



Thong, M. J. Q., Yau, A. Q. X., Goh, S. A., Gu, J., Cao, Q. and Keoh, S. L. (2023) Learning Experiences and Analysis in Professional Software Development Subject. In: 2022 IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALE), Hong Kong, 04-07 Dec 2022, pp. 703-706. ISBN 9781665491174 (doi: [10.1109/TALE54877.2022.00123](https://doi.org/10.1109/TALE54877.2022.00123))

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<https://doi.org/10.1109/TALE54877.2022.00123>

<https://eprints.gla.ac.uk/287296/>

Deposited on 13 December 2022

Learning Experiences and Analysis in Professional Software Development Subject

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Abstract—Software Engineering or professional software development (PSD) course is an important subject in Computing Science of higher education. It teaches the theory knowledge on software development life cycle (SDLC). The students will also be taught to use appropriate quality assurance techniques, continuous integration, continuous development, software version control, and appropriate configuration management techniques, etc. In the curriculum of the joint degree programme of University of Glasgow and Singapore Institute of Technology, the PSD course which teaches theory of SDLC is offered concurrently with another course named Team Projects that students work in groups for software companies on real software development projects. During the learning journey in the courses of PSD and Team Projects, students have undergone different thoughts and experiences. In this paper, analyses are conducted to provide views and opinions regarding the learning journey for both courses. Limitations of the current learning methods are discussed in this paper, together with the proposed ideas to boost the learning effectiveness of PSD and Team Projects to benefit the next student cohorts.

Keywords—Learning effectiveness, Professional Software Development, Team Projects, learning journey, higher education.

I. INTRODUCTION

Software engineering and professional software development (PSD) provide the science of applying theory, knowledge, and practice to the development of proficient software systems. Software engineering or PSD methodology is critical because it aids in structuring, planning, and management of software development process. It is important to master the skills of software engineering.

University of Glasgow (UofG) partners with Singapore Institute of Technology (SIT) in the joint degree programme in Singapore, with three trimesters per academic year. Two courses, PSD and Team Projects (TP) are offered for two continuous trimesters hand-in-hand concurrently in the curriculum of Computing Science (CS) joint degree programmes. PSD course is the theory for software engineering and TP is the practice for Software Engineering.

Throughout the years, both UofG and SIT have been preparing their students in CS with Software Engineering skills to apply them towards the internship, Capstone Projects and TP, similar to the ways reported in [1]. However, students in Higher Education may not apply the Software Engineering

skills due to various reasons such as time constraints and not being taught prior to university [2].

The objectives and motivations of this paper is to provide analyses regarding the learning journey in PSD and Team Projects. The current learning limitations and issues identified in PSD and TP will be discussed next.

PSD has equipped students with knowledge of developing a software professionally. It has a concern if students choose to follow the PSD on software development life cycle (SDLC) in their TP. Many students would skip certain PSD processes, because following step by step is tedious and time-consuming. For example, students give up or simply ignore doing code reviews for each other. Because they feel that it is a waste of time to review codes that are ready to be merged by one software developer, as the developer should have tested functionalities of own codes. There is a huge difference in knowing the PSD processes and going through the processes. It implies that the PSD processes being taught may not be followed, which can result in students not being familiarized with hands-on skills even when they have completed PSD successfully. This downside can be improved by having lecturers to follow on every team's design process closely.

Another reason for students on the neglect of not applying some knowledge of PSD into TP is some misalignments on the teaching schedule for PSD and TP. For example, the code smells and software refactoring topic in PSD is taught in Week 9 of the second trimester, while TP is only several weeks away from the final project demonstration day. Thus, there is a limited time for students to carry out the process of code refactoring. Students are most likely to rush to clean up source codes, conduct testing, and prepare user manuals over the remaining weeks. As a result, some topics learnt in PSD2 is not utilized in TP. As another example, learning the topics of structural and behavioural modelling with Unified Modeling Language (UML) is later than the conduct of requirement gathering process in TP. Thus, during the commencement of requirements gathering in TP, students do not have relevant knowledge of UML diagrams.

To address these current limitations, we propose some ideas to improve the learning effectiveness of PSD. We will be researching on various ways to improve the usage of PSD skills by students. It is to encourage students to apply the PSD knowledge into the real Team Projects.

