Online Service-Learning in Application Development Course: The Challenges during the COVID-19 Post-Pandemic Period

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Abstract
The approaches in teaching and learning at schools and universities around the world have changed since the COVID-19 pandemic occurred in December 2019. It was serious in Malaysia in middle of March 2020 when the government announced the movement restrictions. After almost two years, Malaysia declared the status as towards the endemic phase in April 2022. However, many universities in Malaysia still practiced online teaching and learning with some courses were selected to be conducted in hybrid mode until mid of 2022. This paper reports the challenges in applying service-learning to the Application Development course at a university during COVID-19 post-pandemic in Malaysia from October 2021 to January 2022 that was before Malaysia declared the status of towards endemic in April 2022. The course was one of the core courses for third year students of Bachelor of Computer Science program. A total of 70 students from three sections participated in this study. The findings reflect that both the students and the selected communities managed to benefit from the online service learning integrated in the course despite the challenges during the post-pandemic period.

Keywords
COVID-19 post-pandemic period, online teaching and learning, application development course, service-learning, community engagement, tertiary education

1. Introduction

It cannot be denied that COVID-19 pandemic has forced many sectors including the education sector to move to online platforms. Hence, online teaching and learning (OLTnL) approaches have been a mandatory since early 2020. In Malaysia, 2021 had been a challenging post-pandemic period as the increase of cases forced physical classes for both primary and secondary schools to revert to OLTnL while the tertiary education continued to be online. In early 2022, the cases were under control in line with the vaccination effort and finally the government announced Malaysia status as moving towards endemic since April 2022. Schools have been back to physical mode, but tertiary education has remained online for most colleges and universities mainly those with a high international students' enrollment.

For the scope of this paper, the study involved the third-year students who only attended physical lectures for their first semester in the first year and had been studying online for four semesters. They enrolled in an Application Development (AD) course in their first semester of the third year that was the Academic Session 2021/2022 started in October 2021. Students who enroll in the AD course must have taken a Software Engineering course in the second year of their study planning.

Many studies regarding OLTnL have been reported mainly since 2020 due to COVID-19 pandemic. Our previous study [1] reports the lessons learned when conducting Software Engineering course between March to June 2021. It concluded that despite the students had been studying online since March 2020 that was a year, they still faced challenges in OLTnL. Likewise, Yamada et al. [2] reports the challenges in teaching an introductory software engineering

course during the COVID-19 pandemic in Japan in May 2020. The lecturers offered an alternative to their students by developing an environment to complete their Web application development tasks. The study reflects that academicians must find options for their OLTnL during the pandemic which could cause extra efforts as compared to physical lectures. Moreover, Bringula et al. [3] list the key challenges in OLTnL during the pandemic period that involved programming project in a software engineering course taught at a university in Manila. Among the 13 challenges, the work reports that the lecturers could not address the challenge in relation to the Internet connection and power supply.

Hence, this paper contributes by reporting the challenges when conducting an AD course at a university in Malaysia that comprised three different specializations of Bachelor of Computer Science with honors program, students with varied demographic, different course contents and assessments as compared to some existing studies [4][5][6] related to OLTnL during COVID-19 pandemic period.

Regarding service-learning, Rice-Bailey et al. [7] reports how CREATE Institute plays the role to fulfil all stakeholders' needs and project-based experiential learning initiatives that must have effective communication among stakeholders. However, it does not describe the challenges due to COVID-19 as they report their efforts before the pandemic period. Furthermore, the work by Bandi et al. [8] compares two service-learning models in India without mentioning the issues in online service-learning. Another work by Abu-Mulaweh and Oakes [9] reports the impact from nine students who involved in a service-learning under the Engineering Projects in Community Service (EPICS) program that aims for a balance of benefits for the students and the community partner. The EPICS model engages partners and gives values to the partners, in this case the deaf community. Although the work is published in 2021, it does not ponder issues related to COVID-19 pandemic in service-learning.

