World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:16, No:2, 2022

Using Design Sprint for Software Engineering Undergraduate Student Projects: A Method Paper

Sobhani U. Pilapitiya, Tharanga Peiris

***Abstract*—**Software engineering curriculums generally consist of industry-based practices such as project-based learning (PBL) which mainly focuses on efficient and innovative product development. These approaches can be tailored and used in project-based modules in software engineering curriculums. However, there are very limited attempts in the area especially related to Sri Lankan context. This paper describes a tailored pedagogical approach and its results of using design sprint which can be used for project-based modules in software engineering (SE) curriculums. A controlled group of second year software engineering students was selected for the study. The study results indicate that all of the students agreed that the design sprint approach is effective in group-based projects and 83% of students stated that it minimized the re-work compared to traditional project approaches. The tailored process was effective, easy to implement and produced desired results at the end of the session while providing students an enjoyable experience.

***Keywords*—**Design sprint, project-based learning, software engineering, curriculum.

I. Introduction

SE curriculums generally comprise with theoretical knowledge as well as technical and professional contexts. All of these are vital for a student to excel in their careers. Curriculums should be enriched with a consortium of theoretical concepts, projects, group work and practical sessions in-line with industry expectations. SE is a dynamic area which needs to frequently be updated with latest techniques to receive maximum learning outcomes. One such technique is PBL. BPL techniques are used to develop essential and challenging skills in students via engaging them in projects [1]. PBL encourages approaches such as design thinking and design sprint to be used in strengthening curriculums as it is a problem-solving method geared around goal based and collaborative approaches. PBL approaches will further strengthen transferable skills in students.

Many SE industries embraced agile approach for their projects. The customer-centric collaborative effort of agile approaches brings a consortium of benefits to industrial projects. The need for SE students to be equipped with agile skills is inevitable. Design Thinking (DT) and Design Sprint (DP) are methods which emerged as an aid to requirement elicitation issues in agile approach. DT and DP are innovative mechanisms from which people engage in prospects to design, develop prototypes and attain feedback [2]. Higher education institutions worldwide have begun incorporating these PBL, DT and DP techniques to enhance their curriculums [3], [4].

This paper outlines a method where a tailored DP is used for SE undergraduates as an aid for PBL in Asia Pacific Institute of Information Technology (APIIT), Sri Lanka.

II. Past Approaches

There has been limited attempts in tailoring the DP approach in SE undergraduate curriculums. There have been limited guidelines on a validated pedagogical approach provided so far. However, there have been attempts that state DT and DP could be used to enhance learning strategies of SE curriculums [2]-[4]. Few studies have been conducted incorporating PBL methods such as DP and SCRUM to enhance project management practices in curriculums [5], [6], [10], [11].

Santana et al. have experimented with the use of SCRUM as a means of managing student projects of a university in Brazil. The researchers have stated their experience consisting of pros and cons in using SCRUM for undergraduate project management [6].

Ferreira and Canedo have used DP for Brazilian higher education institutions and shared their experiences. They have identified few time related issues and provided recommendations as to how to manage the time factor in DP [5].

Several blogs which demonstrate the pedagogical approach of DP usage for education are available [9]-[11]. However, these studies do not suggest a generalized approach of implementing DP for SE curriculums.

III. Design Sprint

Knapp et al. [8] have come up with a DP approach with a method of prototyping and testing customer-centric solutions via a structured five-day approach. This method has been a partnered endeavor with Google ventures. This methodology is practiced at world renowned companies such as Google, Uber, Slack, Facebook, Twitter, Airbnb and many more [7].

DP is an efficient method which includes tools and mechanisms to come up with innovative solutions enriched with customer feedback. The customer centric process provides guidance as to set the stage for the whole process. This guidance is provided in an easy-to-understand five-day approach as follows [8]:

- Monday – Map; where the team understands the goal of the sprint involving all the stakeholders. The requirements will

S Umanga Pilapitiya was with the Asia Pacific Institute of Information Technology, Sri Lanka (corresponding author, phone: +94 11 7 675 145; e-mail: umanga@apiit.lk).

