through, and experiences picked up along the journey contribute gradually to the development of the student's knowledge, and skills. According to the report from the world economic forum (WEF, 2016), employees of 2020 are expected to be equipped with these top 10 skills: complex problem solving, critical thinking, creativity, people management, coordinating with others, emotional intelligence, judgment and decision making, service orientation, negotiation, and cognitive flexibility. Graduates are expected to be equipped with these skills and developed to have the competence to apply their knowledge and the skills to solve unforeseen complex problems. Unfortunately, competence cannot be handed directly and will not be built unless the learning process is properly designed, developed and executed because competence is developed from a strong experience.

Over the last six decades, engineering education has been designed principally based on engineering science model (Dym et al. 2005). The first two years are dedicated to a solid basis in science and mathematics to be a foundation for the next two to three years where students apply those principles to technological problems. Knowledge-focused teacher-centered learning has been a common practice and balanced with technical skills development. With this learning approach, knowledge is pushed to the students. Instructors typically design a course in a forward manner, meaning they decide what the students should learn; focus on the content development and on how to teach the content; develop assessments around their learning activities; and then attempt to draw connections to the learning goals of the course (Bowen, 2017). Since only the beginning is clear but the destination is not, learning outcomes may not be achieved. Students learn and gain their experiences mainly from lectures, assignments, laboratory sessions, project works, and a final-year project but what they have learned most of the time is inadequate to produce strong experience to build their competences. Furthermore, it is also not unusual to see the students manage to pass examinations without a

comprehensive understanding of the subjects which reflects the failure to achieve the learning outcomes of the courses.

Backward course design has been introduced and well accepted as an alternative to help improve student learning. With this design approach, knowledge is pulled to fulfil the requirements for achieving the learning outcomes. The instructors start thinking from a student's side with what they want students to be able to do after the completion of the course, followed by how to assess whether the students have achieved the learning outcomes, and move back towards the content development and on how to teach the content (McTighe & Wiggins, 2012). With a clear final destination, it keeps the instructors focus on achieving the final outcomes, and Bloom's taxonomy as illustrated in Figure 1 is a helpful and widely used resource for developing learning outcomes (Krathwohl, 2002).

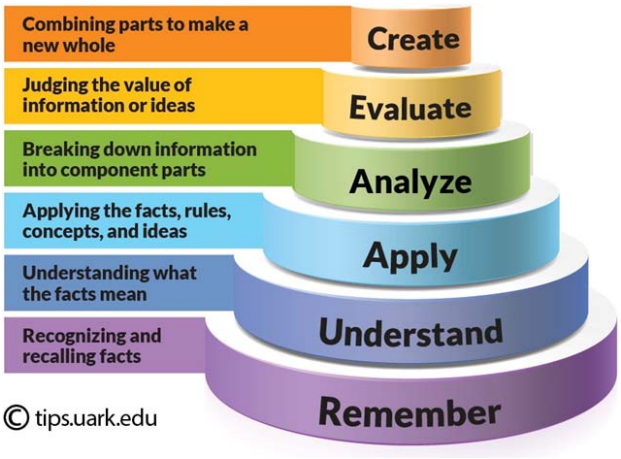


Figure 1. Bloom's Taxonomy (Shabatura, 2018).

