Combining Innovative Technology and Context based Approaches in Teaching Software Engineering

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***Abstract*—Sustainability in learning is very essential for a sustainable future which largely depends on education. Sustainable learning requires learners to increase and rebuild base-knowledge as the circumstances change and get more complex. This becomes very obvious particularly for information technology (IT) discipline where technology is rapidly changing and practice getting more complicated. Sustainability enables students to use their learning from formal education into practice, provide hands on experience (HOE) and help them rebuild their knowledge base in complex situations. This is also essential to achieve a high graduate outcome rate (GOR) which helps the education sector to become sustainable. In the existing policies and frameworks, institutions are moving towards more off-campus learning and less face-to-face learning. As a result, a downward trend is experienced in students' engagement across IT discipline. This affects students' ability in achieving HOE and appears to be one of the reasons of low GOR which poses a threat to the sustainability in the education sector for both stakeholder and learners' perspectives. This paper presents a combined approach of context-based teaching with incorporation of innovative technology to engage students and achieve a better HOE towards sustainability in learning. The proposed approach was adopted in a software engineering course taught at School of IT at Deakin University, Australia. Students were provided context-based teaching material and industry standard software engineering tools for practice to achieve HOE. Students evaluation and assessment results reports that proposed approach was significantly impacted positively to engage the students in classes towards improved sustainable learning.**

Keywords*—Sustainable learning and education; context-base teaching; work integrated learning; hands on experience; graduate outcome rate; positive attitude and engagement

I. Introduction

Sustainability in our future [41] and societies is not easily achievable unless our learning and education sector is sustainable [34], [35], [39]. Therefore sustainability in learning [40] has drawn much attention from many education providers, researchers and stakeholders of sustainable development programs [34], [35], [39]. If education itself is not sustainable then achieving the factors for sustainable development and global citizenship programs is hard to be successful [34], [35]. Sustainable learning is not only limited to the retaining the knowledge [35]. But it is more towards the rebuilding of knowledge and skill-base dynamically as the circumstances change and get more complicated [35], [5]. IT discipline and related industries are facing massive technological evolution [30]. Therefore, sustainable learning is getting more essential component for IT discipline [6]. Sustainable learning requires learners to be proactively engaged in learning from past and present following a constructivist approach that enable them to relearn the knowledge, achieve more HOE and then take the new knowledge into practice for an ever-changing technological discipline [37]. From the stakeholders and business perspective, large-scale investments are also required in the education sectors for sustainability [34]. Therefore, existing policies and educational frameworks are moving towards more on extended off- campus learning and less face-to-face learning. Following the emergence of the pandemic, many institutions are also interrupted from their usual face-to-face learning and are forced to go off-campus/on-line learning [39]. It has been observed a downward tendency in students' proactive engagement which affects achieving HOE and thereby sustainability in learning.

In the information technology discipline, HOE have been explored in many studies [1], [2]. Patricia et al [1] found that more participation on hands on activities help students to achieve higher scores in a standard science-achievement test. Atanas Serbezov [2] et al. showed that students in this discipline need to understand the fundamental working principles of the field instruments' and how these can be integrated into an overall industrial systems in engineering. Literature studies [1],[2] indicate that the main objective of the universities is to provide education to the students in the fundamental areas of the engineering discipline. At the same time, universities need to extend the educational activities to make the educational programs more market oriented and relevant to the corresponding industry trend. Atanas Serbezov [2] et al. found a total of 10% increase in GOR in their quantitative study across few years while they included industry engagement as part of their learning activities.

Sustainable learning in IT discipline requires effective practice in classes to improve HOE by providing students with a real life experience aligned to the theoretical lecture classes. Therefore, many education providers are investigating and testing different ways of teaching methods including located mode practical classes, simulated laboratories, remote laboratories [3], [4] and combination of those [5], [6]. The purpose of these innovative teaching approaches is to engage students and provide HOE which make them ready for the job market after their graduation. In the IT discipline, many software/tools for practical classes are collected from open source or organized from different sources which generally are behind from the dynamic industry market [5]. In many evaluation frameworks [5], with these tools and software

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support for achieving the learning outcome, due to the frequency of practical classes, volume of submissions and complexity of the evaluating the assessments many practical classes are not well assessed. Students are often assessed based only on their summative assessment tasks or based on a combination of assignments and practical assessment tasks with practical assessment tasks have less fraction of total assessment marks of the subject. Therefore, students' participation has been declining in the practical classes in IT discipline across different institutions. This is a concern considering student engagement that results a cohort of technology graduates with inadequate domain knowledge which is a primary obstacle in the pathway of sustainable learning. In achieving successful learning outcome and relearn through deconstruction and reconstruction, student's attitude, motivation and engagement are important [10], [9] which are the key factors for sustainable learning. Therefore many innovative teaching approaches including context-based teaching methods, inquiry-based teaching methods and incorporation of innovation technologies in engineering and IT teaching have been adopted [11], [12]. In [13], Bennett et al. have completed a systematic review and have found that context-based teaching and incorporation of innovation technologies in teaching that worked effectively in developing positive attitude in students' learning activities.

