Design and Supervision Model of Group Projects for Active Learning

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***Abstract*—This research paper presents a group project framework for a second-year programming course, which was conducted during the COVID-19 pandemic. The framework offers well defined stages of the group project which allow students to work on their choice of a real-world problem, integrate their learnings from previous courses, and present a working solution. In the group project, students actively participate, reflect, and contribute to achieving the goals set in the learning objectives of the course. Our framework incorporates key features from Kolb's Experiential Learning Theory (1984) and principles of active learning from Barnes (1989) to achieve active and experiential learning through active supervision. The use of group projects as a teaching pedagogy is widely adopted in many universities. Students work together, develop a plan, and demonstrate their abilities in building on existing knowledge acquired from previous courses, and apply them appropriately for problem solving. Prior to the pandemic, it was the norm for students to work on their group projects together by meeting physically on campus. Key benefits of working together physically are having the support of one another and the ease of communication. With the onset of the pandemic, safe distancing measures, and restrictions put in place have made it challenging for students to work on group projects together. During the pandemic, many courses were forced to move online with limited face-to-face learning opportunities on campus. This posed great challenges to the faculty in terms of effective supervision of students and their project progress. To mitigate the challenges, we devised a flexible strategy that makes use of both technology-based and non-technological means for monitoring students' group project milestones. The faculty receives continuous updates from students as they work towards each milestone. These milestones serve as important checkpoints for students. Continuous checks at different milestones help the faculty adopt appropriate intervention measures as issues arise. The group project learning framework consists of three main stages, namely Group Formation, Scoping of the Project, and Group Solutioning. The framework is overlaid with Kolb's Experiential Learning Theory concepts to describe the learnings, milestones, and deliverables of each stage. Each of these stages adopts Barnes's principles of active learning to enable active participation, reflection, and contribution by students. We evaluated the success of this framework through a comprehensive student survey analysis. The survey asked specific questions to students on all stages of the group project and the overarching component of teamwork and working online. We also present our findings and lessons learned for improvements of the framework. We believe that our framework will be valuable to educators in computing programs that wish to adopt effective supervision measures for group projects.**

Keywords—COVID-19, group-based learning, experiential learning, active learning

I. INTRODUCTION

There has been increased interest in providing real-world experiences for undergraduates as part of their university curriculum even in their initial years. These opportunities can be in the form of internships, work study programs, or working projects with industry partners or industry certifications, as part of their course requirements [1, 2]. In order for undergraduates to do well in such given opportunities, they need to have acquired knowledge that cuts across multiple disciplines and domains, both from the technical and business perspectives [3]. Solving real-world problems will require students to be able to communicate, collaborate, with others [4] and are termed as the skill sets to be successful in the workforce landscape of the 21st century [5, 6].

With the onset of the COVID-19 pandemic, many internships and work study programs are put on hold as organizations work out alternative arrangements for their employees to work from home to minimize social interactions among the employees. There is strict access to organizations' data, with access only given to authorized employees. At the university, strict rules are in place, imposing restrictions on the mode of students interacting with their peers and industry partners. This has resulted in organizations giving lower priorities for their involvement with students for the time being.

In order not to disadvantage students of such learning opportunities, group projects are designed into the course curriculum to meet similar objectives, but at a smaller scale. However, there are challenges in the design and implementation of group projects as part of the assessments in a course as university courses already have a set of predefined learning objectives which students need to be able to demonstrate they have met the key competencies defined for the course within a limited timeframe [7].

The implementation of a group project as an assessment component needs well defined stages, and provides opportunities for students to actively participate, reflect and contribute to the learning and support one another. To the instructors, there need to be an effective way to monitor the students' group project milestones and continuous checks to ensure the project milestones are met and any appropriate interventions measures should be adopted should the needs arise.