Besides reversing process from pushing to pulling knowledge, shifting emphasis from instructors to students will also enhance the student learning experience. Student-centered learning has received much attention in engineering education in the 21st century (Mohd-Yusof, 2017; Lima, Andersson & Saalman, 2017; Koomsap, 2018). Putting students in an active role will further improve their learning beyond remembering and understanding the context of a subject towards being able to apply the knowledge and skills gained in other unseen problems. Lecture, a predominant direct teaching method in many higher education programs (Sajjad, 2010; Močinić, 2012) in particular, has been critiqued of being insufficient to support the intellectual and emotional involvement of the students in the cognitive process because activities for the students are listening, watching and reiterating, and is perceived to be inadequate for deeper understanding, problem-solving and creative work (Sajjad, 2010). Replacement with more efficient teaching and learning methods has been voiced out. Problem-based learning—PrBL (Mohd-Yusof et al., 2005; 2011; Salleh et al., 2007), project-based learning—PjBL (Hadim and Esche, 2002; Arana-Arexolaleiba and Zubizarreta, 2017; Lima et al., 2017), online learning (Iqbal, 2014) and flipped classroom (Toto and Nguyen, 2009; Zappe et al. 2009; De La Croix and Egerstedt, 2014; Gullayanon 2014; Kiat and Kwong 2014) are a few examples of innovative teaching and learning methods that have been seen more in delivery of engineering education to support active learning.

Recently, a LOVE model has been introduced to describe learning experience (Hussadintorn Na Ayutthaya & Koomsap, 2017). Student involvement in any educational process can be seen either as active or passive and it would usually depend on the type of approach used by teachers, methods and tools used, and also on students attitude. The nature of the learning process represents the type of connection offered to students during coursework. Absorption occurs when a teacher brings the ready-to-use content to the students. As opposite, students can physically get involved in the process, by participating in it. Learner role implies active engagement of students but with rather specific, teacher originating, content. Observer role is a passive type of experience that is also made on teacher-based content. Visitor role is also passive but the circumstances are not ordinary ones and students can get immersed with the experience that is not, or not completely, prepared by the teacher. Experimenter role is both active and immerse type of experience that gives students partially

or fully opportunity to use its own understanding and competences to participate and create the experience. In order to attain to researcher role, students must gain a variety of experiences which are transformative, influential, practical, effective and memorable to shape their research capability (Hussadintorn Na Ayutthaya & Koomsap, 2018). The outcome of this transformation is changing students from knowledge consumers to knowledge producers (Lovitts, 2005; Gardener, 2008). No matter if researcher like attitude and competences or just well-educated graduate are the desired outcomes of educational process LOVE model suggest to include all type of experiences in studying programs and in specific courses. If this is the case, balancing the experiences, which nowadays means including more active and more immersive approaches in education, should give the best results (Prince, 2004; Freeman et al., 2014).

Since some of teaching and learning methods, by their characteristics, share some similarities resulted in providing the same type of learning experience. The teaching and learning methods, reported in the pieces of literature, have been classified into four different categories of experiences (Hussadintorn Na Ayutthaya et al., 2019), as illustrated in Figure 2, to assist instructors for the selection of teaching and learning methods.

V-Visiting (passive immersion)	**E-Experimenting** (active immersion)
1. Field classes, trips and excursions 2. Conference 3. Virtual reality	1. Project-based learning (PjBL) 2. Laboratory classes 3. Virtual laboratory
O-Observing (passive absorption)	**L-Learning** (active absorption)
1. Lecture 2. Guided conversation 3. Integrated or interdisciplinary teaching 4. Showing video material 5. Seminars conducted in classes 6. Live lecture from a remote place	1. Discussion 2. Demonstration with exercising 3. Class debate 4. Small groups debate 5. Simulation 6. Problem-based learning (PrBL) 7. Programmed teaching 8. Workshop 9. Brainstorming 10. Case study 11. Online interactive learning 12. Game-based learning 13. Guided practical exercises 13. Role play 14. Assignments 15. Individual presentation

Figure 2. Teaching and Learning Methods on LOVE grid (Hussadintorn Na Ayutthaya et al., 2019).

Graduates who have exposure to a variety of learning activities are expected to perform much better than those who have gone through the conventional lecture, homework assignment and conducting laboratory experiment. However, not only learning outcomes and teaching and learning methods should be considered, but how the class is conducted is also important for the student learning experience. According to Kolb's experiential learning theory (Kolb, 1984), learning has a cycle having four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation, and they connect in this sequence to form a cyclic order. An instructor can design the learning process, to enter students into the learning experience cycle of a subject at any stage, and effective learning occurs when the students cycle through the four stages. Therefore, it is very important for all instructors to be aware of a journey that students walk through and try to ease their learning and to create a strong experience.