II. RELATED WORK

A. Semester v.s. Trimester Environment

A study was done to compare university programs in both semester and trimester environments [3], where the semester program allows students to study and revise better, as most semester programs last for 14 - 17 weeks [3]-[5]. In the semester session, students were able to digest more course materials and allow better creativity in developing better assignment projects [3]. While in the trimester session, students had less time to understand materials and would often struggle to cope with the classes.

Another case study on the trimester environment was done in [6], where a trimester scheme is adopted for their graduate programs back in 2004. However, the students expressed their difficulty in coping with the classes, as classroom discussion and interaction were not extensive due to the limited amount of time assigned to each subject by the school [6]. Not to mention the COVID-19 pandemic has made learning much more difficult for students due to the lack of interactions with teachers [7]-[9].

According to the above case studies, students prefer the semester environment as compared to the trimester environment, with more time to adapt and apply the skills [6].

B. Software Engineering in Lower Education

In the context of Singapore, previously, students that were still in secondary schools were not exposed to technology subjects until they moved on to tertiary education such as university, polytechnic, Institute of Technical Education. However, since 2017, the Ministry of Education of Singapore has allowed students to start taking O'Level Computing as their elective modules. Based on our opinions, teaching software engineering or PSD course in lower education should have been there a long time ago due to various reasons. For starters, it can aid in student development, particularly their creative abilities [10], [11].

One of the approaches that was used to develop basic software engineering skills on students is Problem Based Learning (PBL) [12]. PBL is a teaching method in which students are taught concepts and principles using complex real-world problems rather than the direct presentation of facts and concepts. PBL can help students develop critical thinking skills, problem-solving abilities, and communication skills. It can also facilitate group work, evaluation of research materials, and lifelong learning [13]. A case study was studied in [12]. Students were able to gain new information through the PBL. They were able to construct diagrams and include concepts in. The students were also able to develop skill sets to for their future work through PBL.

Another approach would be Project-Based Learning (PjBL), where a group of students solve a problem together in a project [14]. It focuses on the ability to work with other students [15]. A case study on PjBL was conducted in [15], that skills acquired from project works were indeed helpful and transferable between different professions. Having transferable skills such as disciplinary skills and workplace experience helps students to find better jobs in the future [16].

As such, learning software engineering or PSD skills in lower education is beneficial for students, as skills that they have learnt can help them for better learning in high education.

III. OUR METHODOLOGY

This section discusses the learning methods in PSD and TP to improve the learning effectiveness of both courses.

A. First Current and Proposed Learning Method

Due to the COVID-19 pandemic, Home-Based Learning (HBL) was introduced in Singapore to minimize the spread of the disease. School learning is deeply impacted by school closures [17]. Thus, having online classes become a norm.

The current delivery mode of the PSD and TP courses is online Zoom meetings. Many students felt that online classes are less effective compared to physical classes. Students may pay less attention during online classes. Furthermore, interactions are limited between students and professors during online classes. This happens because students do not actively participate in clarifying and answering questions, having the fear of asking deficient questions with their names displayed in the chat box during online classes. During online classes, students who are shy tend to send private messages to professors to clarify their doubts or answer questions. However, there is a chance of professors missing out on messages, as they are engrossed in teaching the contents.

Therefore, it is recommended to conduct physical lectures of the PSD course in school to provide effective learning experiences for students. This allows students to focus and pay more attention during classes. There will be more interactions between students and professors as students can raise questions instantly on the spot. Thus, with the easing of the COVID measures, physical lecture sessions consisting of a small group size of students can be carried out.

B. Second Current and Proposed Learning Method

Based on the current learning method in PSD tutorial sessions, students are given sufficient time to work on tutorial questions before the professor goes through and explains each question. Before providing answers for each question, the professor interacts with the students by requesting students sitting in the same table to answer tutorial questions. However, there are some downsides of such a learning method. For instance, students have not completed all the questions before being asked to answer a question. Students who have completed the tutorial questions before the start of tutorial sessions are prone to waste their time waiting for the answers. Students may get all answers from their peers in other tutorial groups, thus not doing the tutorial questions or skip their own tutorial session.

Therefore, to maximize the effectiveness of the tutorial sessions, students can be encouraged with additional class participation marks if they complete tutorial questions before going to class. The proposed method can motivate students to attend all tutorial sessions and come prepared with questions to the class. The professor can also prepare a different set of tutorial questions for different tutorial groups to prevent the sharing of answers between different groups. After all tutorial sessions, the professor can release answers of all the different sets of tutorial questions. Hence, the proposed learning method would maximize the students' exposure to different types of questions, improving their learning experiences.