Context-based approaches improve the learning materials and curriculum, then uses different context and applications of the theories in learning activities. Students learn how their learning outcomes can be applied in real life. Many researchers [14], [15], [16] have found that context-based approaches are useful and change students' attitude positively in achieving learning outcomes. However, context-based approaches may vary from discipline to discipline and within a particular discipline the approaches may vary over time. For example, innovation in technology for IT is very fast. This fact significantly affects the industrial market and also changes the job criteria for the graduate. Students need to be able to have a certain level of early experiences which should be achieved through their education in order to get into the job market. To achieve the learning outcomes and be up to date with the fast technological evolution, several factors need to be considered. Approaches to increase the positive attitude in learning activities and engage students into the activities is a possible direction of improvement in achieving hands on experience.

It also has been observed that applications of innovative technologies [17], [18] in teaching approaches including computer simulation, multimedia applications, online as-assessment process and visualization techniques have led to more positive attitude which motive students to engage and provide them enjoyment during their learning session. For ITE discipline, the use of IT tools and techniques is obvious and most of the intuitions are applying these in their teaching activities. For IT students, these approaches appear to be standard practices and may not be much motivating factor. A more motivating approach will be an approach that can give students hands on experiences (HOE) in the engineering methods and techniques, tools software in IT which will be beneficial immediately after their graduation. In this research, a combination of the above two approaches will be used which combines context-based and incorporation of innovative technology in order to engage students, relearn knowledge from past and achieve better hands on experiences (HOE). The procedure will incorporate commercially popular tools/software in the learning activities for students' engagement and will provide related learning resources. Improvement of learning material will be done progressively and its practice will be completed in practical classes.

The rest of the paper is presented as following. Section II discusses the related work. Section III discusses proposed methodology (Materials and methods), data analysis and performance measures. Section IV presents the result of this study and last section discusses the conclusions of this study.

II. Related Work

A. Sustainable Learning and Education (SLE) in the Current Literature

To achieve sustainability from stakeholder perspective, educational institutions are moving towards more off-campus education [33]. Therefore sustainability in learning and education is a rapidly growing research area. Jay Hays, Hayo Reinders [34] proposed a detailed curriculum for SLE and identified the expected learning outcome. They also made a conclusion on the principles of sustainable learning. Mina Chiba [34] presented a detailed review of effective teaching methods for sustainable development and global citizenship. Asmat Ara Shaikh, Anuj Kumar et.al, [36] investigated application of artificial intelligence (AI) and its sustainable impact on online learning for off-campus classes. They find that AI is useful in automated identification of gap in learning. Fatma [37] proposed a discriminant analysis technique to predict teachers view towards sustainable education. Fatma [37] concluded that criteria for curricula evaluation and students centered teaching are the key factors that identify teachers' dispositions for sustainable education. O. Polyakova and R. Galstyan-Sargsyan [38] studied tele-collaboration based sustainable education systems. They find that plurilingual competence can be developed in tele-collaboration which helps sustainable university training. Alvyra Galkiene˙ et al [39] has investigated modeling of the sustainable educational on a group of vulnerable learners and they find that innovative technologies such as digital tools have a positive impact on vulnerable students for sustainable education. Existing literature has a gap to understand how a better HOE can be achieved towards sustainable learning. The problem of achieving high HOE gets more complicated for off-campus students. Many research studies and practices in engineering have been accomplished to address this issue. Considering the importance of HOE in higher education, many teaching approaches have been studied in different literature [1]-[10], [11]-[16], [19] including remotely operated laboratory for off-campus students, simulated laboratory for off-campus and on-campus students, and students' placement and work integrated learning.

B. Remotely Operated Laboratory for off-campus Students

Mihaela M. Albu et al. [3]-[4] have shown a remote operation of power engineering instruments can be used for off-campus students. In these cases [3]-[4] the authors find

that if machines constraints are properly implemented such that students cannot do any mistake beyond the normal operating conditions, then the experimental environment can be set up successfully. However, this study has shown that the approach has limitations where students cannot have full experiences of field experiences in using the power instruments for abnormal situations. In a real life situation, power instruments can go to abnormal condition frequently.