In this paper, we seek to share a group project learning framework (GPLF) that is able to meet the above mentioned needs. The group project learning framework consists of three main stages, namely Group Formation, Scoping of the Project, and Group Solutioning. The framework is overlaid with Kolb's Experiential Learning Theory [8] concepts to describe the learnings, milestones, and deliverables of each stage. Each of these stages adopts Barnes's principles of active learning [9] to enable active participation, reflection, and contribution by students.

The GPLF was piloted during the COVID-19 pandemic with one of the courses where students mainly worked virtually through the use of online tools. The success of this framework through a comprehensive student survey analysis. The survey asked specific questions to students on all stages of the group project and the overarching component of teamwork and working online. We also present our findings and lessons learned for improvements of the framework. We believe that our framework will be valuable to educators in computing programs that wish to adopt effective supervision measures for group projects.

The paper will be structured as follows. Section II will present related works, Section III will provide the background of the university's key teaching and learning pedagogy and the course. In Section IV, we discuss the GPLF framework, its design, and implementation strategies. Section V will provide our findings through the survey, followed by Section VI which provides the limitations of our approach and we conclude in section VI.

II. RELATED WORKS

In order to achieve the objectives met out for the group project learning framework (GPLF) in Section I, a high-level guiding framework as shown in Figure 1 will help us define the critical elements that are necessary to be incorporated into the proposed framework. The goal of allowing students to work on real-world problems can be achieved through experiential learning and project-based learning. But more closely, there are key characteristics from project-based learning approaches which we can adopt given that the framework has to be effective during a pandemic such as COVID-19 where there are many restrictions. The following section will look at relevant related works in these areas.

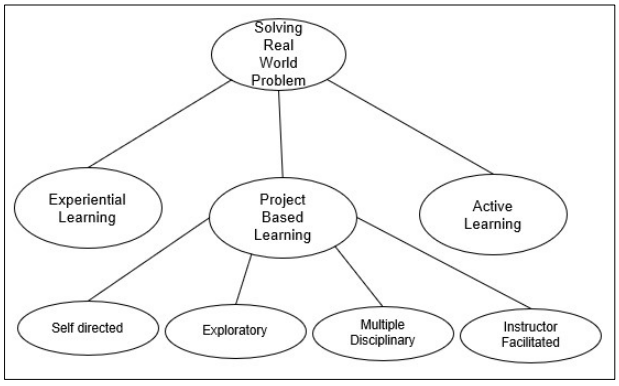

Fig. 1. GPLF Guiding Framework

A. Solving Real-World Problem

Solving real-world problems is part and parcel of an IT professional and they need to provide an effective bridge between the technical expertise and communities within the organization [10]. Experiential learning is considered one of the important modes of learning. Kolb proposed the Experiential Learning Theory (ELT) that is widely adopted [11]. The learning by doing [12] way of learning allows students not only to be socially engaged with one another but with constant reflections [1] as they work together through hands-on experience of a multi-disciplinary [3] real-world problem. Through experiential learning, students have accountability of their own learning and this equips them with future work skills to tackle complex problems in the future [11]. The multidisciplinary nature of experiential projects will require insights from individuals from various backgrounds and often needs to be studied beyond boundaries to come to a solution [3]. For students to do well, they will be interacting with people from the community, even outside of the classroom [1, 13, 14], working as a real team in a workplace [15].

B. Exploratory

Project based learning is one such approach to experiential learning [7]. However, project based learning takes on a guided, instructor-facilitated approach [6, 16, 17], where milestones are put in place with the instructors to collaborate between teacher and students, this method promotes interactivity, social context, and technologies provide suggestions on improvements as the project progresses [6]. In project based learning, students get to work in groups for a project scope in which they get to explore real world issues and solve the problem[10, 18]. Real-world situations are deemed more interesting and thought provoking [7] as compared to predefined scenarios as students can easily associate them with their experiences [19] and will be encouraged and motivated to complete the project [18].