On the other hand, Ngai et al. [10] specifically reports the STEM education using online service-learning during COVID-19 pandemic. The STEM workshop was conducted by university students between August to October 2020, participated by 275 primary school students who were from four different countries. The study lists some lessons learned that include tangible teaching kit, parents' involvement, and training for their non-governmental organization (NGO) partners. In

contrast, this paper reports the development of software applications by the students enrolling in AD course to solve diverse community issues as part of the students' service-learning requirement in the course during the post-pandemic period in Malaysia.

The following sections elaborate on the case study (Section 2), analysis and findings (Section 3) and finally its conclusion in Section 4.

2. The case study

The section includes the explanation on the students enrolled in an AD course, the 15-week planning for the course and its assessments, and details for the online service-learning that requires community engagement.

2.1. Course and enrolled students

All courses at the university followed OLTnL mode due to the COVID-19 pandemic status at that time with the exception for some critical courses. The AD course has been one of the core courses in four specialized programs under Bachelor of Computer Science with honors that was also offered in Session 2021/2022, Semester 1 from October 2021 to January 2022. There were ten sections of third year students who enrolled in the course. Software Engineering course was the pre-requisite for the AD course that should be taken in the second year of their study.

For the case study, three sections were selected that included Section 3 and 4 consisted of 36 and 11 students respectively under Bachelor of Computer Science (Software Engineering) coded as SECJ, and 23 students of Section 2 under Bachelor of Computer Science (Graphics and Multimedia Software) coded as SECV. Other programs are Bachelor of Computer Science (Bioinformatics) and Bachelor of Computer Science (Network and Security). All 70 students participated and responded to the survey.

Thus, the study applied non-probability sampling method that is cluster sampling by selecting two sample groups out of four SECJ sections and one group from other specializations.

2.2. Course information

The AD course is a four-credit course for third year students in their first semester that is their fifth semester of the total eight-semester study.

Table 1 lists the deliverables and respective assessment by weeks within 15 weeks, which the eighth week is the mid-term break. There are four sprints following the Agile software development methodology. Each sprint covers two weeks that requires the iterative prototype release within eight weeks.

Table 1
Course information

Week (W) No.	Assessment Distribution		
	Topic/Sprint No.	Assessment*	%
W1	Agile methodology		
W2	Community service and problem solving	Project proposal	5
W3	Project planning	Project planning	5
W4	Sprint 1		
W5	Sprint 1	First prototype	10
W6	Sprint 2		
W7	Sprint 2	Second prototype	10
W8	Mid-term break		
W9	Sprint 3		
W10	Sprint 3	Third prototype	10
W11	Sprint 4		
W12	Sprint 4	Fourth prototype	10
W13	Integration and testing		
W14	Integration and testing	Final application	20
W15	Project showcase	Final report, presentation	20

*Assessment includes logbook and peer review (10%)

All assessments are team-based except for the logbook and peer review (10%). This course has no final exam. Students should form a team of four to five members. However, teams with less members could consider fewer user stories (user requirements in the Agile methodology) to ensure the scope was not too huge and to be fair to all teams. The course assessments include:

- Project proposal and planning (10%): Students should solve any communities chosen by their teams or as assigned by the course lecturer and plan for the development following the Agile development methodology (see W2 and W3 in Table 1)
- Project prototypes (40%): Students need to develop the proposed application iteratively using Agile development methodology (see W5, W7, W10 and W12 in Table 1).
- Final application (20%): Students have another two weeks for final integration and testing before delivering the final application (see W14 in Table 1).
- Final report and presentation (20%): Students need to showcase their deployed applications, present, and submit the final report following the given template suitable for Agile manifesto that is "working software over comprehensive documentation".

2.3. Service learning

The Application Development course is one of the selected courses at the faculty that should have community engagement, which is known as service learning. Hence, students need to identify community problems and provide the solutions through their proposed applications. Normal practice in the course is either students choose their own communities or course lecturers assign selected communities. For the scope of this study, students had the opportunity to select their own local communities as they were still in their hometowns and undergoing OLTnL. Due to the COVID-19 pandemic, the students had limited engagement with the selected communities.