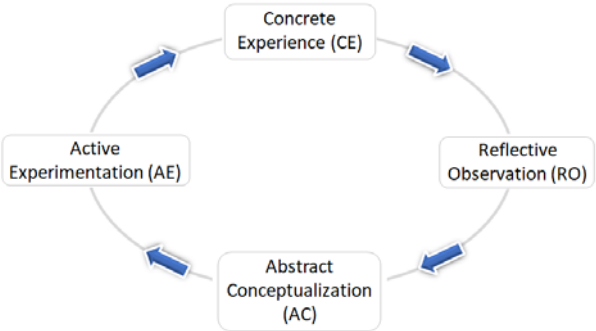


Figure 3. Kolb's Learning Cycle (Kolb, 1984).

This paper aims to make a contribution to the course design and development, focusing on embedding learning experience into a course. This contribution will be based on a process for course design and development following a backward design approach. Bloom's Taxonomy is utilized for identifying learning outcomes. Kolb's Experiential Learning Cycle is introduced for planning learning activities for ease of learning. Last, but not least, a LOVE model is applied for the selection of teaching and learning methods for offering a diversified learning experience. These three modes will be introduced in the next section before the introduction of the proposed approach for course design and development.

2 Learning Experience-Focused Course Design and Development

This section presents a proposed Learning Experience-Focused Course Design and Development (LEF-CDD) process.

2.1 LEF-CDD Concept

LEF-CDD is a student-centered approach focusing on designing a student journey of a course, which eases a student learning and creates a strong experience. How students will learn is as important as what they will learn. Bloom's taxonomy can guide on how to write and set the course learning outcomes properly. According to the Kolb's four-stage learning cycle, effective learning will occur when a student completes the cycle, but rather than expecting the individuals to complete their learning cycle by themselves, a proper design of the course will ensure the majority, if not all, of the students to achieve the learning outcomes. For each of the topics, the instructor can design to enter the students to this cyclic order of concrete experience (CE), reflective observation (RO), abstract conceptualization (AC) and active experimentation (AE) at any stage. When leading with sequential topics, if the cycle of one topic is completed before the introduction of the next one, the students will have a better understanding of the topic, and be ready to learn the new ones. Besides, diversifying teaching and learning methods as described in the LOVE model will further enrich their learning. Therefore, by having a clear set of the learning outcomes and assuming that the topics of the course are arranged logically to achieve them, the skeleton of the student journey is formed. The selection of activities to complete the cycles for all topics provides details to the journey, and the selection of teaching and learning methods decorates a memorable journey. This "ideal" student journey is illustrated in Figure 4.