C. Simulated Laboratory for off-campus and on-campus Students

In contrast to remote operated laboratory, simulated laboratory and simulations tools are very common approaches in IT and Engineering discipline. A simulated laboratory is an experimental environment which uses internet, information technology tools [5]-[6], programs and multimedia and networking facilities to simulate a real experimental environment. These approaches are used particularly in Engineering and IT discipline where instruments are very expensive or experiential processes are risky. For example, in IT discipline, conducting experiments for different types of targeted attack on a computer or a network, testing firewall vulnerabilities and cyber warfare in real environment is highly risky. Most classroom experiments use simulated network environment or a combination of simulated and real environment. Simulated tools are beneficial for off-campus education as well. A review [5] shows that simulations tools have many limitations. Many simulation tools [5] cannot facilitate performance analysis, available only for limited protocol, not fault- tolerant, inadequate Graphical User Interface (GUI) and have limited documentation which makes them difficult for off-campus education. A comprehensive study by Muhammad Azizur Rahman [5] on network simulation tools shows that these tools often can reach incorrect implementation solution due to lack of generalization and rigor. To overcome these and in order to provide HOE, a combination of real and simulation environment can be provided. Sushil K. Sharma et al [6] presented a case study on information security education hands on approach at Ball State University, USA for three courses where every course had 20-25 students. It is seen in this study [6] that students were highly engaged in the courses and participation in practical classes was maximum compared to other courses. This kind of real experimental environment provides students HOE and are fruitful for students' engagement as students enjoy the classes and get excited which they cannot do using simulation tools at their home environment. However authors [6] did not mention about any result whether this approach was considered for off-campus students. Literature studies [5]-[6] show that one of the difficulties for many IT courses in IT discipline is many experiments require real environment including security and hardware related subjects which are difficult to offer for the off-campus students due to inability to support for practical classes.

D. Students' Placement and Work Integrated Learning

Students' placement and work integrated learning are also used to provide students with a real life experiences achieve HOE in engineering and IT discipline in many institutions. Work integrated learning (WIL) extends the formal university studies with a placement in work place before they graduate. WIL can be organized at the end of program or every year or in any particular course. Particularly in engineering and medical discipline [7]-[8] this is compulsory in most of the institution's undergraduate programs. Statistical analysis and research [7]-[8] show that the approaches have been able to fill the gap of students' understanding about the theory and its application in practical work.

E. Gamification Approach of Engaging Students and HOE

In many research studies [26]-[28] gamification has been used for educational process which was successful in engaging students that improved students' motivation towards learning and assessment activities. Gamification process in teaching is defined as the transference of game design in teaching activities to increase students' motivation in learning [28]. Often this process allows students to achieve an instant reward based on their progress in the classroom tasks [26]. In [28], the authors accomplished a study based on gamification with cohort of 97 students which demonstrated a positive impact on students' attitude and achievement. Li Ding, Chan Min Kim et al [29] used a gamification approach in online discussion forum and developed a tool named 'gEchoLu' to investigate the effect of specific game in the tool for engagement. Flipping the class model is a popular approach of engaging students in learning activities. Jingying Wang et al. [25] used a combination of flipping model and innovative technology to engage students. They find that the combined method was successful in knowledge construction and improved the transfer of new knowledge. Curtis R. Henrie, Lisa R. Halverson, Charles R. Graham [30] provides a detailed review on student engagement using innovative technology. In this review [30], they mentioned the limitations and strengths of technology mediated teaching. They [30]] find that evaluation of technology-mediated teaching can provide meaningful student engagement data. In [30], it is observed that quantitative observational measures are effective at the activity level which disrupts comparatively less to the students in learning during data collection but expensive.

F. Campus-Class-Technology (CCT) Theory in Engagement

CCT theory was proposed by Selim Gunuc [31] who explained the relationship be- tween technology and student engagement. CCT theory describes that the value given by the student in their university life is one of the important factors for which students have the sense of belonging to a university. Then CCT theory continues a cyclic path which states that academic achievement have influence on the value for which students have the sense of belonging to a university. CCT theory [31] shows that technology is the prime factor which contribute to the student engagement. In [32] Selim Gunuc tested CCT theory with path analysis which was conducted on 332 teachers and students. It was observed that value of belonging positively impacted emotional engagement which predicted behavioral and cognitive engagement. It shows that the use of technology in class was an important factor in student engagement. Although different approaches have been adopted to engage students. In the literature, student engagement in the context of HOE was not revealed much. Therefore, achieving HOE for students still is a crucial research problem for institutions due to the dynamic job

market, changes in technologies and cost due to organize the tools/equipment for engaging students. Therefore, it is important to investigate more on student engagement and achieving HOE.

