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Creating an Immersive Learning Environment for Teaching Agile Scrum and Team Software Process: A Framework for Software Engineering Education

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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. This paper presents an innovative framework tailored for the establishment of an immersive learning environment within the context of a Software Engineering Project course. The overarching objective is to effectively tackle the inherent challenges associated with teaching intricate software engineering concepts, notably Agile Scrum and Team Software Process (TSPi). Conventional pedagogical approaches often prove inadequate in providing a comprehensive and engaging learning experience for students, educators and stakeholders. In response, our study introduces a pioneering immersive learning approach, offering a robust solution to this educational gap. To gauge the framework's efficacy and pertinence, we conducted online surveys, specifically targeting third-year students enrolled in the Software Engineering Laboratory course and the project stakeholders involved. These surveys were instrumental in collecting valuable feedback on the practicality and impact of our approach in enhancing the teaching and learning processes. This study presents a thorough exposition encompassing the framework's conceptualization, implementation and iterative evolution. Our research outcomes reveal that our immersive learning approach has successfully met the predefined course objectives, effectively addressing the intrinsic challenge of imparting hands-on experiences associated with software engineering principles and concepts. As a significant contribution to the ongoing initiatives aimed at elevating software engineering education, our study underscores the importance of providing students with tangible exposure to vital concepts such as Agile Scrum and TSPi. Moreover, this paper delineates the collaborative journey involved in the creation, execution and refinement of the course framework. Ultimately, our research endeavours to evaluate the degree to which our innovative framework aligns with the objectives established by both students and stakeholders. By doing so, it underscores the transformative

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potential of our approach in reshaping the landscape of software engineering education, ultimately enhancing its effectiveness and relevance.

1. Introduction

The success or failure of students in computer science courses is contingent upon their ability to work effectively in teams. Within the context of Software Engineering, students must receive instruction not only in the academic and technical aspects of software development but also in collaboration and interpersonal skills. A pivotal component of the Software Engineering curriculum is the execution of software projects, with the ultimate aim of creating software systems or applications that will be consistently utilized by users or stakeholders [1]. Additionally, students are exposed to the challenges of addressing real-world industrial problems through group work.

Software Engineering Laboratory (TME3413) is a course offered by the Faculty of Computer Science and Information Technology (FCSIT) at UNIMAS [2,3]. This course is specifically designed for third-year students enrolled in the Software Engineering degree program who have already acquired proficiency in programming languages, scripting, software modelling and database management systems. These acquired skills and expertise play a crucial role in enabling students to engage in the development of diverse systems.

1.1 Literature Review

In order to adequately respond to the requirements of a Future Ready Curriculum [4,5], it becomes imperative to embrace a revolutionary educational approach known as Immersive Learning. Immersive learning is an educational approach that involves creating a highly engaging and participatory learning environment where students are fully immersed in the subject matter [6]. It typically goes beyond traditional classroom settings, encouraging active participation and practical experiences. Immersive learning can take various forms, including virtual reality simulations, hands-on projects, field trips and interactive discussions, among others. The key goal is to provide students with a deeper and more meaningful understanding of the material by involving them actively in the learning process.

This methodology places a strong emphasis on experiential learning, characterized by hands-on engagement and active involvement with the industry and the community. When integrated with the development of Software Engineering projects, this pedagogical approach offers students invaluable exposure to real-world industry dynamics through the application of authentic case studies and meaningful interactions with stakeholders and the community. This holistic approach not only encourages inquisitiveness but also nurtures problem-solving skills and facilitates the acquisition of knowledge throughout the learning journey.

Immersive learning experiences, which revolve around face-to-face instruction and blended learning approaches, enable students to actively engage in tasks and projects that extend beyond traditional classroom boundaries. This approach delivers a meaningful and impactful learning experience to students [7]. Students will get hands-on experience in dealing with stakeholders (local entrepreneurs) and developing a high-quality software solution that demands comprehension of the subject matter. As a result, students will learn how to do case studies, establish a value proposition and analyse data pertaining to user experience. Furthermore, the ability to work successfully in a team as well as outstanding time management are required talents in order to achieve a shared objective.

A noteworthy observation is the increasing necessity for curriculums to be "Future Ready." To accomplish this, educational strategies must evolve, leading to the consideration of "Immersive Learning" as a potentially game-changing approach. Immersive Learning, as described, emphasizes total engagement in the subject matter. It seeks to push students out of the conventional classroom paradigms, thrusting them into a world where learning is experiential, hands-on and closely tied with real-world applications. The diverse formats it can take - from virtual reality simulations to hands-on projects - emphasize its adaptability and range.

Interestingly, when Immersive Learning is integrated with Software Engineering, it offers an enriched, multifaceted learning experience. Students aren't just passive absorbers of knowledge but active participants in a dynamic learning process. They're thrown into the deep end, liaising with stakeholders, such as local entrepreneurs, understanding and determining value propositions, analysing user experience data and more. This doesn't just make their learning robust; it shapes them into holistic professionals who are ready to tackle the challenges of the industry. Another salient feature of Immersive Learning is its blended approach. By integrating traditional face-to-face instruction with experiential learning, students are provided a platform to venture beyond traditional educational confines. This teaches them invaluable skills, such as teamwork and time management - talents that aren't just academically relevant but are essential life skills.

In essence, for the future of Software Engineering education and perhaps education as a whole, the path forward seems to be one of immersive, experiential and holistic learning. By embedding students in real-world challenges, fostering collaboration and emphasizing active participation, we're not just nurturing better professionals but also more prepared individuals ready to navigate the complexities of the future.