C. Self-directed Collaborative Learning

Group projects promote collaborative learning [6, 18] which are the necessary social skills for students. By working with each other, students are able to share information and skills [16]. The close affinity of working relationships not only encourages peer learning where students are actively helping each other [20, 21, 22], it creates a safe environment for active, reducing anxiety which students might face while working on a real-world problem [7]. This encourages self-directed learning as students, as a group learns how to make progress by inquiring [23]. One of the goals in project based learning is to ensure that students are engaged and acquired knowledge through interactions with their peers and the environment [24]. As students take control of their own learning, they will be able to set their own goals and source appropriate resources [26] to aid their learning process. Self-evaluation and reflection become part of the learning process in this setting [6].

D. Multiple Disciplinary

Real-world problems are multidisciplinary in nature. By getting students to work on real-world problems in a project-based learning setting has allowed students to have the opportunities to solve problems that require different skillsets and knowledge. The group project allows them to integrate what they have learned from various courses as they work together to solve the problem. Students working on such group projects will have the opportunities to link knowledge, acquired across multiple courses in their undergraduate program [6, 18]. With students working with each other to

solve the problem, critical thinking skills, and collaborative skills which are crucial in the future workforce significantly increase [24, 25].

E. Instructor-Facilitated with Active Supervision

The role of the instructor in a project-based learning setup is as a facilitator providing a framework with relevant questions for students to work with rather than didactic. While facilitations can be achieved in many forms, a framework with guiding questions can be used to provide a basic structure for the students to kick start their work [7]. The teaching involved focuses on guiding students towards their goal of solving the real-world problems [27]. In our model, we also bring in active supervision by the instructor to support active learning. Active supervision is necessary for the COVID-19 situation to ensure that students are working actively towards the completion of their projects.

F. Active Learning

In active learning, students are heavily involved in their learning process. Barnes suggested seven principles of active learning – Purposive, Reflective, Negotiated, Critical, Complex, Situation-driven and Engaged [9]. Active learning has proven to achieve good students' performance in STEM courses [28]. This learning approach is student centered which generates opportunities for students' interaction with guided activities provided by instructors [29]. As students work through the activities, they are fully engaged – reflecting, analyzing, evaluating possibilities, and communicating with each other [30].

III. Background

In this section, we will first present some learning objectives from the university's teaching and learning pedagogy that is adopted by the school in its Information Systems program Year 2 programming course – Web Application Development II (WAD II) , followed by an overview of this course and one of its assessment components which the GPLF framework is implemented.

A. Teaching and Learning Pedagogy

At the university, a well-defined learning pedagogy is paramount to the success of the learning of the students. The authors' university has defined a set of graduates learning outcomes for all undergraduates regardless of the programs they are taking. These are identified as key skill sets required in the 21st century workplace [5, 31]. In the context of this paper, we focus on three of the key areas in the learning outcomes, interactive learning, experiential learning, and peer learning.

Interactive learning takes place when students work with each other collaboratively in projects and assignments. Students get to discuss and deliberate with each other in order to come up with the best solution for their team. This can be done through various channels of communication that they are familiar with both online and face to face. The course instructors also play an equally important role to facilitate learning, suggesting alternative scenarios, or uncover blind spots that are often overlooked.

Experiential learning as defined in Kolb's experiential learning theory is "the process whereby knowledge is created through the transformation of experience [32]. Students need to be provided with the opportunities to work on problems that entails multi-disciplinary knowledge. In many cases, these are a real life community or industry problems that need to be solved. By putting themselves in a real life situation, they get to experience what it is like to work in the industry or community, and are able to experience the success or failure of their proposed solution instantly.

Learning can take place between students sharing their experiences, ideas, explaining theoretical concepts, and supporting each other [20, 21]. It can happen informally or through a platform that benefits both parties [20]. Active learning creates a cooperative learning environment for all. Peer learning also promotes lifelong learning and is linked to generic capabilities of teamwork and interpersonal skills that employers view highly [33]. It encourages students to take accountability for their own learning to become independent learners.