III. Materials and Methods

Research [11]-[13] shows that students' positive attitude and engagement affect largely not only in achieving HOE but also in accomplishing other theoretical learning activities. Therefore engagement has been active research keywords in teaching and learning domain for long time. Many approaches have been proposed including active learning [22], context-based teaching method, inquiry-based teaching method [11]-[13] , flipped classroom [20], incorporation of innovation technologies in science teaching have been proposed. Flipped class room allows the students to complete their homework in lecture class time and traditional class activities are accomplished at home [20]. In this case, students watch the lecture video, read the lecture notes and additional reading at home. This is a new instructional model and it is observed that this model helps students to be engaged in the class, particularly for lecture classes. A review of different flipped models has been presented in [21]. However, if there is a downward tendency in attendance in practical classes in the current setup, then flipped model may not be a good choice. In contrast, context-based teaching approaches introduces attractive learning materials in which learning activities are designed based on the application of the theories [14]-[16] with varying context and real life examples. Several research studies [17]-[18] show use of innovative technology including visualization, simulation model of real environment, has also been useful for positive attitude of students towards learning activities. Earlier studies [13]-[16] on students' attitude shows that context-based teaching method and incorporation of innovation technologies in engineering teaching have been effective to gain positive attitude of students towards learning activities. This draws an attention for current studies to focus on these methods [14]-[16] since HOE is more related to context-based approach where learning context varies as technology changes. In addition, inclusion of innovative technology [17]-[18], [30]-[32] can attract students' attitude which can be made available in the practical classes. Based on the literature review, a hybrid model has been proposed that combines the context-based teaching and incorporation of innovative technology. In this context, the proposed approach resembles the active learning approaches [22] in the practical classes where students accomplish meaningful real-life learning activities and can think about what they are doing. However, proposed approach not only considers the meaningful activities, but also considers innovative learning tools to engage students and at the end of practical learning sessions may provide higher level of HOE.

A. Research Design and Procedure

The proposed methodology incorporates attractive industry-aware content and tools/ software which will cover both traditional theories and industry practices in the lecture content of the course. Then those lecture contents are made related to context-oriented practical classes where students will have the activities related to contemporary industry practices. The assessments will also include the tasks based on the weekly practical classes. The procedure will incorporate innovative commercial software/tools in the learning activities for practical classes and will be made available for off-campus students. Context- based learning material will be delivered progressively on a weekly basis in both lecture and practical classes.

B. Case Study and Data Analysis

The proposed methodology considers the "Software engineering"– course as a testbed as the target discipline is engineering and IT. As part of the process, new context-based learning materials have been introduced from the beginning of the trimester in the lecture class in every week. The topics have been selected through the literature study and industry practices, based on author's own industry experiences and through the consultation with industry experts. The industry consultation has been performed with a renowned software modeling expert in Sparx systems, Australia [24]. Participants are post-graduate students.

C. Design of Lecture-practical Content and Assessment Tasks

Summative assessment task is considered for main evaluation of students' engagement and achievement of HOE. The course has two assignments and final examination. During each week, there is an ungraded formative assessment task. For comparison of the proposed methodology, the assessment tasks have been designed such that main objective of the tasks remain same as the previous year. However, the approach of solving the assessment tasks should be based on the new industry practices and context-based teaching. In every lecture, new contents have been added which are practiced in the industry. A typical assessment task is to prepare an analysis and design report to improve an existing web application by identifying new services (epics) where services should include dynamic content update, functional processing, and navigation and over all presentation of the existing web site. The whole analysis process should include modern agile scrum approaches, target is to prepare different artifacts such as personas, a product story map backlog, use UML profile [24] to prepare content and process class models, navigational and functional models and sprint backlog for the proposed services. An example of context-based material is given below: Students need to develop a process class model from the user-interaction scenario of a web application. Students need to keep in mind that the model should be useable later stage in the navigation design and implementation of the application.

1) Engagement fact in the lecture material: How to integrate processes in the navigation when any user interaction requires the system to response to the users and; the processes should be visible or system's internal processes. This integration requires students to think and find the processes by investigating the user interaction scenario for the web application. In every lecture, a number of context- based facts were included in order to engage the students For example, for the above topic, students were shown an example piece of code where the processes from their process model could be used and the way practically it is done using a real

programming environment. In this case, it has been shown to the students the relationship between a Java Server Programming (JSP) technique [42] and Java Bean (JB) instantiation [42] of process classes with their design process classes. These techniques (JSP and JB) [42] are very popular in the current industry practices and students will achieve industry standard HOE through the learning process.

2) Context-based and innovative industry practice/ activities in the practical classes: In practical classes students had to use the most popular industry standard software engineering tool "Enterprise Architect (EA)" [24] to design the above models. For example, to relate the theory of lecture with practical, in the practical class, it also has been demonstrated how the code is generated from their design and relationship between design and generated code. That will give them ability to maintain the design and code in future.