2. Methodology

The Team Software Process (TSPi) and Scrum Agile [8] software methodology were used in this TME3413 – Software Engineering Lab course [9,10]. The Team Software Process (TSPi) offers software engineers with a set of operational practices that may help them organise software development projects more efficiently, effectively and productively [11,12]. Humphrey's "Team Software Process (TSP) Body of Knowledge (BOK)" is a valuable resource for software professionals aiming to implement effective project management practices and achieve greater success in software development projects. It offers insights and guidance to help teams work cohesively and efficiently while maintaining a strong focus on product quality and performance [13].

Agile software development emphasises individual and group interaction, functioning software, stakeholder cooperation and adaptability. Iterative and incremental software development. Both approaches include recognising and addressing risks and concerns to eliminate obstacles [14-16]. TSPi and Scrum Agile have their merits and are valuable in different contexts. Combining the structure of TSP with the adaptability of Scrum Agile to achieve the best of both worlds. Ultimately, successful software development teams understand when and how to apply each methodology effectively to deliver high-quality software products.

2.1 Framework

Product, Team or People and Technology all impact software quality and team or organisation performance. Fishpool *et al.,* [17] and Ciriello *et al.,* [18] emphasized on the significance of effective communication, collaboration and project management in ensuring successful software projects. They provided valuable insights into team dynamics, client interactions and the importance of

maintaining a customer-centric approach throughout the development process. In Figure 1, the process is at the heart of the triangle linking these three components, where software process efficiency is assessed by defects, productivity, calendar time, etc. Customer or Stakeholder characteristics (communication), Business situation (requirements norms) and Development Environment may all impact quality and performance (Software tools).

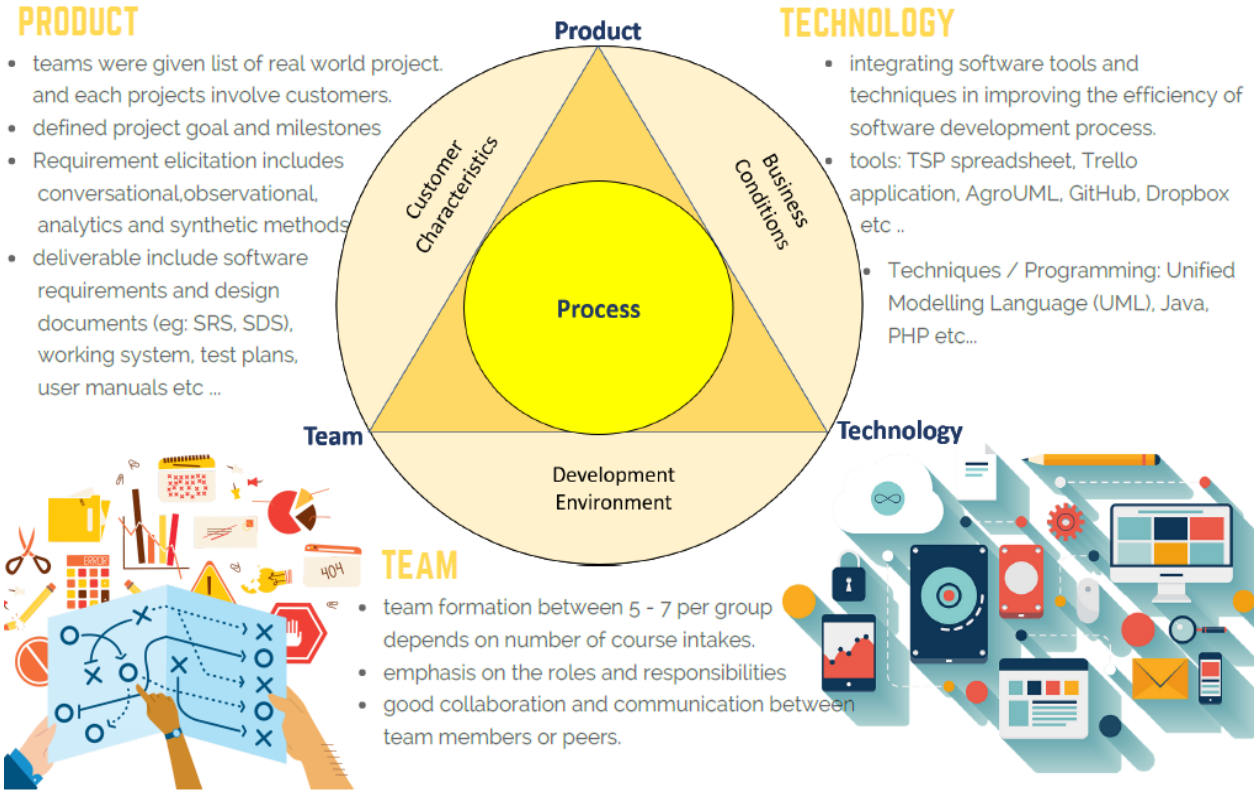


Fig. 1. Software engineering lab project framework [18]

2.2 Course Plan, Activities and Assessments

As each software project possesses its unique characteristics, there exists no predefined set of deliverables obligatory for all projects. It falls upon the project teams to discern the specific requirements for each endeavour. Usual deliverables encompass functional code, documentation, training materials, test suites, among others. The projects are segmented into four distinct phases, culminating in respective milestones. At the conclusion of each milestone, the team presents a comprehensive written report, which includes items such as Software Requirement Specification (SRS), Software Design Specification (SDS), Team Software Process (TSPi) documentation, test suites and user manuals. Following the second, third and final milestones, the team conducts presentations to both the client and the course team. Following the initial milestone, each project team provides a weekly progress report.