Tharanga Peiris was with the Asia Pacific Institute of Information Technology, Sri Lanka (e-mail: tharanga@apiit.lk).

also be prioritized for the first sprint.

- Tuesday – Remix, improve and sketch; where the teams will propose solutions for the prioritized requirements of Monday. The teams will also perform lightning demos where they will review what others have done for similar solutions.
- Wednesday - Decide; where team members individually vote on the proposed solutions of Tuesday and the select the best solution to build.
- Thursday – Prototype; build the prototype.
- Friday - Test and customer feedback; where the prototype will be tested and improved with end user feedback.

IV. Methodology

A systematic literature review is conducted to identify the usage of instances where PBL approaches such as DT and DP can be adopted. Even though there were limited researches in the domain authors were able to review few of the existing attempts.

The DP methodology by Knapp et al. [8] seems like an effective methodology to be used in SE project-based modules. Therefore, authors have experimented using the DP methodology via a workshop of 6 hours. The DP methodology was tailored to best suit APIIT SE curriculum and its student body. The tailored DP was applied for a batch of second year SE students of APIIT in a three-year degree program. It was a controlled group of 35 students with no previous PBL experiences.

The students were chosen for this workshop as they undergo an agile-based assessment for one of their core modules in the curriculum. As per the assessment, students have to implement a solution for a third-party. The implementation is via three sprints. The workshop was to aid the students in achieving best results in the assessment using DP.

The tailored methodology included the following areas:

A. Set the Stage

The students were advised to get in to groups of five members in which they needed to select project roles such as deciders (final decision maker), customer expert (looks into customer requirements and business perspectives), technical experts (developers, quality assurance engineers) and design experts (business analyst). Not all the DP project roles are used since budget and resources approvals are out of scope. The teams were also encouraged not to use devices for their initial requirement elicitation and design phase. A suitable scenario for implementation and necessary supplies are provided (whiteboards, stickers, sticky notes and stationery).

B. Monday

The teams commenced the workshop with setting a goal for their sprint followed by two main sprint questions. Afterwards, the teams created a map of the challenge which indicates maximum three paths to achieve the goal. Finally, the teams selected a best path and prepared use case diagrams for the same. Use case diagram is included at this stage as it is a requirement in the module they engage in. Teams pasted these art works on their whiteboards.

C. Tuesday

Teams searched for similar solutions and found improvement areas (new features, better ways of implementation) for the lightning demos. The improvement areas were attached to the proposed solutions in the whiteboards. Lightning demos was followed by sketching of proposed solutions. The original DP suggests to come up with crazy 8s where individual team members need to sketch eight designs for their user interfaces. Due to the time constraint, the teams were asked to come up with crazy 4s. Each member then attached their sketches to the whiteboards.

D. Wednesday

The workshop environment transformed in to an art museum where the teams then voted for the other team's designs using stickers provided. Each team's facilitators stood near their dedicated whiteboards to explain the designs if necessary to the spectator groups. Each group also consisted of a scribe whose duty was to jot down the feedback of spectators of other teams based on its relevance and importance.

After the teams were done with their voting it was time for the super votes. Each team's decider had the luxury of providing their vote; which is considered as a super vote for theirs and other team's designs. The sketches with the super votes were decided as the final designs.

E. Thursday

This session was for the teams to design their finalized functions and build a prototype. Teams are given adequate time to design and implement while incorporating best practices.

F. Friday

This is when the teams finally test their product and demonstrated their implemented solution in front of the rest of the batch mates to receive feedback.

Table I depicts the changes made by the authors to the original DP approach. Non-stated activities are executed as per the original approach.