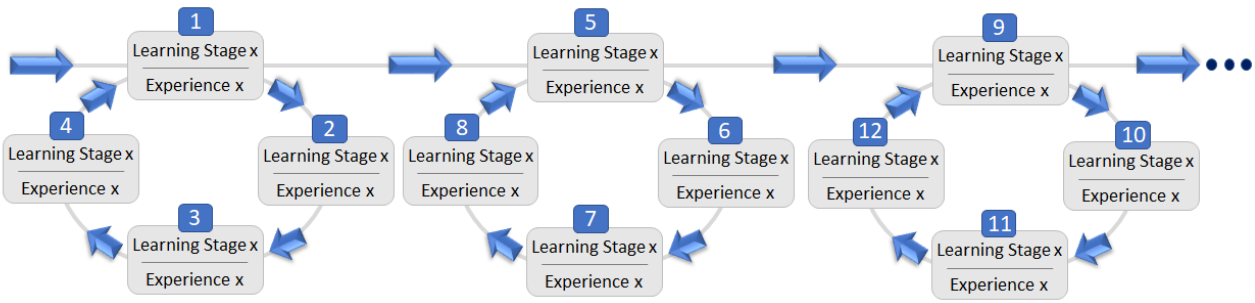
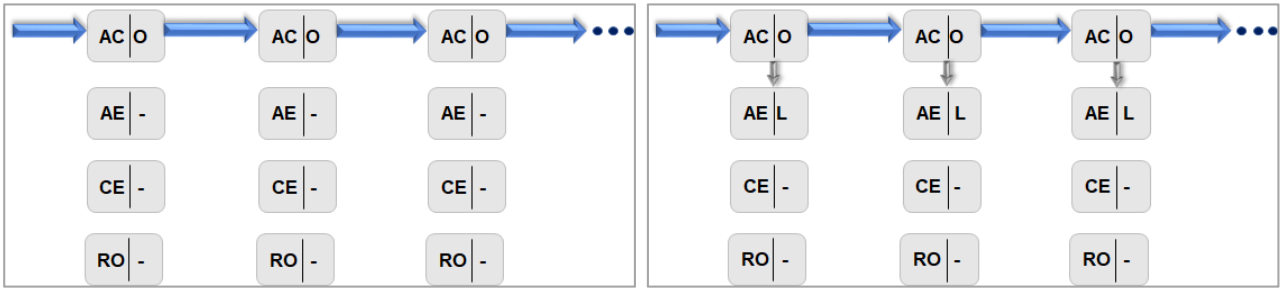


Figure 4. LEF-CDD concept.

The concept can also illustrate a flaw in the old teaching style that an instructor delivers lectures week after week, students enter their learning experience at abstract conceptualization stage and gain observing-experience. If there are no other learning activities and the students do not try to complete the loops by themselves, they will be stagnant at this stage and limited to only one type of experience. As a result, they will only manage to pass the examination, not to achieve the learning outcomes. Homework assignment and laboratory sessions will move them to the active experiment stage and give them learning-experience, but still, they are asked to close the loop by themselves. Unless they put effort to complete a cycle for each topic, their learning remains ineffective. Figure 5 illustrates the scenario.



(a) Intensive Lecture Type Class (b) Intensive Lecture and Assignment Type Class

Figure 5. Student Journeys in Conventional Lecture Type Classes.

2.2 LEF-CDD Process

Similar to other backward designs, LEF-CDD process starts with writing course objective(s), aligned with the expected professional competences, and applying Bloom's taxonomy to write course learning outcomes. The objective presents the purpose of the course and what an instructor will cover in the course while the outcomes present what the instructor expects students to be able to do after the completion of the course. According to the outcomes, course assessment and topics for attaining the learning outcomes are identified. Next, ease of learning and learning experience are considered together for each of the topics. By progressing topic-by-topic, the entry stage to the topic is decided. An entry activity is identified along with the selection of teaching and learning methods. It is important that after the completion of the entry stage the focus is on completing a cycle. The activities and supporting teaching and learning methods are identified for the successive stages. Ideally, most of the times, the cycle should be closed before starting of the next topic. In practice, it might be difficult, but the instructor should try to close the loop as soon as possible. Furthermore, the selection of teaching and learning methods should be diversified.

3 Illustration of the Application of the LEF-CDD

This section illustrates the application of LEF-CDD. Based on the current offering, a postgraduate course on Product Design and Development (PDD) is presented according to LEF-CDD process.

3.1 Product Design and Development

This is a 3-credit course containing 30 hours of lecture and 45 hours of laboratory. Students will learn and practice how to design products systematically in a team environment. It is a participant-centered learning course that the students actively involve. Lecture materials include, but not limited to, slides, case study, games, interesting animations, and videos. Most of the lecture sessions contain discussion and students are encouraged to participate actively in the discussion. For topics such as strategy, obtaining voices of customers, identifying customer needs, and concept generation, there will also be activities in class before students practice them in their projects. To increase understanding of the subject, the students are required to do literature reviews, group project, and presentations. The literature reviews are individual assignments. The group project is for the students to develop and practice several skills including, but not limited to, decision making, problem-solving, communication, critical thinking, negotiation, conflict resolution, and teamwork. Presentations are a part of the project and assignments for personal development and knowledge sharing.