B. Information Systems Program and Core Programming Courses

The Information Systems undergraduate program at the university provides a broad based education in the foundation years to build the technical competencies in the area such as business solutioning and management, software development, and information management. For software development in specific, students are required to complete three core programming courses. In Year 1, they complete the Introduction to Programming course which provides the fundamental programming concepts, and Web Application Development I (WAD I) which equip them with the knowledge and skill to develop database-driven web applications. In Year 2, students proceed to the Web Application Development II (WAD II).

C. Web Application Development II Course

The WAD II course runs over 14 weeks for students who have cleared WAD I. In this course, students learn about client-side programming using tools such as HTML, JavaScript, Cascading Style Sheets (CSS), Bootstrap, Document Object Model (DOM), AJAX, APIs, and JSON. The course concludes with the introduction to Vue.JS, a progressive JavaScript framework for building rich user interfaces. Throughout the 14 weeks, students have multiple hands on exercises working on weekly in-class challenges for specific topics.

One of the assessment components for this course is a group project where students work in groups to pick their choice of real-world business problems and propose a technical solution integrating both back-end and front-end web technologies. A responsive, interactive web application should also include at least an external publicly available Application Programming Interface (API) via AJAX. Each team will be required to submit a working prototype, a presentation video to walk through the application functionalities and an online 10 minute presentation in week 14. Under the COVID-19 pandemic restrictions, students leverage online tools and means to execute and deliver their solution.

This group project provides an opportunity for students not only to apply their acquired programming skills in core programming courses, but also skills from courses such as Business Process Analysis and Solutioning (BPAS), which equipped students with a methodical approach to translate business process change requirements into clear IT solutions

and skills from Interaction Design and Prototyping (IDP) course which shares the process of designing information systems that are useful, usable, and a pleasure to use.

The role of the instructors in this project is as facilitators to guide students to derive high quality solutions. It mimics an organization where students get to bounce ideas as they go through their requirements gathering phases before pinpointing a problem they will like to solve. Course instructors are also able to identify stages in which potential failure can occur and to work with the students immediately to prevent any delays.

For the instructors to track the progress of each group, each project group is given access to a Google Document in which students within the group have to update it as the project progresses in a timely manner. The basic structure of the Google Document includes the Project Overview, Objectives of the Project, Project Functionalities, List of APIs to use, and any other information the students like to share with the instructors. The role of each student in this project must be specified as well. The use of Google Document is a convenient way to track students' progress and it allows instructors to provide their comments and inputs to their students' group projects anytime. Its version tracking functionality will be useful as a tracking tool for progress made by the team ensuring active supervision by the instructors.

The group project can be broken down into four stages over 14 weeks, completed over the COVID-19 pandemic. To replicate the presence of organization partners in the project, course instructors will have to play this role to provide inputs and requirements and criticize in some cases for the user flow and usability of the web application.

IV. GROUP PROJECT LEARNING FRAMEWORK (GPLF)

The group project in the WAD II course provides a great opportunity to build the Group Project Learning Framework (GPLF) which is aligned with the university's teaching and learning pedagogy of interactive, active, and experiential learning and achieving the requirements of the course.

We aim to synthesize Kolb's ETL and Barnes's active learning principles into our framework. Together with the essences from learning pedagogies as described in the GPLF Guiding Framework we will first present the overview of the Group Project Learning Framework implemented in the WAD II course.

Kolb developed the Experiential Learning Theory (ELT) that provides a four-stage learning process. ELT is widely adopted in many works of literature [8, 34]. The four stages of learning give the learner to work with each other to work on real-world problems integrating their initial knowledge, developing new ones, and together solve the problem. The four stages of ELT can be applied to what we have identified our structure of the WAD II group project, as detailed in TABLE I.