3) Design of assessment task: Assessment tasks were assigned group wise and were designed so that students must follow the industry standard tool using EA. An assignment group consists of two students. In the first assignment, students have been advised to use supplied commercial software engineering tool. In the second assignment, it was mandatory to use the provided tool (EA) [24]. In addition to this, the second assignment includes more tasks related to industry practices such as development of Unified Modeling Language (UML) profile [43] and use of the UML profile [43] in their design, development and integration of the data model in the navigational and functional design for a selected web application. An example in the assignment was related to the lecture content where students were asked to develop the analysis and design model of a web application. Students will complete different analyses including content, interaction, functional, configuration and relationship-navigation as part of the requirement analysis. Then students need to prepare different design models including content, navigation, functional, architecture, component and web application extension UML (WAE) model [44]. A part of the assignment task was to prepare the conventional analysis and design models and then integrate this with UML profiling [43]. A part of a sample design task is presented in Fig. 1, Fig. 2 and Fig. 3.

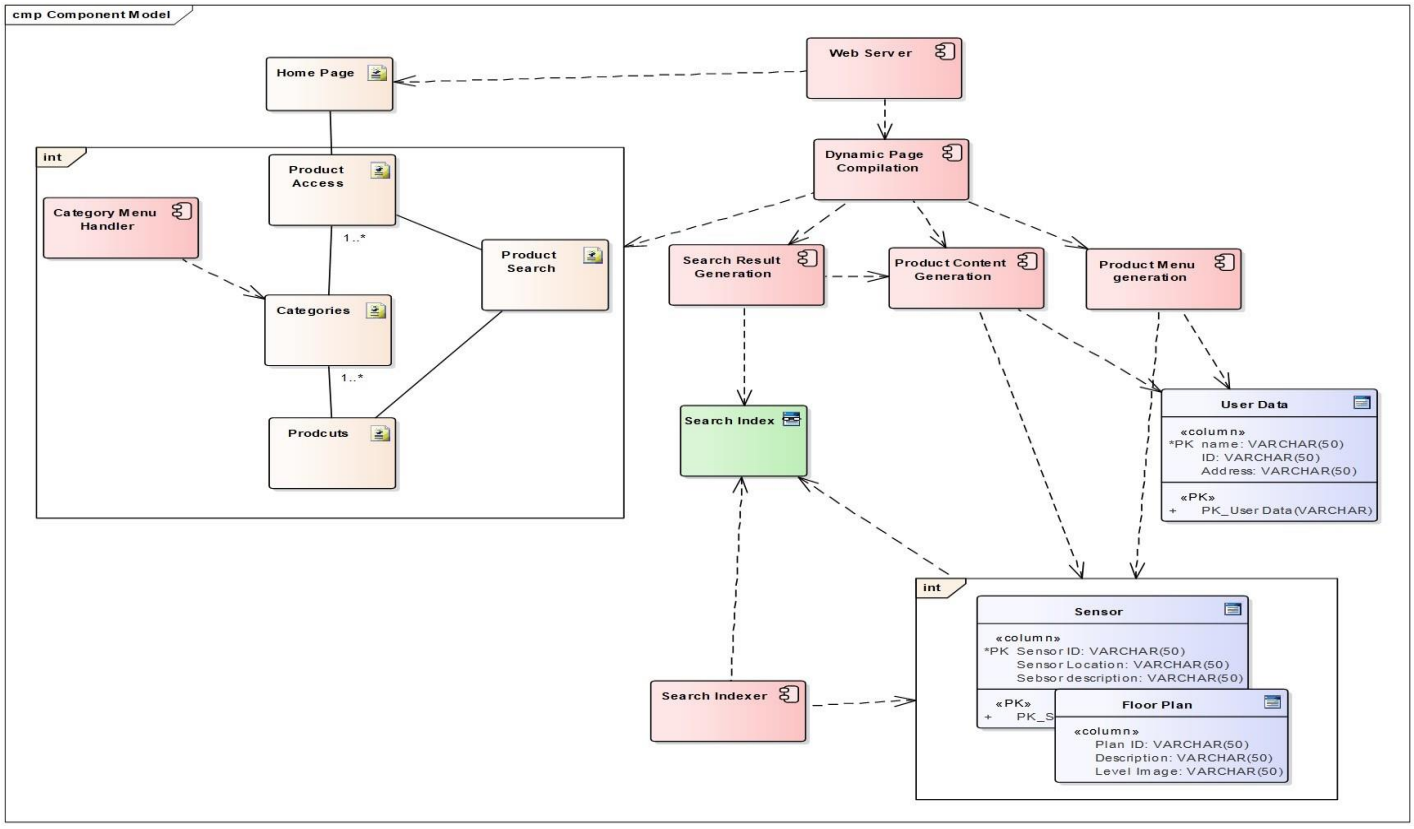

Fig. 1. A Functional Architecture of a Safe Home Web Application. The Design has been Redeveloped using EA following the Source[23].