TABLE I
Tailored Activities

Day/Activity	Changes from original approach
Set the stage - Team	Limited to deciders, customer expert, technical experts (Developers, quality assurance engineers) and design experts (Business analyst).
Sprint Questions	Sprint questions are limited to 2 per sprint (usual practice is to have 1-3 questions).
Add on activity	Drawing the use case
Lightning demos	Students were asked to research and find similar systems/features/improvements (as students lack product-based experience).
Crazy 8	Was changed to crazy 4's.
Final demo	Students presented their implemented solution to the class and received feedback (instead of actual client feedback).
Sprint Questions	Sprint questions are limited to 2 per sprint (usual practice is to have 1-3 questions).

V. Results and Discussion

The tailored experimental approach provided the authors

with the following list of observation points. The approach was thoroughly enjoyed by the students.

A. Observations

- Students generated more innovative ideas - Students collaborated in a planned approach while focusing mainly on the end goal, resulted in a full array of innovative ideas compared to the traditional development approaches.
- Early design errors are detected - Since students have to firmly focus on a clear idea followed by a voting procedure, design errors were corrected before starting any design and implementation activity. This resulted in less rework.
- All student ideas are respected and treated equally - All students in the group have a defined viewpoint (based on their roles) and therefore everyone's ideas are respected in the initial stage. Furthermore, every student has to provide their own design implying that everyone's ideas are respected and treated equally but the best ideas are selected from voting. This provided them a sense of acceptance and satisfaction among the group.
- High success rate and achieve learning outcomes - All the student groups designed and implemented a working prototype with-in the allocated timeframe.
- Programing is fun - Students enjoyed the tailored project development approach very much. During the COVID-19 pandemic students were mostly indoors and this experience was thoroughly admired by them.

To further evaluate the use of DP for the SE undergraduates; a well-structured feedback form was given to all the students at the end of the workshop. The feedback form posed seven questions for the authors to understand the student satisfaction levels and learning outcomes. The responses for the questions were presented in a rating scale ranging from 1-Strongly disagree to 5- Strongly agree.

A 100% response rate for the feedback forms received from the participants. The following is a summary of responses gathered via the feedback forms:

Question 1: The DP Approach Was Very Effective for Group-Based Projects

Some 57% of the students said they strongly agree and 43% agree that the DP approach is very effective for group-based projects. This showcases that students are positive towards using this PBL method for their group projects at APIIT.

Question 2: The DP Approach Supports Individual Ideas to Be Considered

Majority of students (53%) said that they agree that the DP approach supports their individual ideas to be considered. This response proves that DP provided that individuals are heard in terms of their ideas.

Question 3: The DP Approach Can Be Easily Adapted and Used in Your Projects

A total of 71% of the students have said that the DP approach can be easily adapted for their projects.

Question 4: The Outcome Generated at the End Is Satisfactory

Majority of students (43%) strongly agree and 34% agree that the outcome generated at the end is satisfactory whereas 23% say they have neutral responses. The students are mostly satisfied with the outcome of DP. Some groups could not complete their final designs in-time for the presentations on the Friday segment; which might be the reason for neutral responses.

Question 5: The Time Provided for the DP Approach Is Sufficient

This question has received mixed responses from the students. Only 14% strongly agree and 29% agree that the time was sufficient, while 31% stated that they are neutral about the time period. Some 26% say they disagree and that the time was not sufficient. It is evident that the time provided has been challenging for the student teams.

Question 6: The DP Approach Allows Designing, Implementing and Testing an Artifact Quickly Compared to Traditional Approaches

The majority of respondents (52%) agree that the DP approach allows project tasks to be completed quickly compared to traditional approaches. This is followed by 32% who said that they strongly agree and 14% who say they are neutral.

Question 7: The DP Approach Minimized the Rework Compared to Traditional Approach

Some 43% and 40% of students, respectively, said that they strongly agree and agree that the DP approach minimized the rework compared to traditional approach. Only 1% answered neutral for this question. Having rework is a main challenge when it comes to SE undergraduate projects. The students, during their degree program, need to engage in simultaneous projects most of the semesters. Hence, minimizing rework would enable them to manage their efforts and time more adequately. It seems that the DP approach helps them to do just that.