TABLE I. APPLYING KOLB'S ETL TO WAD II GROUP PROJECT

KOLB's ETL	Description of that to WAD II group project
Concrete Experience	This stage starts with an assigned task or project. In order to accomplish the task, the team has to be formed and get to know each other and kick off the initial discussions, problem solving and research on the topic. It is only through active hands on participation that learning will take place.
Reflective Observation	This stage requires taking a step back to review and reflect on what has been done. It creates the opportunity to question the way things are done and get feedback and inputs. There will be open discussions, potentially with users of the project and thus it is important to speak the language of the business domain.
Abstract Conceptualization	In this stage, it requires the process of finding the relationship between surrounding events and making sense of the relationships between them. They will need to draw comparisons between what they have come up with the requirements. More in-depth research and exploration will be required to interact with parties involved as they build the end product.
Active experimentation	The last stage is to have a plan in place where everyone will have a role to play. At the final stage, the team will put everything together to realize the final product. There will be fine tunings along the way with modifications to meet the requirements of the context.

Similarly, mapping Barnes's principles of active learning [9] to the design of the WAD II group project, will provide us with a set of clear principles to follow. This is critical given the COVID-19 situation where students are working with each other virtually. It is necessary for students to be actively engaged in problem solving than to learn from a passively listening pedagogy that is often used in a classroom setting. The mapping is detailed in TABLE II.

TABLE II. MAPPING THE BARNES'S PRINCIPLES OF ACTIVE LEARNING INTO WAD II GROUP PROJECT

Key Principles	Description
Purposive	The task given to the student is to identify a real-world problem to solve using what they have learned in the WAD II course.
Reflective	Throughout the group project, students need to reflect and evaluate the knowledge and skills they have gathered and acquired and applied into the project. Continuous reflection will be necessary to improve their solution.
Negotiated	More significantly in the initial phases where students get to bounce ideas as with the team and later with their instructor as they go through their requirements gathering phases before pinpointing a problem they will like to solve.
Critical	As the students work on a real-world problem, they will appreciate the different perspectives of the issue raised with different stakeholders. They will need to take this into consideration when solving the problem.
Complex	The complexity of a real-world problem is higher than a predefined scenario. While it is more challenging to work on real-world problems, it is through the complexity that enhanced the students' critical thinking and problem-solving skills.
Situation driven	There are multiple ways to solve a problem, but the preferred solution will have to consider the situation in which it occurs and who the stakeholders are.
Engaged	To better appreciate a real-world problem, students have to be involved in researching and finding out more about the issues. These can be in the form of observations or interactions with stakeholders involved.

An instructor-facilitate approach with well-defined stages is adopted given the COVID-19 pandemic situation where classes are conducted virtually. The different stages will be beneficial to both instructors and students to be aligned with the group project requirements. The WAD II group project will be broken down into various stages - Group Formation, Scoping the Project, Group Solutioning.

In each of these phases, there will be a set of questions to be addressed by the instructors and students. These serve as a set of guiding questions to surface failure points and keeping track of the status of the project. The details of each stage of the group project can be found in TABLE III.

TABLE III. STAGES OF WAD II GROUP PROJECT

Stage	Description	Questions to address
Group Formation	Students get into groups of 4-5 students to work on the project together. For easy administration by the course instructors, students are allowed only to pick team members from their own classes. Given the requirements of the group project, students may want to make use of some time to think about who they will like to work with and the web application that they will like to develop.	1. How do students form groups? Will it be based on familiarity (prior interaction) or technical capabilities?
Scoping the Project	Team members brainstorm on possible business problems for their group project. After identifying possible business problems, they will need to go deeper to understand or map out existing processes and suggest the to-be process which will make use of their new application. Project teams are encouraged to go deeper into checking out possible APIs and explore possible front-end technologies that can be used for their target users.	1. How do students identify real-world business problems and scope a project? 2. Are students able to identify the target users of their problem? 3. Do students make use of their knowledge from other Year 2 core modules (IDP, BPAS) to understand a top-down before mapping out the business processes (e.g. how does an e-commerce platform work) and identify pain points or problems? 4. How do students define possible solutions to solve identified pain points and problems?
Group Solutioning	The team works together to define the look and feel of their web application. Each member will contribute a part and will be integrated as a seamless solution, meant for the identified target user to solve a business problem.	1. Are students able to apply what they learn in the WAD II course to designing the solution? 2. Can the students propose multiple solutions and weigh pros and cons? 3. Can the group work together to propose, evaluate solutions?