Table 2 lists 17 teams and respective proposed applications for the communities they had chosen. They also identified the Sustainable Development Goals (SDG) [11]. The most popular SDG is SDG3 that is good health and well-being as proposed by T5 (EzCalorie), T8 (MetaTr@cker), T12 (HELPSHI), T13 (Oiishi Recipe), and T17 (RecycleApp). Among the listed 17 projects, only two teams, T12 (HELPSHI) and T4 (Zero Hunger) managed to approach NGOs. HELPSHI supported the society that caters to the period poverty issue while Zero Hunger supported the initiative to help the poor through a food bank run by volunteers. Seven teams (41%) chose individual communities through any of their team members' contacts. Although this was not the best targeted community, students could proceed with the consideration of OLTnL and online service-learning while students were mostly in their hometowns and could not meet physically for team discussion and community engagement.

Table 2
Team's proposed application and community

Team No.	Project Details		
	Software Application	*Community*	*SDG**
T1	Bro Fund Me	Individual	1, 2
T2	JomShare	Carpool group	11
T3	e-Library	College	4
T4	Zero Hunger	Food bank	2
T5	EzCalorie	Individual	**3**
T6	FutBook	Small business	9
T7	BookIt! Facility	Residence	8
T8	MetaTr@cker	Individual	**3**
T9	TuTime	Tutor	4
T10	Food Sharing	Small restaurant	12
T11	JomTolong	Residence	11
T12	HELPSHI	Women society	1, **3**
T13	Oiishi Recipe	Individual	**3**
T14	Earth Hand	Individual	12
T15	VOTION	Individual	4
T16	WearIt	Individual	1, 13
T17	RecycleApp	Village	**3**, 12

*SDG: Sustainable Development Goals [11]

At the end of the semester that is Week 15, students should showcase their projects. A total of 22 secondary school students of a rural region who also enrolled in Computer Science subject as an elective course at their schools attended the virtual showcase via a tele-conference platform. Thus, the secondary level students had an exposure of learning Computer Science and software development at the tertiary level. Figure 2 shows one of the showcase slots by a team to the panel of judges and the selected community.
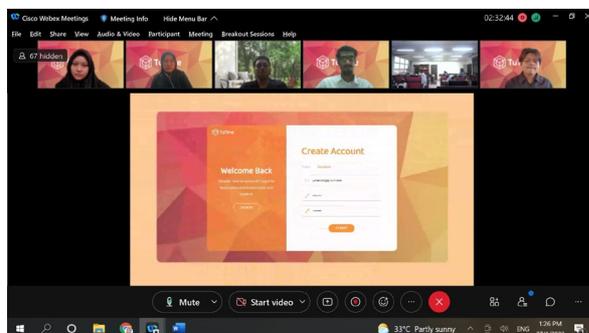

Figure 1: One of virtual showcase slots

3. Analysis and findings

This section explains the analysis and findings of the survey, students' challenges, threat to validity and lessons learned from the study.

3.1. Survey

The survey includes the demographic, the application of Agile and Jira tool in the course, the online service learning and its overall rating, project deployment, and communities' acceptance towards the applications. Figure 2 shows students' gender for all sections. Majority of them were male students (45 or 64%) while 25 students (36%) were female. This trend of more male students enrolling Computer Science program can be observed in this study.
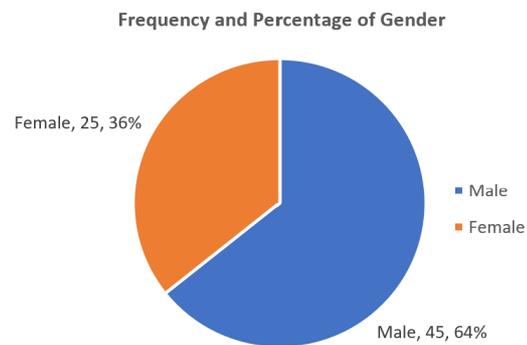
Figure 2: Students' gender