VI. Conclusion

This paper presented the method of using a tailored version of the DP by Knapp et al. [8] for a project-based SE module at APIIT. The tailored version was experimented via a workshop for a group of second year SE students. The goal was to incorporate this PBL approach to aid an assessment in a core module.

The DP was tailored to match the SE curriculum, nature of the module and its assessment expectations. The tailored approach helped to meet the expected timelines as well.

The students enjoyed and well interacted with the workshop and majority of students were able to reach the Friday segment of testing and presenting their final designs to receive customer feedback; whilst few groups struggled to meet the timelines. The student feedback indicated that majority of the students are satisfied with the DP approach to conduct their projects. The

students seemed to prefer the DP in terms of reducing rework, meeting project milestones faster, having individual ideas heard and collaborating appose to traditional methodologies. However, one challenge emerged from the workshop and student feedback was that the time was not sufficient for some students to meet the final outcome.

Based on the success factors, positive experience and satisfactory feedback from students, this method of using the DP approach for projects is recommended for APIIT SE curriculum. Furthermore, the use of PBL such as DP is recommended for other higher education institutions to enhance the student learning outcomes and effective engagements in SE projects. As this recommendation is made, it is also important that universities take adequate measurements to provide sufficient time periods for the DP so that no student will be at a disadvantage in terms of achieving their project goals.

REFERENCES

[1] W. N. Bender, Project-Based Learning: Differentiating Instruction for the 21st Century, 1st ed. United States of America: Corwin, A SAGE Publications Company, 2012.

[2] R. Razzouk and V. Shute, "What Is Design Thinking and Why Is It Important?", Review of Educational Research, vol. 82, no. 3, pp. 330-348, 2012. Available: 10.3102/0034654312457429 (Accessed 10 January 2021).

[3] D. Hardy, T. Myers and M. Sankupellay, "Cohorts and cultures", Proceedings of the 20th Australasian Computing Education Conference on - ACE '18, pp. 9 -16, 2018. Available: 10.1145/3160489.3160494 (Accessed 11 April 2021).

[4] N. Anderson, "Achieving higher education graduate attributes in the area of creativity, innovation and problem solving through the use of design thinking", in QS Apple Conference, Manilla, Philippines, 2011, pp. 29-33.

[5] V. Ferreira and E. Canedo, "Using design sprint as a facilitator in active learning for students in the requirements engineering course", Proceedings of the 34th ACM/SIGAPP Symposium on Applied Computing, 2019. Available: 10.1145/3297280.3297463 (Accessed 17 February 2021).

[6] L. Santana, L. dos Santos, T. Silva, V. Villar, F. Rocha and V. Gonçalves, "Scrum as a Platform to Manage Students in Projects of Technological Development and Scientific Initiation: A Study Case Realized at UNIT/SE", Journal of Information Systems Engineering & Management, vol. 2, no. 2, 2017.Available: https://www.researchgate.net/publication/316908757_Scrum_as_a_Platform_to_Manage_Students_in_Projects_of_Technological_Development_and_Scientific_Initiation_A_Study_Case_Realized_at_UNITSE. (Accessed 1 March 2021).

[7] "Google Ventures Design Sprint - Design Sprint", Design Sprint, 2021. (Online). Available: https://design-sprint.com/google-ventures-design-sprint/?fbclid=IwAR3_VYuiZK4RMKZWUipGRv1TqKX7mn-szqkIlh2eiMxxHDTUw-BxtS3t4FA. (Accessed 12 February 2021).

[8] Knapp, B. Kowitz and J. Zeratsky, Sprint. London: Bantam, 2016.

[9] A. Gordon, "What we've learned from doing a design sprint", Digital Team Blog, 2019.

[10] "Medium", Medium, 2021. (Online). Available: https://sprintstories.com/first-design-sprint-in-an-educational-context-c34b59eabf8d. (Accessed: 11- Apr- 2021).

[11] A. Turibio, "A how-to guide to run a successful Design Sprint For Education", 2021