Developing an Evaluation Framework for Immersive Learning Experiences for Software Engineering Project Course

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ABSTRACT

Most of the principles and concepts that need to be taught in Software Engineering courses are hard to share the realistic experiences because it is difficult to give the student practical exposure to the insight and processes involved. There is a non-existent approach to conveying the concepts of applying Agile Scrum and Team Software Process (TSPi) that involve learner, instructor and business stakeholder. This paper will explain the concept of a framework for efficiently building an immersive learning environment for both learner and instructor of Software Engineering Project course with the involvement of business stakeholder. This provides an opportunity for learning to be more focused on learning design through the prism of immersive environments rather than the collection of information. The online surveys were disseminated to third-year students who took the Software Engineering Laboratory course and the projects' stakeholders. This study aims to gain feedback from both sides on the effectiveness and suitability of the framework and concept in teaching and learning the course. Our experience in the creation, conduct and iteration of the course is outlined in this paper. It ends by assessing the degree to which we were able to achieve the course objectives established by the students and stakeholders.

Keywords: immersive learning, software engineering, experience, knowledge management.

I INTRODUCTION

In Computer Science, especially in Software Engineering courses, students' success and failure depend on the collaboration between the team members. The Software Engineering students must be taught on the theory and technical aspects of the software development discipline and the effectiveness of teamwork and social capabilities.

A significant component in Software Engineering courses is a software project development. The objective is to develop a software product for users or stakeholders who intend to use it regularly. Furthermore, students will learn to solve real industrial problems in the team. The Software Engineering students must not only be taught on the theory and technical aspects of the software development discipline, but also the effectiveness of teamwork and social capabilities.

TME3413 Software Engineering Laboratory (Jali, Masli, Shiang, Bujang, et al., 2017) is a course at the Faculty of Computer Science and Information Technology (FCSIT), UNIMAS. It offers to the third-year students of Software Engineering programme students who have grasped and self-equipped with the fundamentals of programming languages, scriptings, software modelling and database management system (DBMS). These skills and knowledge help the students to develop different kind of systems.

II BACKGROUND

In coping with Future Ready Curriculum, a transformative delivery in teaching and learning such as Immersive Learning based on experience for the student to discover and share their experiential learning through hands-on and engagement with the industry and community (MOHE, 2018). Sharples states that Immersive Learning enables individuals to experience a situation as if they were there, using their expertise and tools to solve an issue or learn skills. In a virtual location, creating a feeling of partial immersive learning often involves Augmented Reality (AR) or Virtual Reality (VR) (2019). Applying Software Engineering project development with this learning pedagogy enables the students to experience real-world industry exposure with a real case study, stakeholder and the community. This allows the students to ask, learn strategies for solving problems and gain information by learning.

Immersive Learning Experiences focused on face-to-face teaching and blended learning methods that provide an impactful and meaningful learning experience to the students by allowing them to be actively engaged in tasks or projects that are not restricted to classroom settings (Carroll, 2014).

Students will experience communicating with the stakeholders (local entrepreneurs) and building a quality software product that requires understanding. Thus, students will learn to perform user analysis, identify a value proposition, and analyse user experience data. Furthermore, working in a team

effectively and excellent time management are essential skills to accomplish a common goal (Bruegge et al., 2015; Rodriguez et al., 2015).

Active learning is assessed through students' oral communication skills. Students are given the opportunities to both discuss and observe their peers. It is also believed that real-world software development project experiences encourage students to enhance their written and oral communication skills (DiYanni et al., 2020; Offutt, 2013). Students will be assisted in developing problem-solving, critical thinking and analytic skills that are all valuable instruments in which students can prepare for better choices, become better students and finally better future employees.

Students have always been exposed to the necessary fundamentals, theories, and concepts in previous courses, but have not been asked to use these skills in real projects exposure settings with actual stakeholders. Assessments mainly solve the case studies taken from the textbooks or capstones projects, and students are not engaged with the real world project and actual clients. This course will help students to experience using Agile software development methods in industrial experience projects. The industries will be among the small and medium-sized local entrepreneur or stakeholders. During the semester, the project team will work together through the full development cycle, from understanding the requirements to delivering a functioning product. It will make a series of presentations and reports of the work to the client and the course coordinator.

III METHODOLOGY APPROACH

This TME3413 – Software Engineering Lab course practices involved the adoption of the Team Software Process (TSPi) (Jali, Shiang, Masli, & Asmadiah, 2019; Over, 2000; Sussy, Calvo-Manzano, Gonzalo, & Toms, 2008) and Agile software methodology for managing software projects in the industry. The Team Software Process (TSPi) provides a series of operational processes to the software engineers, which can help them organise software development projects more efficiently and effectively and improve their projects' quality and productivity.