Cutting across each of the stages, students are expected to take ownership of their own learnings and contributions to the group project. They need to demonstrate that they are a valuable team member, able to work independently and contributing to the team. As part of the project proposal, each team is asked to include a work breakdown structure for their proposed solution. During the COVID-19 pandemic, students have to work and meet online. The expectation from students is detailed in TABLE IV.

TABLE IV. EXPECTATIONS OF STUDENTS FROM GROUP PROJECT

Expectations	Description	Guiding Questions
Group Work	The team has to work together as one for a single delivery of the final product. The workload should be distributed equally among the team members.	1. Do team members agree with each other? 2. Do team members distribute work evenly? 3. Do team members communicate effectively? 4. Do team members resolve conflicts? 5. Do team members regularly meet? 6. Do team members trust one another? 7. Do team members help one another?
Working Online	Due to safe distancing requirements, students will have to make use of online channels for their discussions throughout the project. They are encouraged to make use of online technologies to track their schedule for the project.	1. Does working online hinders the effectiveness of the team? 2. Do team members meet online regularly? 3. Do team members leverage available tools for project coordination?
Individual Contribution	As part of the course requirements, students should be able to work independently and as a team to contribute to the project. The details of the work breakdown have to be included in the project proposal.	1. Does everyone have the technical know-how to contribute to the project independently? 2. Does everyone work independently well? 3. Does everyone deliver on time? 4. Is everyone accountable for the assigned work? 5. Did everyone allocate sufficient time to this project?

Checkpoints are built into the weeks to help students achieve the various milestones. In each of these checkpoints, it provides a means also for the instructor to identify potential failure points for the students and to render help. It is necessary to have more frequent checkpoints at the initial stages of the group project as this is where multiple brainstorming sessions have to be carried out. The project being real-world problems that are multidisciplinary, it will be helpful to students to clear their doubts early and ensure that the scope of work is manageable and sufficient to achieve the course requirements.

After their group project proposal is confirmed, it is very much into the development phase where students will make use of what they have learned in the course and applied them into the context for their solution.

Throughout the 14 weeks, besides the key checkpoints, students can update their instructors via the Google Doc updates, and similarly, instructors are able to actively track the students' progress.

The key checkpoints defined for the WAD II group project are tabled in TABLE V.

TABLE V. KEY CHECKPOINTS IN WAD II GROUP PROJECT

Key Checkpoints	Timeline	Description
Overview of Group Project	In Week 1	As part of the course overview, instructors share all the required assessments points for the course. This includes the requirements and overview of the group project.
Confirmation of Team Members	End of Week 3	Every group has to confirm their team members. All team members must be from the same class.
Pre project proposal sharing	By end of Week 5	The initial sharing of their project idea with their course instructors. This is to ensure that the scope of their project is sufficiently large for the team.
Confirmation of Project Proposal	By end of Week 7	The confirmation of the topic for their team project and the business problem they will like to solve.
Project Submission	End of Week 13	Submission of the project which includes a working prototype, a presentation video and all source codes.
Project Presentation	Week 14	A 10 min online presentation by the team to walk through significant functionalities of their group project followed by a 5 min

Key Checkpoints	Timeline	Description
		question and answer session with their course instructors.

By synthesizing the above, Figure 2 shows the Group Project Learning Framework that will provide a structured approach for both the students and the instructors, clear checkpoints and well-defined stages.

The adoption of Kolb's ELT, Barnes's Active Learning Principles, and the key features of project-based learning provides the framework with good pedagogical support to achieve the goal of designing the WAD II group project to be solving real-world multidisciplinary problems, during the COVID-19 pandemic situation [8, 9].