Lectures and group project are run in parallel. For laboratory sessions, all groups will share their progress on the projects to the class and receive feedback from their instructor and classmates.

In sequence, the application of the LEF-CDD process will be illustrated by presenting the course objectives, the expected learning outcomes and the planned learning experiences, classified according to the Kolb's and LOVE models.

Course Objective:
Effective product design and development process is necessary for a company to be competitive in the market. The objective of this course is to provide students knowledge on a systematic approach for product design and development process. In this course, the students will learn and practice how to systematically design products in a team environment.

Learning Outcomes:
On the completion of this course, students should be able to: 1) analyse products offered in a market for their effectiveness; 2) develop a mission statement according to the identified business opportunity; and 3) systematically apply knowledge learned for the design and development of a product.

Assessment Scheme:
The weight distribution for calculating the final grade is as follows: final examination 30%, group project 40%, individual assignments 10%, and class participation 20%.

An "A" would be awarded if a student can demonstrate a clear understanding of the knowledge learned in class as well as from literature reviews, can apply the knowledge appropriately in the project, and involve actively in class discussion.

Course Outline:
The topics covered in this course are presented in Table 1, and according to learning activities in the course, the sequence of learning stages is identified. Learning experiences are also analyzed from the teaching and learning methods used.

3.2 Discussions

As illustrated in Table 1, a sequence of learning stages and learning experience have been introduced into the topics. It can be seen that abstract conceptualization (AC) is the common entry stage for most of the topics. Besides, concrete experience (CE) is the entry for course explanation and video illustration of previous years projects at the beginning, and active experiment (AE) is the entry for the Kano model and concept generation.

It can be seen that cycles can be completed quickly when the instructor introduces cases or activities during the lectures instead of waiting for the students to close them during the project time. For example, for the topic of blue ocean strategy, the instructor gives a case study for the student to practice in a group. All groups present their strategies to class to share and get feedback and finish with group discussion. The learning cycle of this topic conducted recently is illustrated in Figure 6. For other topics with no activities during the lecture, the students will complete the cycles after they experience them in the project and sharing them to the class to get feedback during the laboratory sessions. Since some of the project activities take time, the students cannot complete them before the starting of the next topics. If the instructor can bring in activities to the lecture, the cycle will be completed much sooner. There exists also topics at the end of the course that the students will have to complete the learning cycles by themselves.

In term of learning experience, the students will gain L, O and E types of experience from lecture, case study, presentation, group project, class discussion but if the instructor can take them to see this product design and development process be done in practice, LOVE learning experience will be complete.

Table 1. Learning Experience Embedded Course Outline.

Main Topic	Subtopic	Sequence of Learning Stages (Learning Experience)			
		AC	AE	CE	RO
I. Importance of Product Development	1. Introduction			1 (O)	2 (L)
	2. Product Development Strategies	3 (LO)	4 (LE)	5 (LO)	6 (L)
	3. Development Processes and Organizations	7 (LO)			
II. Product Concept Development	1. Mission Statement	8 (LO)	9 (E)	14 (LO)	15 (L)
	2. Customer Need Assessment				
	2.1 Obtaining Voice of Customers	10 (LO)	11 (LE)	12 (LO)	13 (L)
	2.2 Identifying customer needs	16 (LO)	17 (LE)	18(LO)	19 (L)
	2.3 Kano Model	23 (LO)	20 (LE)	21 (LO)	22(L)
	3. Product Specifications	24 (LO)	30 (E)	31 (LO)	32 (L)
	4. Quality Function Deployment (QFD)	25 (O)	34 (E)	35 (LO)	36 (L)
	5. Concept Generation	29 (O)	26 (LE)	27 (E)	28 (L)
	6. Concept Selection	33 (O)	40(E)	46 (LO)	47 (L)
III. System Level Design for Product Development	1. Process Driven Design	37 (LO)	41 (E)	46 (LO)	47 (L)
	2. Product Architecture	38 (LO)	42 (E)	46 (LO)	47 (L)
	3. Industrial Design	39 (O)			
	4. Design for manufacturing	43 (O)			
	5. Prototyping	44 (O)			
	6. Economics of Product Development Projects	45 (O)			
	Entry Stage				
	Fulfil during the group project				
	Self-learning				