The success of a project is primarily gauged by three key criteria: meeting the client's requirements, ensuring the usability of the product and ensuring its maintainability throughout its lifecycle. These are group projects, but the students will also be rewarded individually for extra contributions to the project. The TME3413 course plan and activities is shown in Table 1. All the procedure on Agile methodologies and TSPi practices are brief and clear guidelines are given to the students. Standard templates for documentation such as SRS, SDS and test plans are essential.

Table 1
TME3413 course plan and activities

Week	Course Plan/Activities
1	Team formation and project selection
2	Lecture on the introduction to Agile methodology and TSPi
3	Project lunch and proposal submission
4	Development strategy on product functions and assess risk
5	Develop product size estimation plan, task to be completed and quality plan
6	Document the Software Requirement Specification (SRS)
7	Mid-Term Break
8	Produce a complete and precise software design
9	System implementation
10	System implementation and integration testing
11	Document the Software Design Specification (SDS)
12	Generate test plan
13	System testing and user acceptance test
14	Post-mortem

To facilitate teaching and learning, Bloom's Taxonomy served as a valuable tool for designing the learning activities within the projects [19,20]. This taxonomy comprises three hierarchical models categorising learning objectives into three distinct domains: Cognitive (knowledge), Psychomotor (skills) and Affective (attitudes) [21]. These domains activities pertain to the proposed Software Engineering Project Learning Activities, represented in Figure 2. This learning activity structure has been practised for TME3413 Software Engineering lab course since 2017.

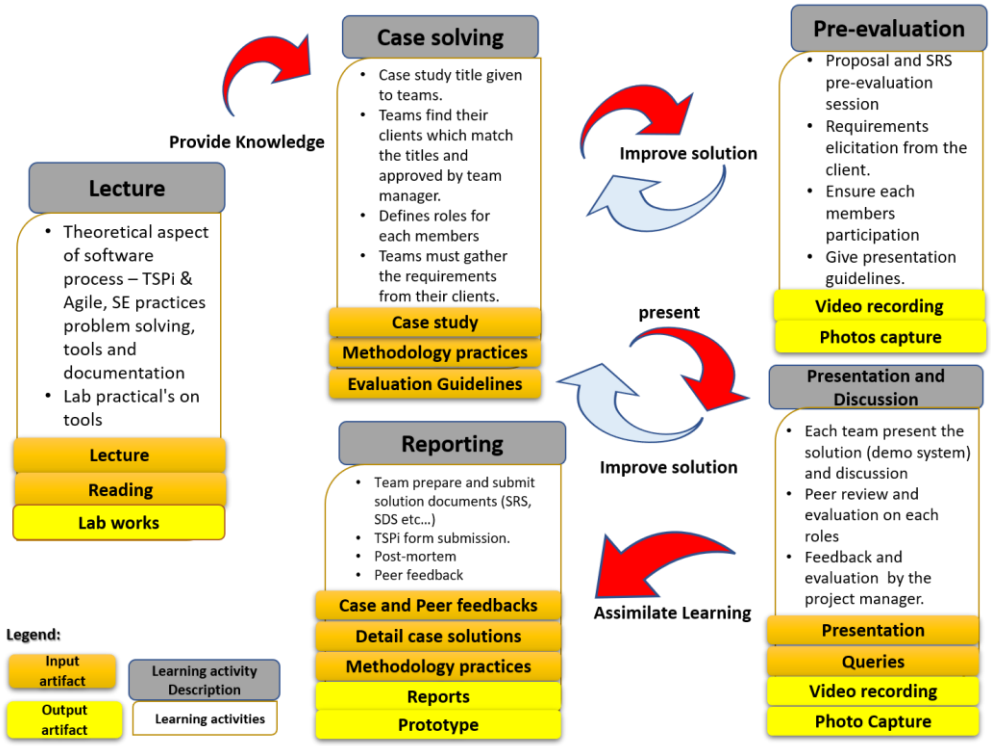


Fig. 2. TME3413 – Software engineering project learning activities

The framework was effectively put into practice prior to the emergence of the COVID-19 pandemic and this publication provides insights into the results during both the pandemic and post-pandemic periods. However, due to the prevailing COVID-19 circumstances, certain aspects of the

framework needed to be either adjusted or eliminated. Face-to-face interactions among students, instructors and stakeholders became unfeasible due to lockdown measures, which included adhering to Standard Operating Procedures (SOPs), maintaining social distancing and imposing restrictions on students' campus access. To align with the framework's goals, online video conferencing platforms such as Skype, Microsoft Teams, Zoom Meeting, Google Meet and similar tools proved invaluable in enabling virtual face-to-face discussions despite the pandemic-related limitations.

Figure 3 and Figure 4 show the online support tools such as Trello, Padlet and TSPi Spreadsheet that use to manage, track and trace the project progress. These tools ease the instructor to examine and evaluate the project, teams and each member.