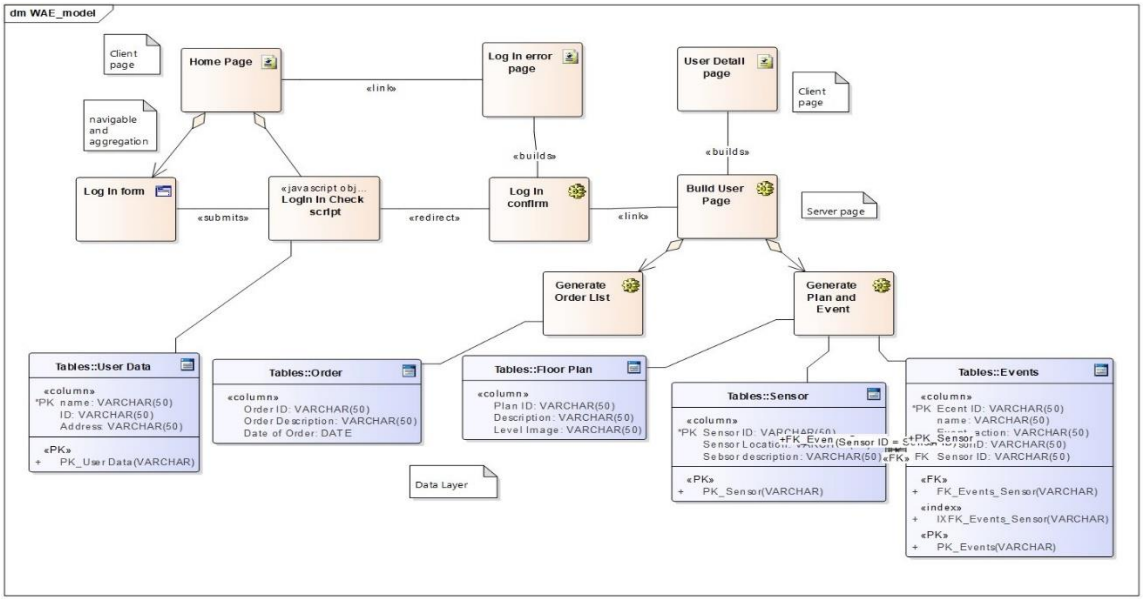

Fig. 2. A WAE Model of a Safe Home Web Application. The Design has been redeveloped by using EA According to [23].

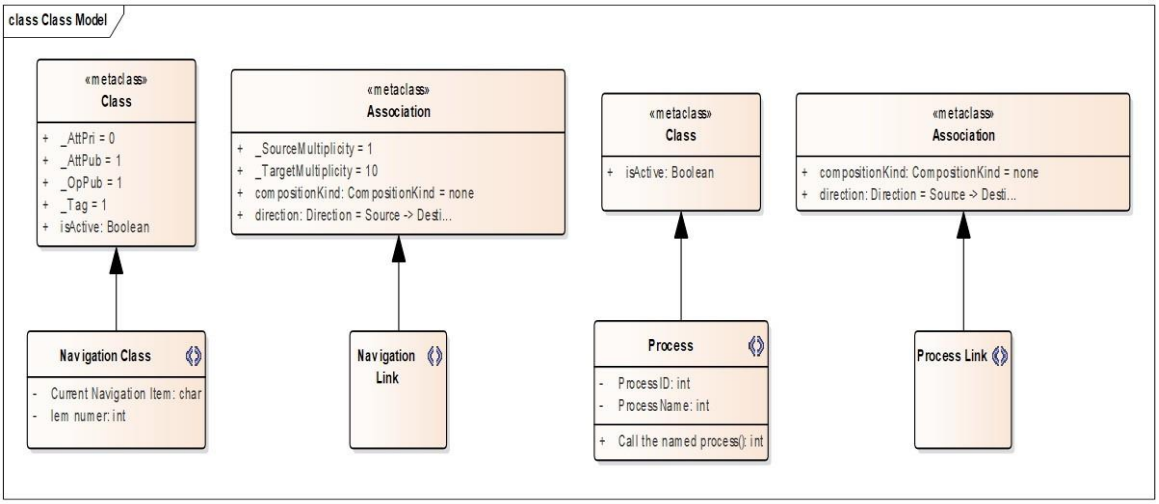

Fig. 3. A Part of a Typical UML that Student will Practice and Integrate in different Levels of their Web Application Analysis and Design.