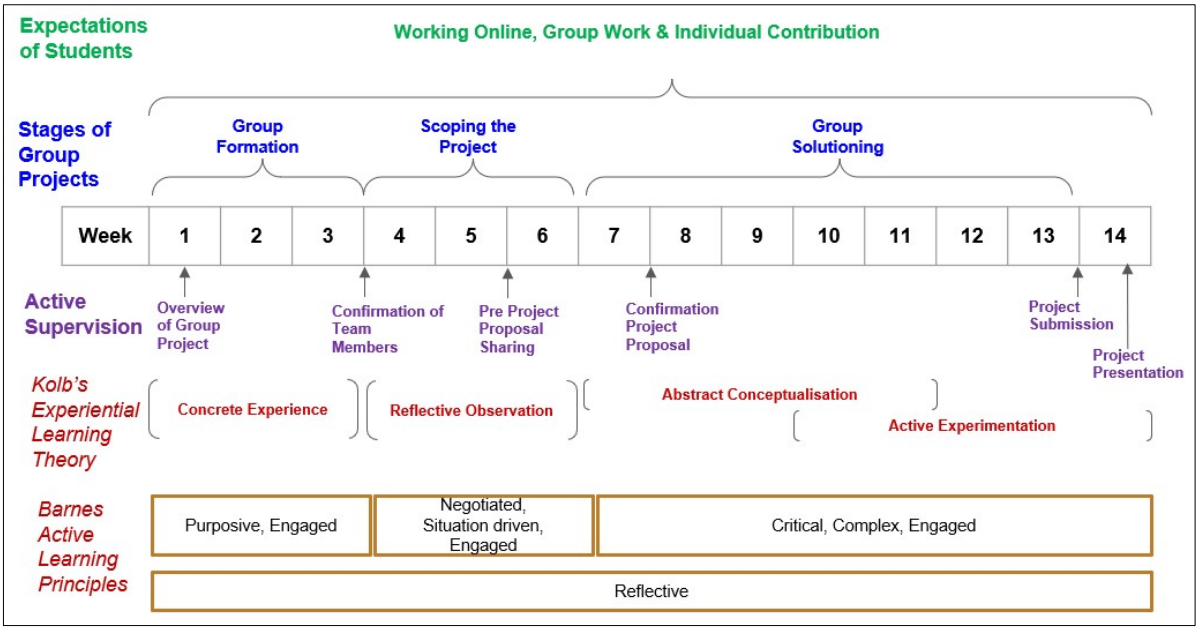

Fig. 2. Group Project Learning Framework

In this paper, we also seek to answer the following research questions:

RQ1: Are students able to identify and scope real-world problems that are suitable for their group projects?

RQ2: Do students benefit from multiple consultation sessions throughout their group projects?

RQ3: Can students integrate their knowledge and skills to solve the problem?

RQ4: With most of the work is done virtually, are students satisfied with their individual contributions to the group project?

V. RESULTS AND FINDINGS

In this section, we will first present some learning objectives from the university's teaching and learning pedagogy that is adopted by the school.

A. Student Feedback

To evaluate the effectiveness of the GPLF proposed in Section IV, a survey was carried out at the end of the Group Project for students. The results of the survey are presented in TABLE VI below. The survey is designed according to the stages of the group project where students went through. As this project is completed during the COVID-19 pandemic, students make use of online tools to communicate with each other. The survey included a set of questions to address this.

Additionally, the instructors have to ensure the students complete a peer evaluation in their Learning Management System to evaluate their team members as well as themselves. The students are required to rate each other on a scale of 10 and provide constructive feedback and comments for their team members.

TABLE VI. SUMMARY OF GROUP PROJECT SURVEY RESULTS

Experiential Project's Areas of concerns	*Survey Questions*	*Strongly Agree / Agree*
Group Formation	It was easy to form a group with my classmates.	**84.2%**
	I chose the group based on the people that I already knew.	**79.1%**
	I chose the group based on the technical capabilities of the group members.	**25.9%**
	It was easy to form a group with classmates with good technical capabilities	**43.9%**
Scoping the Project	It was easy to identify a business problem to solve for the group project.	**60.5%**
	Other Year 2 core modules (e.g. IDP, BPAS) provided some background that helped my group map out the project scope.	**73.3%**
	My group had a well-defined project schedule to work on.	**66.2%**
Group Solutioning	It was easy to formulate a solution using HTML, CSS, Bootstrap, JavaScript, DOM, AJAX, API, and JSON to solve the problem.	**64%**
	My group was able to come up with one or more solution options for the identified business problem	**69.8%**
	My group had sufficient technical know-how to propose a solution to the identified business problem	**78.5%**
	My group was able to make use of available resources to propose solutions to the identified business problem.	**92.1%**