Figure 3 shows the distribution of students by the specialization. Both Section 3 and 4 (47 or 67%) are software engineering specialization while 33% (Section 2) are graphic and multimedia specialization. As mentioned in Section 2.1, the sample reflects the highest enrollment in software engineering specialization.
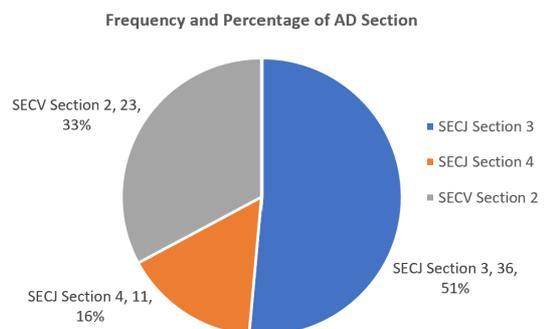
Figure 3: Students' distribution by section

Regarding service-learning in the course, the majority of the students were very satisfied (61%) followed by satisfied (37%) and only one stated neither satisfied nor dissatisfied (see Figure 4).
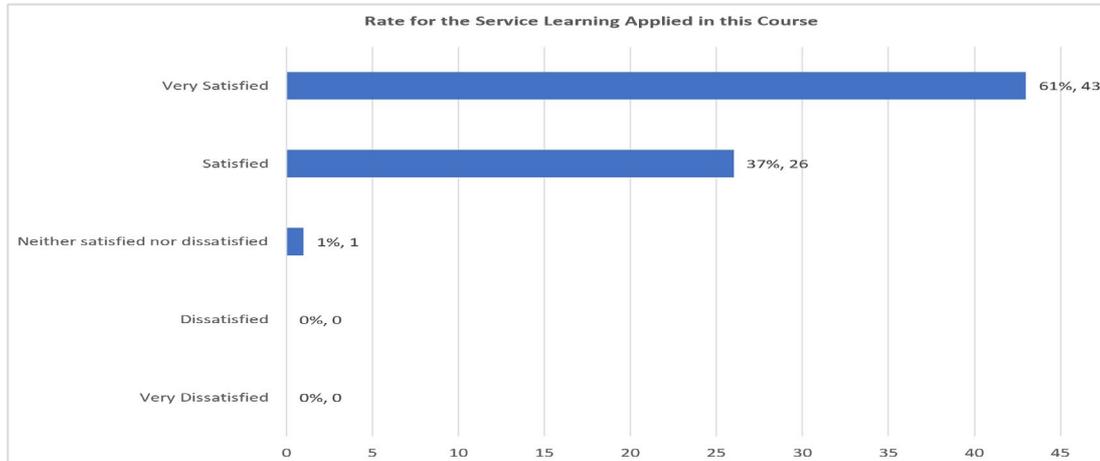
Despite the service learning was conducted online, their responses deduce that students could accept the approach.