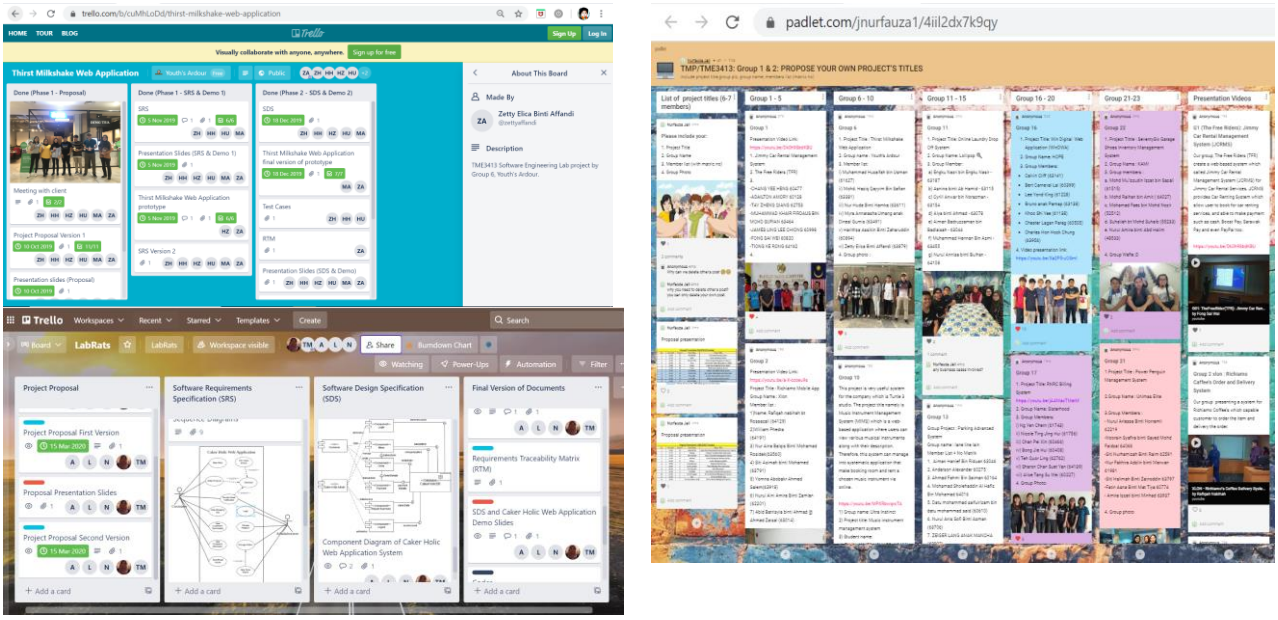


Fig. 3. Trello and Padlet as project team management tools

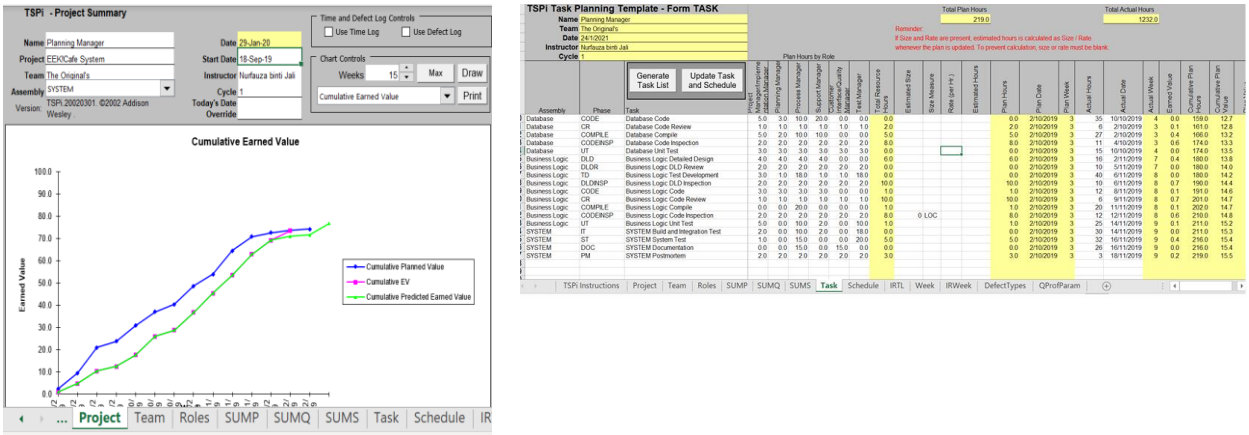


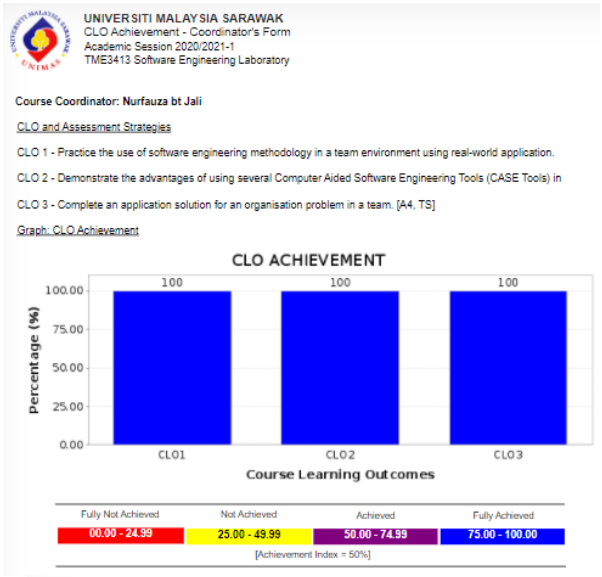
Fig. 4. TSPi spreadsheet support tool

3. Result on the Achievement and Feedback from Students and Stakeholders

3.1 Course Learning Outcomes (CLO) Achievement

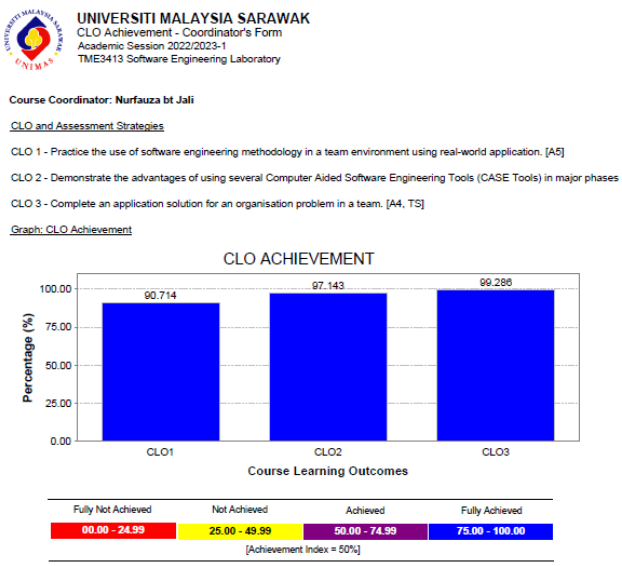
Students enrolled in the TME3413 Software Engineering Laboratory are required to fill out an evaluation form addressing the content, instruction and delivery of the course. This evaluation form will be accessible through their student course management page at the conclusion of the semester. In contrast, to gather feedback from the clients, a link to an online form will be disseminated via email

and private messaging. The research for this paper incorporates data gathered from 280 students and 44 clients (equivalent to number of project) across the enrolments for year 2020/2021 and 2022/2023. According to the feedback from the students, all Course Learning Outcomes (CLOs) have been fully achieved for both cohorts, during and subsequent to the Covid-19 pandemic (Figure 5).



CLO	No of student who achieved LO	Percentage of student who achiev
CLO1	140	100.00 %
CLO2	140	100.00 %
CLO3	140	100.00 %

(a) TME3413 CLOs Achievement during the Covid-19 Pandemic



CLO	No of student who achieved LO	Percentage of student who achieved LO
CLO1	127	90.71 %
CLO2	136	97.14 %
CLO3	139	99.29 %

(b) TME3413 CLOs Achievement after the Covid-19 Pandemic

Fig. 5. CLOs achievement before and during the Covid-19 pandemic

3.2 Feedback from Students and Stakeholders/Clients

As presented in Table 2, the students' reflections provide insights into their project experiences, revealing a significant journey marked by personal growth, teamwork and valuable learning. Several overarching themes emerge from their interactions and collaborations with stakeholders.

Table 2
Reflections from students

Collection of student's reflections on their experience working with the stakeholders
i. I had the opportunity to work as part of a team on a project for a real client. My role was to design the system interface based on the requirements from the client, creating interactive programs that enhance a customer's experience and present design ideas. One of the challenges I faced was balancing the client's requirements with the technical limitations of the website. However, I was able to solve it by working closely with the client and the team and making sure the client is satisfied with what we are doing. Throughout the project, our group received positive feedback from the client and the instructor. Although we lack in some factors, we worked together to complete the tasks as the instructor guide us throughout the project. The Nafilzatul Crochet Web Application managed to get completed on time and the instructor is satisfied with our work. Overall, this project was a valuable learning experience for me as it taught me the importance of effective communication and problem-solving skills in a team setting. It also taught me that I still have more to learn and improve myself better in the future.

ii.	Throughout the project, there were ups and downs that our team has faced. The support and hard work that each member gave were tremendous that in the end we could still finish off well even though the outcome might not be the best. We utilised each of our abilities and skills into the project in order to ease each other's work. As a team, we learned that team work makes the dream work because we complemented each other's strengths and weaknesses although there were some unpleasant moments along the way. As for me personally, I learned a lot of things from my group members including coding skill, web development and other new IT related things that I have never known before. With Mdm Nurfauza as our instructor, she