IV. Results and Discussion

A. Performance Measures

1) Students' engagement: An anonymous survey was conducted at week-6 of 11 week trimester and continued its participation till the end of trimester using CloudDeakin system which is an online teaching and learning system used by Deakin University. Different questions have been presented by asking whether the students were attracted and influenced in the practical and lecture classes through the delivery and teaching material. Students have also been asked whether they think the content will be helpful for them in finding a job. A sample question on assessing students' engagement has been presented as below: "Have these industry related activities using EA attracted and engaged you in the course?" Student's answer should be in four categories "High", "Medium", "Low" and "Not at all".

2) Importance of face to face contact: To justify the significance of face to face contact, survey questions were introduced whether students feel comfortable with face to face teaching in practical class. A sample question is presented here: "Do you think it would be difficult if you don't come in practical class to learn the techniques of EA? (What is the level of difficulty?)" The answer should be: "Very difficult", "Difficult", "Easy" and "Very easy".

3) Learning achievement: This has been measured through the achieved marks of two assignments by the students and compared with earlier offer of the course.

The survey results are automatically stored in the CloudDeakin and statistical analysis has been shown in the below Tables I to Table VII.

TABLE I. QUESTIONS RELATED TO THE MEASURE MENTIONED IN ITEM-1: UML PROFILE HAS BEEN PRESENTED IN THE MATERIAL. DO YOU THINK THAT IT WILL HELP YOU LATER?

Answer	Number of Participants	Percentage
True	19	95%
false	1	5%

TABLE II. QUESTIONS RELATED TO THE MEASURE MENTIONED IN ITEM-1: UML PROFILE IS EXTENSIVELY USED ININDUSTRIES AND ORGANIZATIONS. DO YOU THINK IT CAN BE AN ADDITIONAL INDUSTRY SKILL THAT YOU LEARNT FROMTHIS COURSE?

Answer	Number of Participants	Percentage
True	19	95%
false	1	5%

TABLE III. QUESTIONS RELATED TO THE MEASURE MENTIONED IN ITEM-1: IN THIS COURSE, ENTERPRISE ARCHITECT (EA) HAS BEEN INTRODUCED FIRST TIME. MANY NEW AND INDUSTRY STANDARD OBJECT ORIENTED DESIGN TECHNIQUEUSING EA HAS BEEN ADDED AND DELIVERED. HAVE THESE INDUSTRY RELATED ACTIVITIES USING EA ATTRACTED AND ENGAGED YOU IN THE COURSE?

Answer	Number of Participants	Percentage
High	8	40%
Medium	11	55%
Low	0	0%
Not at all	1	5%

TABLE IV. QUESTIONS RELATED TO THE MEASURE MENTIONED IN ITEM-1: HOW DID YOU ENJOY THE DEMONSTRATION OF PRACTICAL TASKS INCLUDING THE VIDEO AND IN CLASS DEMONSTRATION?

Answer	Number of Participants	Percentage
Very well	11	55%
Well	6	30%
Less	3	15%

TABLE V. QUESTIONS RELATED TO THE MEASURE MENTIONED IN ITEM-1: ARE YOU ENJOYING THIS COURSE SO FAR?

Answer	Number of Participants	Percentage
Very well	6	30%
Well	11	55%
Medium	1	5%
Not much	2	10%

TABLE VI. QUESTIONS RELATED TO THE MEASURE MENTIONED IN ITEM-2: DO YOU THINK IT WOULD BE DIFFICULT IF YOU DON'T COME IN PRACTICAL CLASS TO LEARN THE TECHNIQUES OF EA? (WHAT IS THE LEVEL OF DIFFICULTY?)

Answer	Number of Participants	Percentage
Very difficult	7	35%
Difficult	13	65%
Easy	0	0%
Very easy	0	0%

TABLE VII. QUESTIONS RELATED TO THE MEASURE MENTIONED IN ITEM-2: IF THIS COURSE IS OFFERED IN FULL ONLINE MODE IN WHICH THERE WILL BE NO PRACTICAL CLASS IN CAMPUS, DO YOU THINK IT WILL BE DIFFICULT FOR YOU? (WHAT IS THE LEVEL DIFFICULTY). GIVEN THAT SAME/CURRENT MATERIALS ARE PROVIDED BY ONLINE ONLY. (WHATIS THE LEVEL OF DIFFICULTY?)