Meanwhile, Agile Software development focuses on individual and interaction, working software, stakeholder collaboration, and responding to change. It is an iterative, incremental method in the software development process. Both processes have similarities in terms of assigning roles and responsibilities and defining and discussing risks and issues to remove impediments (Jovanović et al., 2015).

Three important factors influence the software quality and team or organisation performances; Product, Team or People and Technology. Referring to the Figure 1.0, the process is placed at the centre of the triangle connecting these three factors in which the efficiency of the software process is measured via defects, productivity, calendar time, and so forth. Besides, three environmental conditions may influence the quality and performance, which include; Customer/Stakeholder characteristics (communication), Business condition (requirements rules) and Development Environment (Software tools).

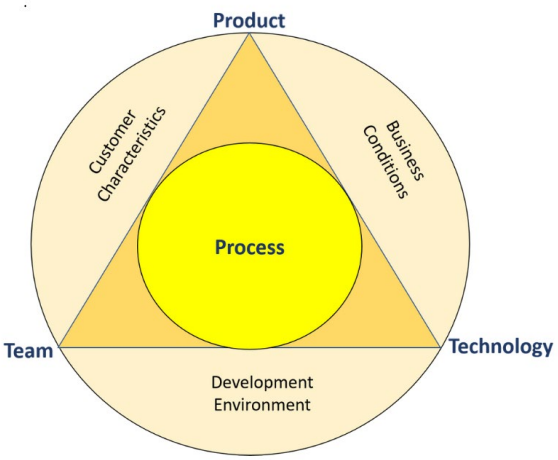

Figure 1.0. Software Engineering Lab Project Framework (Jali, Masli, Shiang, Mat, et al., 2017)

A. Product

- The teams were given a list of real world projects and each project involved small-sized business stakeholders.
- The teams also encourage to find their own business stakeholders that suit for the project course.
- Defined their team's and project goal and project milestones.
- Elicited requirements via conversational, observational, analytical and synthetic methods.
- Dliverables include software requirements and design documents (eg: SRS, SDS, working system, summary test repost, user manuals, etc.

B. Technology

- Integrating software tools and techniques in improving the efficiency of software development process.
- Utilise different tools for project management: TSPi support tool, Trello application, AgroUML, GitHub, Dropbox, so forth.
- Techniques/programming: Unified Modelling Language (UML), Java, PHP, and so forth.

C. Team

- The team formation between 5 to 7 members per group depends on the number of students course's enrolment.
- Project team emphasis on the roles and responsibilities
- A good collaboration and communication between team members, instructor and clients.

IV IMPLEMENTATION

Since every software project is different, there is no set list of deliverables that every project must provide. Part of the teams' task is to decide what is needed for this specific project. Typical deliverables include working code, documentation, training materials, test suites, etc.

The three primary criteria for a successful project are satisfying the client's needs, the usability of the product, and maintainability over the life of the product. These are group projects, but the students will also be rewarded individually for extra contributions to the project or fail to provide a fair share of the effort.

The project consists of two phases of a software product. The first phase is exploratory and represents the first attempt at developing the proposed software product. The deliverables for the first phase are reports 1 (revised proposal and SRS) and demo 1. After that, the instructors will provide feedback, and the students should reconsider and possibly revise the project goals before moving on to the second phase. It is acceptable to modify your objective in the middle of the semester, once the teams learn more about the project and better understand what they can accomplish within the semester timeframe.The deliverables for the second phase are report 2 (revised SRS, SDS, Test logs etc…) and demo 2.

Table 1. Project Deliverables

Project Deliverables					
Phase 1			Phase 2		
Proposal Presentation	Initial Report	Demo 1	Final Report	Demo 2	e-Archive
Week 5	Week 10	Week 10	Week 13	Week 14	Week 15

This course does not assess on written examination and more on assessing the team's final product (e.g., design, report, presentation), their group processes (e.g., ability to meet deadlines, contribute fairly, communicate effectively). The course assessments are summarised below;

Table 2. Course Assessment

Course Assesments							
Continuous Assessment (70%)					Final Assessment (30%)		
Project Proposal & Planning	Requirement Specifications	Design and Implementation Specification	Testing & Release	Presentation	Peer Evaluation	Individual Evaluation (Personal log, participation, presentations, etc.)	Team Evaluation (foundation and functioning)
10	15	25	10	10	10	10	10

This course approaches provide a meaningful learning experience to your students;

i. Help students gain a deeper understanding of concepts by seeing their application in complex real-world situations
ii. Involve students in active learning and encourage discussion.
iii. Nurture interpersonal or communication skills
iv. Teach the students how to manage time effectively

V STUDENTS' ENGAGEMENT/ INVOLVEMENT

As a means to support teaching and learning, the Bloom's Taxonomy (Anderson, Krathwohl, & Bloom, 2001). is used for designing the projects' learning activities. It consists of a set of three hierarchical models that classify the learning objectives into three learning domains; Cognitive (knowledge), Psychomotor (skills), and Affective (attitudes).