has always been very supportive, informative and helpful. Her guidance throughout the project kept everyone on track. She gave feedbacks, reminded all groups to do the project, ways to do documentation correctly and never failed to respond whenever there would be questions. My group felt at ease knowing that we have Mdm Nurfauza as our instructor. Our client was also very supportive and understanding as well. He did not put excessive pressure on us as we were working on the project as part of a course. He provided valuable insights and feedback and even made time for us to interview and visit his store, which allowed us to gain a deeper understanding of the store's operations and areas for improvement. Overall, the experience and lessons that I gained from this project will be my guidance to improve myself in the near future.
iii.	This project has taught me several valuable lessons when managing my team. Of course, when completing this project, we encountered many challenges and obstacles. However, I am grateful that all team members because they always do their best to make this system as perfectly as possible. Being a project manager and team leader is not an easy task to do. It requires a lot of things and skills to handle different members at the same time as I need to aware about their problems and conditions. Sometimes we could argue when problem and miscommunication happen but we manage to solve all of it through discussion and meetings. I also learnt that documentation is also important and we need to do it properly as it is an important thing to record our progress. I am thankful for other team members as they work very hard to complete this project and without them, this system will work perfectly. I would like to express our gratitude to our client, Ultimate Athletic Gym and Fitness Centre because giving us an opportunity to create a system that will help them managing gym membership's database. Although it is hard to keep up with their requirements, but we learnt something when completing this project. Lastly, I am very grateful to Madam Nurfauza for her guidance throughout this course. She is always available to answer our questions and giving us opportunity to improve our project. Thanks for the feedback and suggestions. Thank you to the team members for trusting me to be a project manager and I am sorry if there is any lack when handling the team. I will try to improve myself in the future.
iv.	Throughout the whole project, there were numerous difficulties that our team had to overcome in order to finish the job but because of team member's dedication and assistance, we were able to complete the task successfully despite the limited time and issues that we had. To make each other's jobs easier, we put our individual talents and skills to use on the project. As a team, I discovered that despite challenges along the way, every member of my team will put in endless effort to help the other members finish this job. Personally, I picked up a lot of knowledge from my group members, including the fact that communication is the key to every solution and that it's important to record the system so that we can refer to it when we need to understand it. Regarding my experiences with Madam Nurfauza, I can say that she has always been quite encouraging, instructive and helpful. Everyone stayed on task thanks to her leadership throughout the project. She provided feedback, urged all groups to complete the project, explained how to properly complete documentation and never failed to answer any queries. For our client, Mr Darren, he was incredibly kind and helpful. Even though we were working on the assignment as part of a course, he didn't put us under too much pressure. He gave us insightful advice and even made time for an interview and store visit, which helped us better understand the operations of the store and its potential for development.