Figure 4: Responses on the service-learning

However, Figure 5 shows slightly lower frequencies of positive ratings towards the online showcase with the selected community and panel of judges. Five of them (7%) felt neither satisfied nor dissatisfied, 31% satisfied, and 61% were very satisfied. In the show case, each team was given approximately ten minutes to present their applications including question and answer session at the end of all slots. Besides, their applications were also judged when presenting and demonstrating to the selected community via the video conferencing platform (see also Figure 1). This deduces that students could feel less satisfied with the service learning (as shown by five students or 7%) when they experienced less physical engagement with the community.
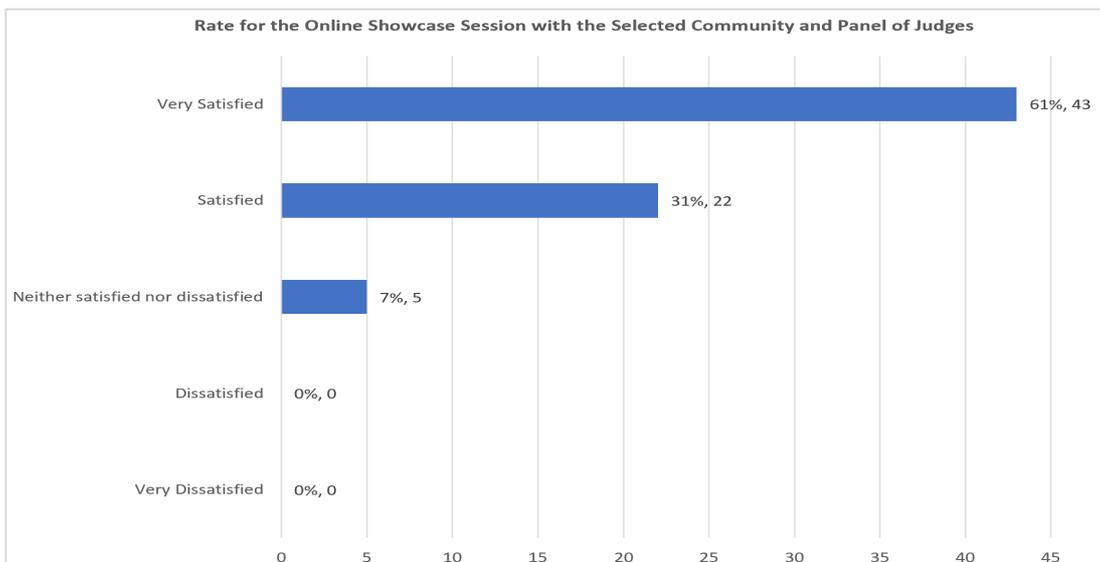
Figure 5: Responses on the online showcase with the community and panel of judges

As revealed in Figure 6, most of the teams (47 or 67%) managed to deploy their applications on various deployment platforms as exposed and chosen to them such as Microsoft Azure and Heroku. This reflects positive achievement among the teams despite the challenges they had faced for the OLTnL and online service learning.

Frequency and Percentage of Project Deployment

No, 23, 33%

- ■ Yes
- ■ No

Yes, 47, 67%
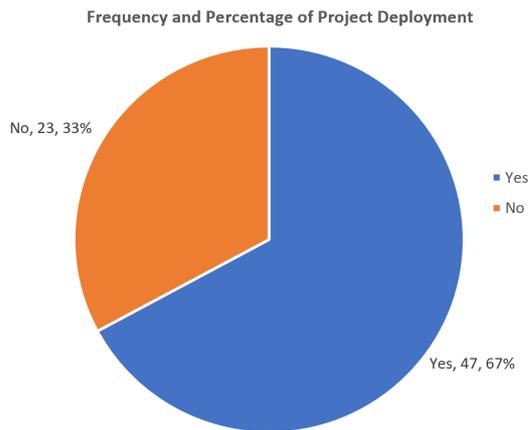
Figure 6: Responses on whether the teams manage to deploy their software applications

In addition, Appendix A shows the responses on the Agile development methodology exposed through the course. Most students (67%) strongly agreed that the course had increased their knowledge of how to apply Agile methodology, followed by agreed (30%) and neutral (3%). The same responses for the effectiveness of the role of development team with the appointed Scrum masters and product owners. Besides, 43 (61%) strongly agreed that Agile with minimal documentation allows more focus on the development rather than the documentation, 23 (33%) agreed and four (6%) were neutral. Regarding sufficiency of 14 weeks to simulate the Agile methodology, 37 (53%) strongly agreed, 22 (31%) agreed, 9 (13%) neutral, and only 2 (3%) disagreed. It can be deduced that most of the students had positive responses in the exposed Agile methodology through this course although it was 100% online.