Presented in Figure 7 is the summary of student surveys conducted after the deliveries of the blue ocean topic to Master students at two different universities. The delivery at Asian Institute of Technology (AIT) was a part of a regular course and at Thammasat University (TU) was a three-hour seminar. The feedbacks were very similar. Overall, the students were satisfied with the deliveries. Additional information about the survey are as follows:

AIT Master's Students (2nd year student):

- Demographic data (valid responses = 8): male = 50%, female = 50%
- Some comments and suggestions from this group of students are 1) a valuable course to follow in an excellent working environment; 2) PDD session is interesting because the class arrangement is different from common classroom studying sessions; 3) module is interesting and we are getting time to express our ideas and improve thinking in different ways; and 4) love attending this course.

TU Master's Students:

- Demographic data (valid responses = 47, total responses= 52): male = 34%, female = 66%; 1st year student = 57%, 2nd year student= 43%
- Some comments and suggestions from this group of students are 1) I gained pretty much of knowledge from this class; 2) the quality of instruction and instructor was good; 3) the instructor was widening my perspective from the examples of many brands; and 4) I would love to attend his other seminars.

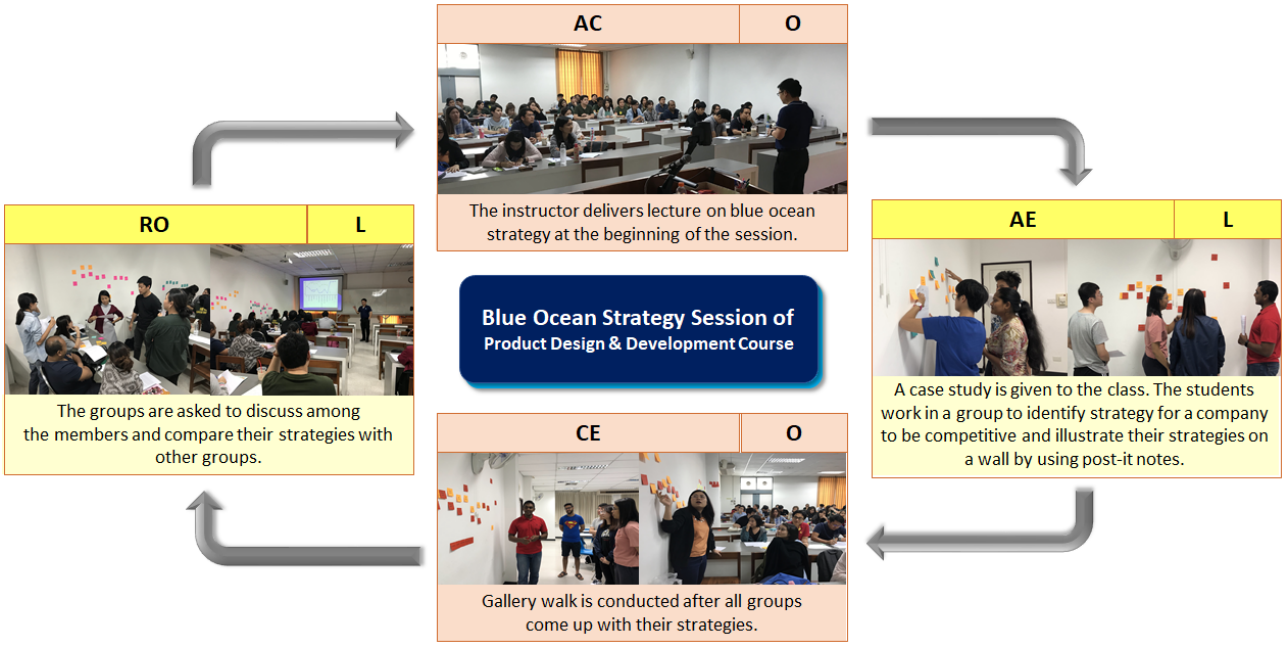


Figure 6. Learning Experience Cycle of a session on Blue Ocean Strategy.