v. This project has given me a vision and experiment with software development engineering methodology in a team environment using real-world applications, whereby each person will perform their own roles in a short period of time by organising the project based on the software engineering process and practice including software development life cycle, standards of analysis and design and aspects of management for a software engineering project, then work as a team in solving a complex problem while giving appropriate justification and able to present solution clearly and confidently and at the same time produce a clear and complete Software Requirement Specification (SRS), Software Design Specification (SDS) and furthermore experience in handling test plan which is kind of a new thing to learned for me. Throughout the project, our team encountered various challenges and obstacles such as miscommunication among team members, a lack of time management, an error occurring and a lack of knowledge of certain parts of coding during the code phase and rapid changes in client requirements, but we were able to overcome them with hard work and perseverance to achieve our goals. Firstly, I would like to express our gratitude to our client, for their willingness on giving us an opportunity to collaborate and work together to create a system that will help them manage the gym membership database. Despite the fact that it has been challenging to keep up with their demands, we learned something from working on this project: it's important to engage with and elicit needs from our customer, who is always contributing constructive criticism and recommendations to the development process. In addition, I would like to express my thanks to Madam Nurfauza for her patience and guidance with us as we worked to finish this course. Without her insightful observations and encouragement, which she provided throughout the project, we would not have been able to finish the course of the project. Then of course, I want to acknowledge the entire Castor team, especially the project manager, Mohd Amir, for believing in me and giving me the chance to work with them and contribute to the team project's success. I also want to apologise if there was any wrongdoing or omission when contributing to the team and I promise to make every effort to improve going forward. Ultimately, the UAGMS project was a beneficial learning experience for all of us at Castor because we learned a lot about effectively managing a project's workflow by using the right methodology and tools to keep everyone, including our client and instructor, in the loop. We also learned new knowledge and skills that will be helpful in future projects and we strengthened our relationships with our team members as we look forward to facing new challenges.

i. Individual Learning and Client Interaction: The students recount their role in designing the system interface and the challenge of balancing client requirements with technical limitations. They emphasise the importance of effective communication and problem-solving skills and express their commitment to continuous improvement.
ii. Teamwork and Support: The students highlight the ups and downs faced by the team and the importance of mutual support. They stress the value of teamwork, learning from each other's skills and the guidance of their instructor. The student also acknowledges the client's support and understanding throughout the project.
iii. Leadership and Project Management: The students reflect on their role as a team leader, emphasising the challenges they faced in managing team dynamics, communication and documentation. They express gratitude for their team's hard work and the importance of proper record-keeping.
iv. Overcoming Challenges and Learning: There are various difficulties the team encountered during the project, highlighting the dedication and assistance of team members. They emphasise the importance of communication and documentation and express gratitude to both the client and instructor for their guidance.
v. Experiencing Software Development Methodology: Students shared their experience in applying software development engineering methodology within a team environment. They highlight the challenges, including miscommunication and changing client requirements, but underscore how hard work and perseverance led to successful outcomes.

In all reflections, gratitude is expressed toward the client, the instructor and team members for their support and collaboration. The project served as a valuable learning experience, providing

insights into real-world applications, teamwork, project management and effective communication. The students' collective growth and newfound knowledge will undoubtedly serve them well in their future endeavours.

In conclusion, these student reflections encapsulate a journey of personal growth, teamwork and technical learning. They showcase the challenges faced and the determination to overcome them, ultimately resulting in a successful project. These experiences will serve as a valuable foundation for their future endeavours in the field of software development. Table 3 shows the Comments and suggestions from clients or stakeholders.

Table 3
Comments and suggestions from clients or stakeholders

Survey questions	Feedbacks from Clients/stakeholders
What are the greatest strengths of the system? (Please provide supporting examples)	• *sistem ini memberi peluang saya untuk memberi invoice secara online kepada semua pelanggan dan dapat berinteraksi secara terus dengan pelanggan saya tanpa perlu menggunakan aplikasi whatsapps atau instagram* • items are categorised accordingly and it provides a user-friendly interface to all users • *Penyediaan sistem digital utk urusan manual di taska cth log book* • Handling Merpati Studio's project as well organized and fulfilled its goal to reach more clients. • My customers can view the products that I have in store and also keep the items that they like in the cart until they are ready to purchase from me. Receipt is also provided and it is easier for me to keep track of customer orders instead of through WhatsApp/ Instagram DMs. Customers go through less hassle when ordering as they can simply choose the size n type, they want instead of having to inform me personally. • It can ease my online ordering process. For example, I can keep track of my orders online instead of using WhatsApp.
What are the areas where the students need to make improvement? (Please provide example and suggestions for improvement)	• Overall functions of the website are very good and it meets what i asked for. Maybe can also add functions where the products are disusun ikut category. But i only provided them with my cardigan products. • If there is any improvement, I think is more on the design colour background and the icon of the design. It would look much more professional if they can adjust on the colour tone and use nicer icon to symbolise the content. • a friendlier user interface and faster interaction with clients probably by using bot chat answering services. • Overall functions of the website is very good and it meets what i asked for. Maybe can also add functions where the products are disusun ikut category. But i only provided them with my cardigan products. • Search Engine Optimisation (SEO) - Get on top of Search Rankings with Google Ads. Leverage on Google Ads for keywords that do not appear organically on your website through SEO. This is among of the important features in website.