As shown in Appendix B, the exposure of Jira tool for the Agile development methodology received positive responses as more than 50% strongly agreed at all aspects that include increase knowledge on the use of an Agile project management tool to manage their teams (66%), provides the guidance to create user stories in Agile (59%), enables setting of sprints easily as what planned in the project (63%), enables task assignment in an organized way (67%), keeps track each team member's progress effectively (66%) and enables the tracking of the overall project progress using burndown charts in the tool. It can be concluded that exposure to tools like Jira in Agile-based project management could support students' understanding on the concepts of Agile especially when all team-based development tasks are conducted online.

Finally, Appendix C reveals positive responses on the online service learning as majority of the students (more than 50%) strongly agreed for all aspects related to the service learning that includes improves communication (63%), provides benefits to the community partner (66%), relevant and meet the content and learning goals to solve a real community problem (66%), provides the opportunity to present the applications to the selected community (71%), provides the option for the final demo and testing via online platform due to COVID-19 pandemic (63%), is effective to deliver the service that is the application (69%), has the impact to deliver the service (63%), and has more impact if face-to-face meetings are allowed and no movement restrictions (61%). This reflects that despite the challenges to conduct the integrated service learning online (to be elaborated in Section 3.3), the students managed to adapt with the needs to conduct community engagement to serve the selected communities.

3.2. Threat to validity

Among the threat to validity includes the diversity of communities' problems to be solved could affect the responses. For instance, most of the teams chose individuals as their communities to be product owners in the Agile-based projects. Due to OLTnL, they were allowed to do so in order to reduce their pressure in approaching and meeting the communities during the COVID-19 post pandemic period.

However, this threat was reduced by the verification of the type of individuals that should be outside the university to be considered as a community engagement. Among the verified and acceptable individuals or communities include those who require options for healthy lifestyle through exercises and food intake, platforms for donations such as old clothes, and alternatives for affordable or free tuitions (refer Table 2).

3.3. Challenges and lessons learned

As the study was conducted during the COVID-19 post-pandemic period that was from October 2021 to January 2022 (before Malaysia achieved towards the endemic status in April 2022), it could observe some challenges due to certain restrictions.

Among the challenges and lessons learned after conducting OLTnL integrated with online

service learning during the post-pandemic period include:

- Students had to work in their respective teams, but they could only discuss online as most of them were still in their hometowns. However, it is learned that exposing an Agile tool in an AD course as analyzed in Appendix B had a positive impact on the students. The tool helped manage their teams' progress online especially when they needed to work in team virtually. Hence, this approach could also eliminate the challenges in teamwork and communication among team members.

- Students could not serve the selected communities physically even though the course should integrate service learning where students meet the communities. As this study was conducted during COVID-19 post-pandemic period, the challenge was eliminated as students could still meet the communities physically by adhering to the standard operating procedures such as wearing face masks and physical distancing. This could lead to positive impacts as analyzed in Appendix C regarding the service learning. However, only students who were located close to the communities could visit the selected communities as most of team members were still in their hometowns.

- Students faced challenges as every team member had to develop their own assigned user stories with limited team communication besides product owners or/and users. As analyzed in Figure 6, most teams members could complete the development and deploy their applications although they still faced challenges in OLTnL and online service learning. Thus, it is learned that the flexible approach in selecting communities at students' convenience as agreed among their team members (see Section 2.3) and verified by the course lecturer could eliminate these challenges. Team members who were close to the communities' locations could meet the communities and partially fulfilled their teams' service-learning needs especially when gathering and testing the requirements.

- As analyzed in Appendix A, despite the challenges, students' commitments could be boosted in such online AD courses integrated with service learning. Students could benefit from the exposure of the Agile methodology to develop software iteratively following the sprints within one semester with the close monitoring by the course lecturer though the course was fully online. It is also learned that despite the challenges, users and/or product owners could join the sprint reviews online, which could give benefits to the students in terms of traveling cost.

- Although students managed to deliver and deploy the final application release, the applications could not be released to the communities until they were fully tested with some crucial aspects like security. This challenge could occur even if not within the COVID-19 period. Hence, the lesson learned is that deployed projects in such AD courses cannot be released to the communities unless they have options to maintain the applications as the students need to focus on other courses in the following semesters. It is better to choose communities with such capabilities in future service learning in the AD course.