C. Third Current and Proposed Learning Method

The trimester system is adopted by the University where multiple modules are taught in a 13-week span. Both PSD and TP courses were taught in the first and second trimester of the

second year. Consequently, some students face the problem of fully understanding PSD contents and using it completely in TP. Some PSD topics are taught later in the trimester and students do not have enough time to carry out what they have learned such as code refactoring, black and white box testing.

Therefore, to increase the learning process of PSD and TP, the proposed method is to start PSD one trimester first, staggered by TP starting in the next trimester. Thus, students can be well-equipped with SDLC knowledge before commencing TP. In addition, there will be one less subject in the second trimester. Students can focus on the deliverables and final demonstration to customer companies in TP.

IV. FINDINGS, ANALYSIS, DISCUSSIONS

To compare and analyse the three current and proposed learning methods, a survey questionnaire was created, consisting of nine survey questions with a mixture of dichotomous, open-ended and Likert scale questions. It invites a total of 20 CS students in the UofG and SIT joint degree programme to gather their feedback and opinions.

For the first current learning method, the satisfaction level of students on the online classes for PSD and TP is analysed. As shown in Fig. 1, the average satisfaction of the students is 6.85 out of 10 (68.5%). It can be observed that students are relatively satisfied with the current learning method.

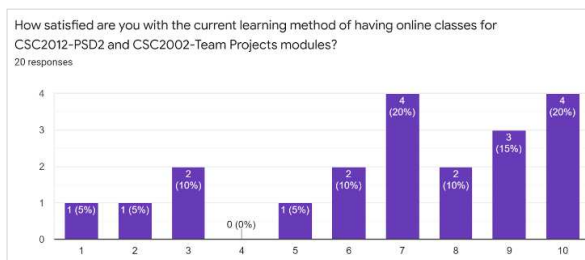


Fig. 1. Responses of the first current learning method

Next, students were asked about their opinions if the improvement of online classes would help improve the learning effectiveness of both PSD and TP. Shown in Fig. 2, 55% of the students agree that improving the current learning method would be helpful to improve the learning effectiveness of PSD.

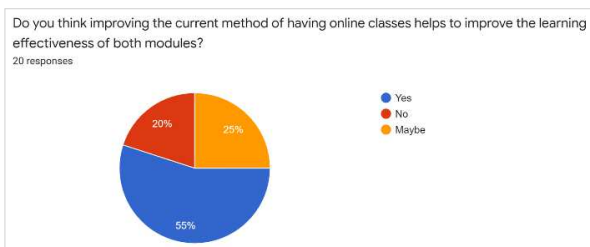


Fig. 2. Opinions of improving first current method

Students were asked for their opinions for the first proposed method of conducting multiple physical lecture sessions in a small group size instead of having online lectures. According to the students' feedback, the majority of them respond that the proposed learning method is good. Students prefer to have physical lessons in a small group size in school because they feel that studying in a small group enhances learning. They would pay more attention in class,

and clarify their doubts and answer questions face to face in school. It has more interactions with the professor. However, a minority of the students prefer online classes because they do not need to go to school for physical classes.

For the second current learning method, students were asked about their satisfaction level of doing tutorial questions in class before having the professor to go through answers. It shows in Fig. 3, the average satisfaction of the students is 7.4 out of 10 (74%). It can be observed that students are fairly satisfied with the current learning method.

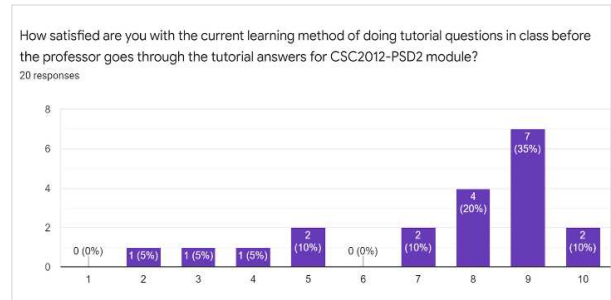


Fig. 3. Responses of the second current learning method

Next, students were asked about their opinions regarding the improvement of the second current method would help improve the learning effectiveness of PSD. Based on the responses gathered in Fig. 4, 45% of the students think improving the current learning method would help improve the learning effectiveness of PSD. Hence, it shows that it is possible to improve the second current learning method.