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. • Inovasi kepada sistem sedia ada perlu dilakukan secara berkala • A website should be able to accomplish one thing to provide the basic information to the user. A good website should also include a contact form and readability. A website must not be too messy, it must have consistent font size to differentiate titles and content. When things are made as easy and user-friendly as possible, everyone wins. • They work effectively and efficiency • Conclusion, overall is impressive, cool, modern and the theme is exactly about music. Thank you, Ultra Instinct, for their much effort. • Nice and interactive undergraduates

The stakeholders' feedback on the students' projects reflects a mix of positive experiences and constructive suggestions as stated in the Table 4:

Table 4
Feedbacks and Suggestions

Feedbacks and Suggestions		Explanation
Positive Feedback:	Online Invoicing and Customer Interaction	The stakeholders appreciate the systems for enabling online invoicing and direct interaction with customers. This feature eliminates the need for third-party applications like WhatsApp or Instagram.
	Effective Categorisation and User-Friendly Interface	The categorisation of items within the systems is commended for its efficiency. Stakeholders find the user interface to be user-friendly, which enhances the overall experience.
	Digitisation of Manual Processes	Some stakeholders highlight the value of digital systems in replacing manual tasks, such as logbooks in daycare centres, streamlining operations.
	Organised Project Handling	Stakeholders commend the students for their well-organised approach and achieving the goal of expanding their client base.
	Enhanced Customer Experience	The stakeholders note that customers can view products, add them to carts, receive receipts and easily track orders. This streamlines the ordering process and reduces customer hassle.
	Efficiency in Online Ordering	The systems are recognised for simplifying the online ordering process, allowing for better order tracking compared to using WhatsApp.
Constructive Suggestions	Product Categorisation	Some stakeholders suggest enhancing the organisation of products by adding features for categorisation, even though they had provided only cardigan products.
	Design and Aesthetics	Feedback includes recommendations to refine design elements such as colour backgrounds and icons for a more professional appearance.

	User Interface and Interaction	Stakeholders desire a friendlier user interface and faster client interaction, potentially through the implementation of chatbot services.
	Search Engine Optimisation (SEO)	One stakeholder emphasises the importance of SEO and leveraging Google Ads for better search rankings, considering it a crucial website feature.
Positive Remarks on the Project Team	Efficient and Responsible Team	Stakeholders acknowledge the project team's efficiency and responsibility, praising them for meeting their requirements
	Detail-Oriented Admin Page	The stakeholder’s express satisfaction with the detail-oriented admin page, particularly highlighting the sales report feature
	Cooperative Team with Prompt Communication	The stakeholders appreciate the team's cooperation and prompt communication throughout the project duration
	Emphasis on Innovation	Stakeholders recommend periodic innovation to improve existing systems continually.
	User-Friendly Websites	The stakeholders emphasise the importance of user-friendly websites, including clear information presentation, contact forms and readability.
	Effective and Efficient Work	The project team is commended for their effective and efficient work.
	Impressive and Modern Theme	One stakeholder describes the project's theme as impressive, cool, modern and perfectly aligned with the subject matter.
	Interactive Undergraduates	The stakeholders appreciate the interactive nature of the undergraduates involved in the projects, which likely contributed to successful outcomes.

Overall, the feedback showcases a balance of appreciation for the positive aspects of the projects and thoughtful suggestions for further improvement, highlighting the students' achievements and room for growth.

4. Limitation

A primary advantage of this course is the emphasis on vital skills like communication, collaboration and problem-solving. By the end, students not only grasp the intricacies of teamwork for project completion but also experience a heightened interest in learning. This is particularly evident when they engage actively in project tasks and discern that these engagements significantly improve their project performance.

Furthermore, the course underscores the paramount importance of 'quality' in software development. Recognizing and incorporating quality in all facets of software development became a salient takeaway for students. This understanding, coupled with achieving the stakeholders' objectives, bolsters the students' motivation and self-assuredness in navigating real-world scenarios. Consequently, they emerge better equipped and more confident as they step into their internship programs in the subsequent semester.

However, as with any study, there were limitations. While the data acquired from the evaluation forms was comprehensive, the feedback from 280 students and 44 clients spanning two enrolment years (2020/2021 and 2022/2023) indicated a unanimous achievement of Course Learning Outcomes (CLOs) across both batches. One must consider external factors that may have influenced these

results, especially as these durations encapsulated unprecedented times both during and after the pandemic.

5. Conclusions

The TME3413 Software Engineering Laboratory course endeavours to bridge the theoretical knowledge taught in classrooms with practical application in the real world. By being a part of this course, students not only get the opportunity to apply their acquired knowledge in tangible scenarios but also to understand the practicality and benefits of methodologies such as Agile and Team Software Process (TSPi) in undergraduate settings.