According to Bloom, the Cognitive domain includes six levels of intellectual skills that are arranged into a hierarchy from simple to complex behaviours; knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom, 1956). In Psychomotor domain, the skills described were those specific to physical movement, coordination and utilising motor skills. The Affective domain involves five areas that deals with emotional factor, also arranged into a hierarchy from simple to complex ways of dealing with things emotionally; receiving, responding, valuing, organising, and characterising (Bloom, 1956) (Krathwohl, Bloom, & Masia, 1964).

Therefore, the projects' learning activities will enable the students' engagement with team members, instructor and stakeholders in meaningful learning in cognitive, psychomotor and affective learning domains.

a. Cognitive Domain

Solving cases from real clients/stakeholders (with analytically and creativity), applying software methodologies, teams prepare the reporting and deliverables (eg: reports, logs, codes etc..). Conduct the discussion and presentation with the teams, stakeholders and the course's instructor.

b. Psychomotor Domain

Perform requirement elicitation (interview, survey, observation etc..), using suitable Computer-Aided Software Engineering (CASE) tools for each software development phases (software, hardware, online tools etc..).

c. Affective Domain

Time management in completing the system, communication skills and professionalism acts with teammates and stakeholders, excellent interpersonal skills, constructive feedback, and individual/teams responsibilities.

These domains activities apply to the proposed Software Engineering Project Learning Activities, illustrated in Figure 2.0. This learning activity framework has been practised for TME3413 Software Engineering lab course since 2017.

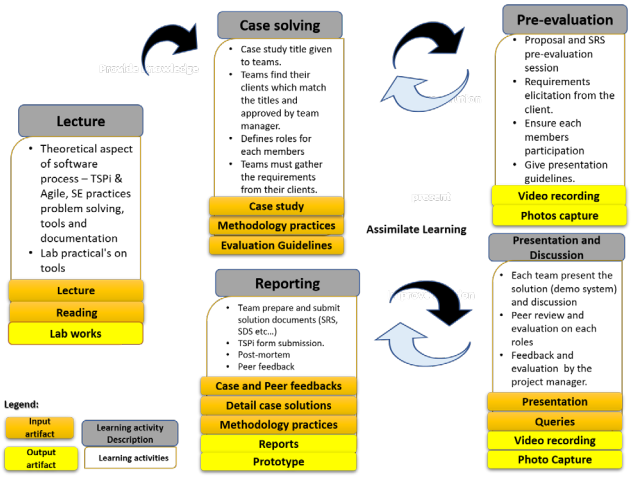

Figure 2.0. TME3413 – Software Engineering Project Learning Activities

Since this study was conducted and completed before the COVID-19 pandemic began, the framework has been successfully implemented and the results were presented in this paper. However, in light of the current COVID-19 pandemic situation, some framework components may not be suitable and have to be omitted or replaced with other means. For example, the face-to-face interactions between students, instructors and clients may be impractical due to the constraints caused by the lockdown, like fulfilling the Standard Operating Procedure (SOP), social distancing, students were not allowed to return to the university and other restrictions. Hence, another way to conduct the face-to-face interactions that will still fulfil this framework's objectives is by using online video conferencing tools like Skype, Microsoft Teams, Zoom Meeting, Google Meet, and other similar tools.

VI ACHIEVEMENT AND FEEDBACK FROM STUDENTS AND STAKEHOLDERS

A. Course Learning Outcomes (CLO) Achievement

Students who enrolled to TME3413 Software Engineering Laboratory course required to submit their evaluation form on the quality of the course content, teaching and delivery. Based on the students feedback, all the CLOs have been fully achieved (refer to Figure 6.0) and the list of CLOs are as follow:

CLO1: Practice the use of Software Engineering methodology in a team environment using a real-world application.

CLO2: Demonstrate the advantages of using several Computer-Aided Software Engineering Tools (CASE Tools) in major phases of software development.

CLO3: Complete an application solution for an organisation problem in a team.