Answer	Number of Participants	Percentage
Very difficult	4	20%
Difficult	11	55%
Medium	5	25%
Easy	0	0%

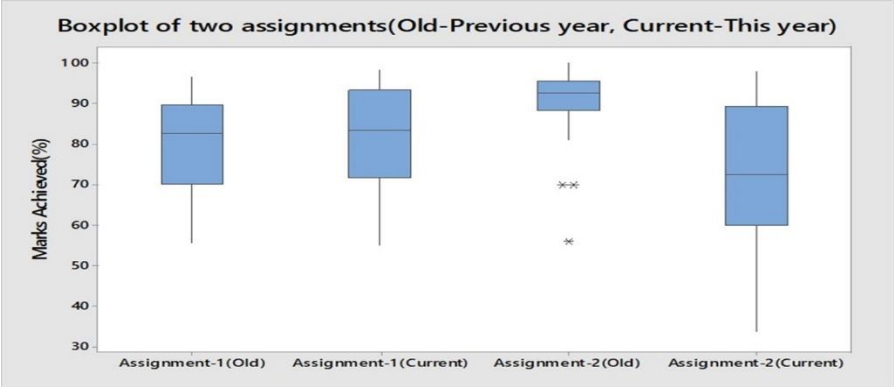

Fig. 4. Boxplot Comparison of Two Assessments' Results for this Year and Previous Year.

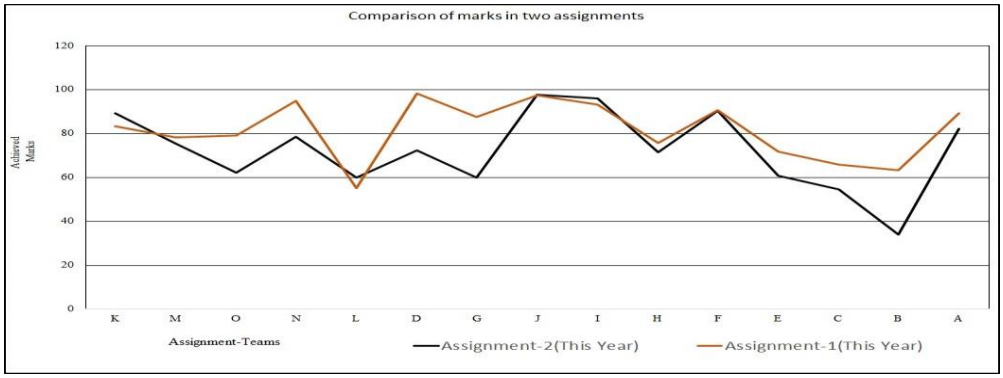

Fig. 5. Group Wise Marks for Two Assignments in this Year.

The survey results clearly show that the proposed approach has been able to engage students with a positive response rate equal to 95% for measure-1 metric within the participants. In the questions measure-2 survey results show that most of the students will face difficulties if they don't attend the practical class and fully online mode of the delivery will also be difficult for the students. To compare the performance of proposed approach for the measure-3, previous year's assessment results of the same course have been compared with this year's results. The students' personal information has been de-identified for both cases and then statistical analysis has been prepared which is presented in Fig. 4. It is observed in the results in Fig. 4 that there is a consistent distribution of marks in first and third quartile of this year's marks. In previous year, the boxplot for assignment-2 has very less gap between upper and lower extreme points with several outliers. In previous year, lower extreme of assignment-2 is also almost equal to the upper extreme point of assignment-2. This clearly shows an unbalanced distribution between the achievements. In contrast, this year boxplots of two assignments have similar patterns and wider extreme points. This shows a consistence and progressive achievement.

Fig. 5 shows that the group-wise marks follow approximately similar pattern across all the group. While in assignment-2, achieved scores are lower than assignment-1, it still follows similar pattern. The reason of lower score in assignment-2 could be explained as the increased difficulty in assessment task-2 compared to assignment-1.

V. Conclusions

High graduate outcome rate (GOR) is one of the key objectives for a sustainable education system. Achieving a good GOR every year and continually outperform is not so easy. One of the key strategies in this pathway is to achieve sustainability in the learning itself. Equipping the learners with the environment and ways of deconstruction and reconstruction for relearning form past are the key factors to achieve high standard hands on experience (HOE) and thereby sustainability for learning. Among many hurdles to achieve the HOE, one of the most important challenges is to keep students proactively engaged in learning in a blended learning model with off-campus students. In this study, a combination of teaching strategies has been proposed including the context-based teaching and incorporation of innovative technologies to achieve sustainability in the learning and education (SLE). A case study is accomplished where software engineering course was considered as a test bed to justify the performance of proposed approach. In the proposed approach, particularly, high standard industry focused teaching material and commercially popular software engineering tools have been introduced to keep the students engaged and being tuned in the course, thereby achieve more sustainability in learning. The statistical analysis of the results of the case study proves the significance of the proposed approach. However, there are limitations in the proposed approach which can be expanded in a future work. 100% engagement was not possible which can be achieved by applying minor assessment on a weekly basis or a milestone task-based minor assessment in the course and then comparing the learning outcome with the proposed

approach in this study. Other strategies such as a combination of flipped classroom model and innovative tools can also be investigated.

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