In a nutshell, the challenges and lessons learned could provide some guidelines to future implementation of service learning via online platforms particularly during the COVID-19 endemic period in Malaysia.

4. Conclusion

The analysis and findings from the case study conclude that OLTnL and online service learning for such team-based AD courses that apply the Agile development methodology supported with a suitable Agile tool could deliver positive impacts though some challenges still exist among the students during the COVID-19 post-pandemic period. Moreover, flexibility in choosing their own communities could eliminate the challenges as team members who proposed the communities could approach them physically or contacted them directly with less bureaucracy. This is vital during the challenging COVID-19 post-pandemic period. Despite the challenges, online discussions with product owners or/and users could be beneficial in terms of reducing the travelling cost as compared to previous face-to-face service learning that require a number of travelling costs to meet the communities.

Future work could include the study for this course in the endemic phase when most courses are expected to be conducted physically or hybrid. The challenges could be lessened with some improvements based on the lessons learned.
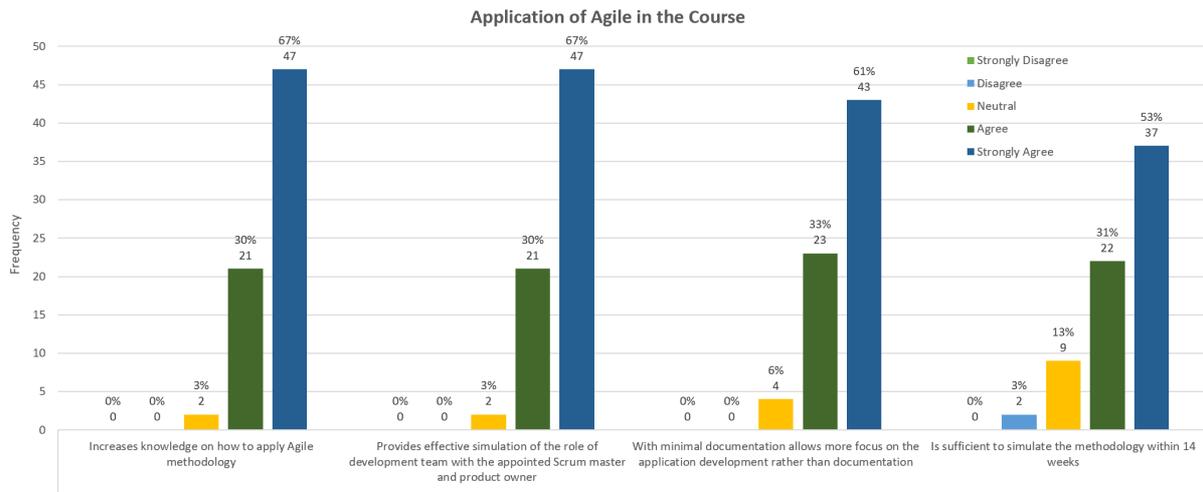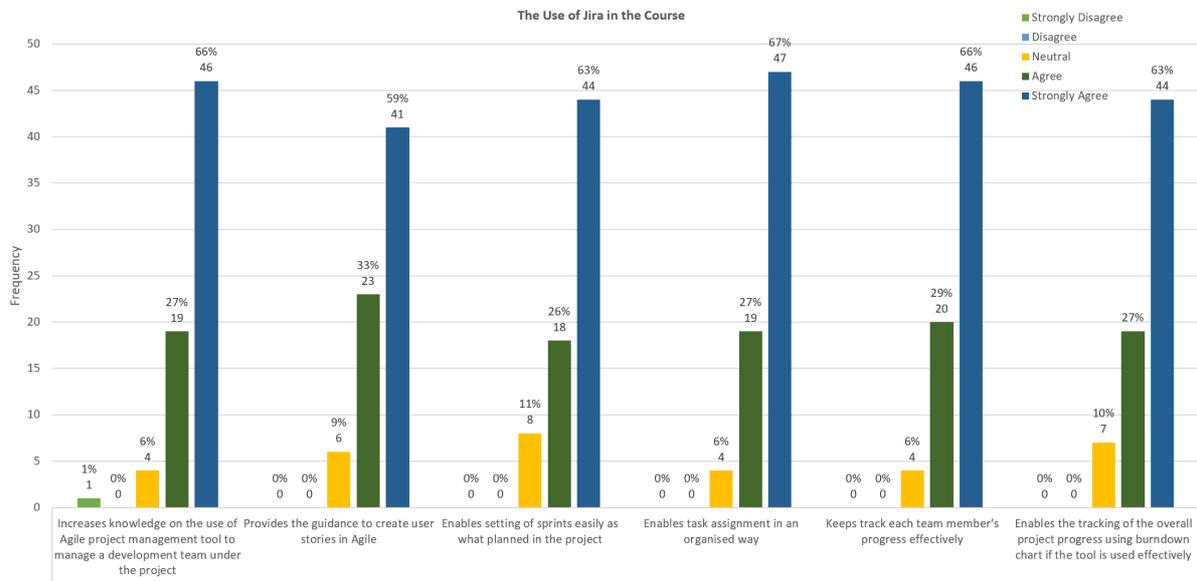
5. Acknowledgements