Consequently, at the conclusion of the course, students had gained an understanding of the significance of quality as a fundamental concept that should permeate all aspects of the software development organisation. When their project meets the goals and expectations of the stakeholders, this will ultimately increase the students' motivation to learn and confidence in working in a real-world context, allowing them to be more prepared for their internship programmes in the following semester.

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References

[1] Bourque, Pierre, Richard E. Fairley and V3 SWEBOK. "0: Guide to the Software Engineering Body of Knowledge." *IEEE Comput. Soc. Press, Los Alamitos, CA, USA* (2014).

[2] Jali, N., A. bin B. Masli, C. W. Shiang, A. R. Mat, Y. R. Bujang and N. M. Hamdan. "Software Development in Software Engineering Course-Looking into Project Planning and Estimation using Team Software Process (TSPi) and Scrum." *SoTL Bulletin* 1 (2017).

[3] Ahmad Khiri, Mohamad Johan, Wee Bui Lin and Eaqerzilla Phang. "Strengthening Curriculum Sructure of Software Engineering Programme."

[4] Malaysian Ministry of Higher Education. “Framing Malaysian Higher Education 4.0: Future-Proof Talents”. Malaysia: Cataloguing-in-Publication Data, (2018).

[5] Majid, Faizah A. and Ainul Azmin Md Zamin. "The 4th industrial revolution: Contemplations on curriculum review and its implementation in the Malaysian higher education institutes." *Global Journal Al-Thaqafah* 9, no. 2 (2019): 7-13. https://doi.org/10.7187/GJAT122019-1

[6] Carroll, John M., ed. *Innovative practices in teaching information sciences and technology: Experience reports and reflections*. Springer Science & Business Media, 2014. https://doi.org/10.1007/978-3-319-03656-4

[7] Carroll, John M., ed. *Innovative practices in teaching information sciences and technology: Experience reports and reflections*. Springer Science & Business Media, 2014. https://doi.org/10.1007/978-3-319-03656-4

[8] Schwaber, Ken and Sutherland, Jeff. “Scrum Guide.” (2023). https://scrumguides.org

[9] Jali, Nurfauza, Cheah Wai Shiang, Azman Bujang Masli and N. Asmadiah. "Team Software Process (TSPi) Web-Based Support Tool." *International Journal of Recent Technology and Engineering* (2019).

[10] Jali, Nurfauza, Norazian Mohamad Hamdan, Cheah Wai Shiang and Suriati Khartini Jali. "Developing an Evaluation Framework for Immersive Learning Experiences for Software Engineering Project Course." In *Knowledge Management International Conference (KMICe)*. 2021.

[11] Humphrey, Watts S. *The Team Software Process (sm)(TSP (sm))*. Carnegie Mellon University, Software Engineering Institute, 2000. https://doi.org/10.21236/ADA386941

[12] Chick, Timothy A., James McHale, William Nichols and Marsha Pomeroy-Huff. "Team Software Process (TSP) Coach Mentoring Program Guidebook, Version 2.0." *Hanscom AFB MA: Camegie Mellon University* (2013).

[13] Jamaludin, Aaishah Radziah, Deepa Alagappan, Wan‘Atikah Wan Ibrisam Fikry, Siti Zhafirah Zainal, Fatin Shaqira Abdul Hadi, Nawal Shaharuddin and Nurul Izzati Abd Rahman. "The effectiveness of academic advising on student

performance." *International Journal of Advanced Research in Future Ready Learning and Education* 25, no. 1 (2021): 20-29. https://doi.org/10.37934/frle.25.1.2029

[14] Jovanovic, Milos, Bojan Lalić, Antonia Mas and Antoni-Llius Mesquida. "The agile approach in industrial and software engineering project management." *Journal of Applied Engineering Science* 13, no. 4 (2015). https://doi.org/10.5937/jaes13-9577

[15] Al-Saqqa, Samar, Samer Sawalha and Hiba AbdelNabi. "Agile software development: Methodologies and trends." *International Journal of Interactive Mobile Technologies* 14, no. 11 (2020). https://doi.org/10.3991/ijim.v14i11.13269

[16] Avila, Daymy Tamayo, Wim Van Petegem and Monique Snoeck. "Improving teamwork in agile software engineering education: The ASEST+ framework." *IEEE Transactions on Education* 65, no. 1 (2021): 18-29. https://doi.org/10.1109/TE.2021.3084095

[17] Fishpool, Bernie and Mark Fishpool. *Software development in practice*. BCS Publishing, 2020.

[18] Ciriello, Raffaele Fabio, Jeppe Aagaard Glud and Kevin Helge Hansen-Schwartz. "Becoming agile together: Customer influence on agile adoption within commissioned software teams." *Information & Management* 59, no. 4 (2022): 103645. https://doi.org/10.1016/j.im.2022.103645

[19] Jali, Nurfauza, Azman Bujang Masli, Wai Shiang Cheah, Yanti Rosmunie Bujang, Abdul Rahman Mat and Norazian Mohd Hamdan. "The Adoption of Agile Software Methodology with Team Software Process (TSPI) Practices in the Software Engineering Undergraduate Course." *Journal of IT in Asia* 7, no. 1 (2017): 1-8. https://doi.org/10.33736/jita.613.2017

[20] Heller, Richard. "A new bloom–adding 'collaborate'to Bloom's taxonomy." *Journal of Learning Development in Higher Education* 24 (2022). https://doi.org/10.47408/jldhe.vi24.906

[21] Krathwohl, David R. "A revision of Bloom's taxonomy: An overview." *İlköğretim Online (elektronik)* 8, no. 3 (2009): 1-7.