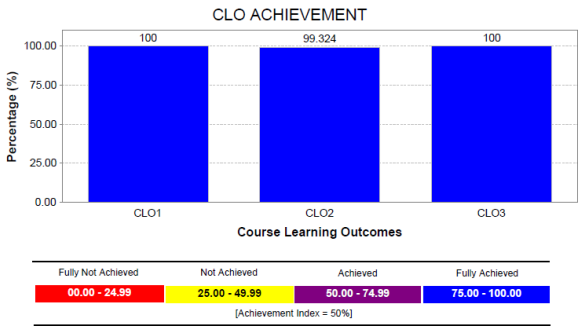

Table: CLO Achievement

	CLO1	CLO2	CLO3	Number of CLO Achieved
G01	148	147	148	443
No of student who achieved LO	148	147	148	443

Figure 6.0. CLO Achievement

B. Feedback from the Students

The list below are the questions given to the students and their feedbacks.

Question 1: Comments and suggestion for improvement on TME3413: Software Engineering Laboratory course.
"I enjoy learning SE Lab Course. All instruction are clearly stated."
"The lecturer give us guidance and good explanation to complete the project assigned."
"Workload is a little heavy but overall interesting course."
"Great course and lecturer. I really like the design of the course."

Question 2: Experience with the industrial client. Share your stories here.
"This is the first time we have the chance to deal with real life which is quite stressful for our team as we worry that we are not able to achieve what the client. Our client is very friendly and after we had showed her our system, she is very satisfied with our work as we had done all tue requirement that she mention before we start our project. Is a very great experiences for all of us to deal with the client."
"Our client which is Mohamad Soleh first impression is he amazed what our system can function just like what he can imagine. Some of our system are include what he did not ask for which he is quite happy that the system will help him a lot. He then suggest some function for our system to make it more reliable than just a simple system. He thanks to us for giving him opportunity to be part of our project and he will support us if we want to improvise this system to another level of difficulty."

C. Feedback from the stakeholders

The list below are the questions given to the project stakeholder / clients who participate in the students' projects and their feedbacks. The questions were circulate via online survey direct to the stakeholders.

Question 1: What are the greatest strengths of the system? (Please provide supporting examples)
"Systematic, simple, clear and fulfil what I needed. It provide an announcement corner for me to outdate the information and also a system which I can keep update my location so my customer can actually know where I reach already."
"We are unable to use the system yet. There are some hiccups during the installation and the team is in the midst of rectifying it. Nevertheless, from the You Tube presentation, it shows that the team has fully understood the user requirement. The system looks very user friendly, simple and easy to understand. Overall all the 4modules meet our expectation."

Question 2: What are the areas where the students need to make an improvement? (Please provide example and suggestions for improvement)
"The User Manual is well written. Unfortunately, there are issues during the system set-up at the client's office. The student has to ensure that in real working environment that the project can be successfully implemented by the client within the planned timeline."
"Search Engine Optimisation (SEO) - Get on top of Search Rankings with Google Ads."

Question 3: Any Other Comments?
"The team is very good and responsible. All the requirement i asked they had done very well. Good Job"
"Overall, I am satisfied with the work done. Especially all the menu bar in admin page. It is very detail especially the sale report which can help me to summary all my sales and convenience for me to check the sales report. Nice!"
"Overall, the team has been very cooperative with our request and has maintained prompt communication throughout the project duration."

The surveys showed students performed and learned well through the immersive environment in communication, teamwork and problem-solving skills. Positive feedback from students indicated that the course could motivate them to learn and boost their self-confidence to work in a real environment. Stakeholders expressed their satisfaction with the students projects besides giving few suggestions for improvement of the course. Throughout the entire project, communication is one of the essential skills in producing a system and work as a team and dealing with stakeholders. One of the most challenging of this course is that students hardly elicits the exact requirement needed by their stakeholders. Thus, by applying the proposed frameworks practices, students have given a full cooperation during the entire system development process, and manage to overcome all the obstacles in building a reliable yet user-friendly system. Furthermore, students need to learn new technology advancement in order to fulfil stakeholder need and demand.

VII CONCLUSION

This Software Engineering course lets the theoretical principles be shown to bridge the difference between theory and practice; from the classroom to the real

working environment. The students are able to apply the knowledge and content of the course in real-world situations. Therefore, they will find the effectiveness of applying an Agile software methodology and Team Software Process (TSPi) which focuses on the team software development project for undergraduate studies.

The course is able to enhance effective learning through the immersive environment and enable the students to develop key skills such as communication, teamwork and problem resolution. The students will also learn to discover how to effectively communicate and collaborate with development teams to carry out projects from concept to completion. Therefore, by the end of the course, they understood the importance of quality as a guiding principle that should be pervasive throughout a software development organisation. When their project satisfies the stakeholder's needs and requirements, this will eventually boost the students desire to learn and feel confident in working in the real world environment and therefore ready for their internship programmes in the coming semester.

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