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Appendix A: Responses on Agile development methodology

Application of Agile in the Course

Legend: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Increases knowledge on how to apply Agile methodology	0% / 0	0% / 0	3% / 2	30% / 21	67% / 47
Provides effective simulation of the role of development team with the appointed Scrum master and product owner	0% / 0	0% / 0	3% / 2	30% / 21	67% / 47
With minimal documentation allows more focus on the application development rather than documentation	0% / 0	0% / 0	6% / 4	33% / 23	61% / 43
Is sufficient to simulate the methodology within 14 weeks	0% / 0	3% / 2	13% / 9	31% / 22	53% / 37

Appendix B: Responses on the use of Jira for Agile development methodology

The Use of Jira in the Course

Legend: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Increases knowledge on the use of Agile project management tool to manage a development team under the project	1% / 1	0% / 0	6% / 4	27% / 19	66% / 46
Provides the guidance to create user stories in Agile	0% / 0	0% / 0	9% / 6	33% / 23	59% / 41
Enables setting of sprints easily as what planned in the project	0% / 0	0% / 0	11% / 8	26% / 18	63% / 44
Enables task assignment in an organised way	0% / 0	0% / 0	6% / 4	27% / 19	67% / 47
Keeps track each team member's progress effectively	0% / 0	0% / 0	6% / 4	29% / 20	66% / 46
Enables the tracking of the overall project progress using burndown chart if the tool is used effectively	0% / 0	0% / 0	10% / 7	27% / 19	63% / 44

Appendix C: Responses on the integrated service learning

The Service Learning in the Course

Legend: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Improves my communication as a result of service activities	0% / 0	1% / 1	3% / 2	33% / 23	63% / 44
Provides benefits to the community partner as a result of the service activities	0% / 0	0% / 0	10% / 7	24% / 17	66% / 46
Is relevant and meet the content and learning goals to solve a real community problem	0% / 0	0% / 0	4% / 3	30% / 21	66% / 46
Provides the opportunity to present the application to the community under the assigned rural community project	0% / 0	0% / 0	6% / 4	23% / 16	71% / 50
Provides the option for the final demo and testing with the community via online platforms due to COVID-19 pandemic	0% / 0	0% / 0	6% / 4	31% / 22	63% / 44
Is effective to deliver the service that is the application	0% / 0	0% / 0	11% / 8	20% / 14	69% / 48
Has the impact to deliver the service that is the application	0% / 0	0% / 0	4% / 3	33% / 23	63% / 44
Has more impact if face-to-face meetings are allowed and no movement control order (MCO) as faced during the period	0% / 0	0% / 0	9% / 6	30% / 21	61% / 43