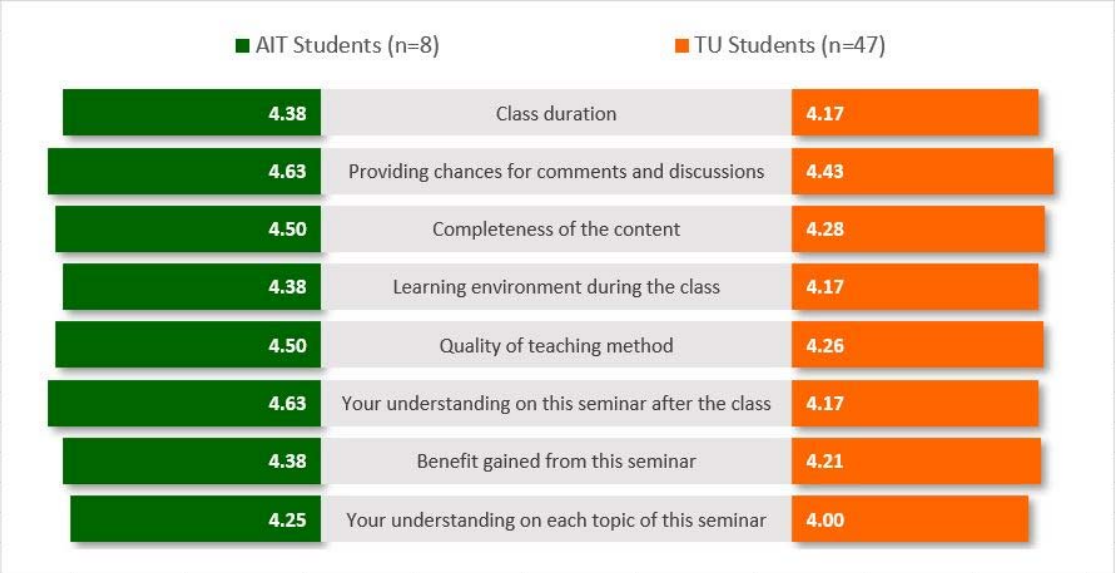


Figure 7. Student Satisfaction on Blue Ocean Strategy Session of Product Design and Development Course.

4 Conclusions

Engineering instructors are not required to obtain educational training on curriculum design, development and delivery before entering the profession of being a teacher. Thus, usually, teachers mainly replicate their experience as students, focused on teacher-centered activities. Nowadays, student-centered learning activities are known to be the most effective for learning success. A process of course design and development that embed learning experience has been developed. The development was based on the following main principles: the course should be aligned with the professional needs; the expected development of the students should be clearly stated by learning outcomes; the learning experiences should respect the Kolb's learning cycle with the application of experiences intentionally chosen by the instructor, in this case, based on the LOVE model. This model was applied to a Master Product Design course and applied into settings. The perceptions of the students were mainly positive. Despite the fact that this design process should be analyzed with a large number

of courses, instructors, and students, this first experience gave good indications of its usefulness. The team has the intention to apply this model in more course design experiences, which will give an opportunity to analyze further its usefulness and its robustness.

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