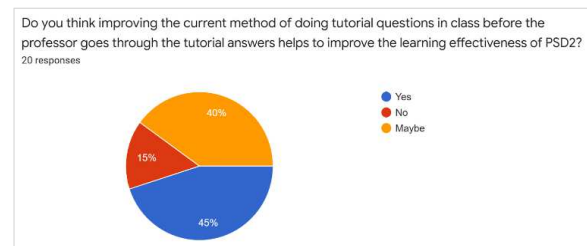


Fig. 4. Opinions of improving the second current method

For the second proposed learning method of awarding students with additional class participation marks as a form of encouragement to motivate students to complete the tutorial questions before attending class, majority of students responded positively. Students prefer such learning method because they feel that the additional class participation marks bring motivation to them. They are encouraged to attend the class. Students have the opportunity to try out all questions in the tutorials before attending class to clarify their doubts.

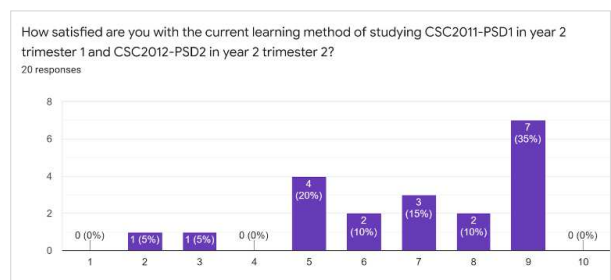


Fig. 5. Responses of third current learning method

For the third proposed learning method, students were asked their satisfaction level on it. As shown in Fig. 5, the average satisfaction level of students is 6.85 out of 10 (68.5%). Based on the responses gathered, it is observed that students are satisfied with the current learning method.

Next, students were asked about their opinions if the improvement of the current method of studying PSD would help improve the learning effectiveness of both PSD and TP. The responses gathered in Fig. 6 shows that 60% of the students chose Yes. It shows that improving the current learning method would have a probability of improving the learning effectiveness of PSD.

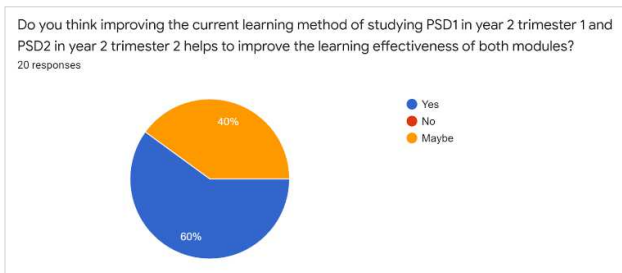


Fig. 6. Opinions of improving third current method

For the third proposed learning method of conducting PSD and TP in a staggered schedule, that starts PSD in Year 1 trimester 3 to prepare students for TP in Year 2, students are asked for their opinions regarding it.

Based on the students' responses, all of them responded that the proposed learning method is highly recommended. They feel that it is a good idea to shift PSD to Year 1 trimester 3, so that they would have one less subject in Year 2, which ease the difficulties for coping with many subjects in Year 2. Also, students can apply the knowledge they learnt earlier which prepares them for the TP course in Year 2.

Observed from all the findings and analysis of the responses gathered from students, the current learning methods could be improved. Firstly, most of the students support the idea of having physical classes as compared to online classes. Secondly, majority of the students support the recommendation of having more effective PSD tutorial sessions by awarding them additional class participation for completing tutorial questions before attending the class, as compared to doing the tutorial questions on the spot in class. Lastly, all students agree on the idea of adjusting the timeline of taking PSD to the trimester break in Year 1 trimester 3. Therefore, even though the current learning methods are effective as well, students feel that all the three proposed methods are more effective, benefiting them, thus improving the learning effectiveness of PSD and Team Projects.

V. CONCLUSION

The study reflects on the team's learning journey in PSD and TP courses. This paper has identified a few limitations in the current learning of PSD and TP. We propose three methods on how to address the limitations to help improve the learning effectiveness in both the courses. For instance, transforming online classes to physical classes, completing

tutorial before attending class to obtain additional class participation marks as an encouragement rather than doing tutorial in class, and shifting the timeline for taking to in Year 1. Comparisons and analysis of the current and proposed learning methods are conducted. Conclusions can be deduced that majority of students prefer the proposed learning methods. Therefore, it is recommended to take into consideration the suggested learning methods in the next academic years, to enhance students' learning experience and effectiveness in PSD and Team Projects.

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