Experiential Project's Areas of concerns	*Survey Questions*	*Strongly Agree / Agree*
	I am happy with the final solution (web application) that my group has developed and delivered.	**88.5%**
Group Work	My group was able to agree on a solution quickly.	**84.2%**
	My group was able to distribute work evenly across all group members.	**79.1%**
	My group was able to communicate effectively.	**82%**
	My group was able to resolve conflicts quickly.	**85.6%**
	My group was able to meet our project schedule and integrate all parts easily	**67.6%**
	In my group, members were trusted to complete their own tasks with good quality and in a timely manner	**82.7%**
	In my group, members were willing to help one another with task completion.	**92.8%**
Working Online	My group met online on a regular basis.	**61.9%**
	My group made use of online tools to come up with the scope of the project and to update each other on a regular basis	**79.1%**
Individual Contribution (how active learning is happening with them)	I had sufficient technical know-how to work on my own part independently	**84.9%**
	I had sufficient technical know-how to research independently to find possible solutions for my own part.	**91.3%**
	I was always able to meet the deadlines set by my group.	**93.6%**
	I was accountable for my contribution to the group project.	**98.6%**
	I allocated sufficient time to the group project and for completing my part with good quality.	**94.9%**
	I am happy with the work that I have contributed to my group.	**91.3%**

From the results of the survey, we observed that 84.2% of the students can form a group with their classmates. Although 79.1% will prefer to work with people they know, the other 20% are willing to work with someone who they have never worked with. Students do not select their teammates based on their technical capabilities even though the group project requires every student to be able to contribute to a technical component. As the group project is to solve a real-world problem, team members need a varied skill set in order to identify issues from a business perspective and come up with a flow of their website functionalities to tell a story. The students' priority is to have a team that is aligned with the problem statements rather than focusing on team member's technical skills and thus the low percentage of 25.9%. The alignment of the project with the curriculum and instructors making consultation sessions available have assured students that help is available throughout the project. This answers RQ1 and RQ2.

This cohort of students joined the university at the peak of COVID-19 and many courses were conducted online with lesser interactions between students. On top of that, students are assigned or chose their WAD II classes based on their individual timetables. They may end up in a class with new faces and will be difficult for them to know the technical capabilities of their classmates. This is reflected in the low 43.9% in the survey result.

About 60.5% of the students find it easy to identify a real-world business problem to solve. While a majority of 73.3% are able to apply knowledge acquired from other courses into the context of their group, 66.2% of the students are able to craft a project schedule to work on for the duration of the group project. This answers RQ1 on students' ability to identify and scope real-world problems that are suitable for their group projects. The knowledge acquired from other courses in their undergraduate program provides good background for students to identify problems to solve. Although done virtually, students can make use of resources available to them to decide, as a group for a problem to solve.

The results are in alignment with the observations from the course instructors where students requested multiple consultations before they submit their group project proposal at the end of Week 7. Students approached the instructors as a group to brainstorm and share their ideas for the group project. As part of the learning process, instructors play an active role in guiding them through the thinking process for the team to decide on project scope. This iterative process lasted many weeks. Due to the COVID-19 situation, such sessions were carried out either online or face to face where advance bookings were required to ensure safe distancing measures were put in place. This answers RQ2 of the effectiveness of multiple consultation sessions and instructors' active supervision throughout their group projects. With evidence that students are working well together on their group project and have good teamwork, they can come up with their proposal on schedule.

In the solutioning phase, the survey results show that 64% of the students are able to apply what they have learned in the course to solve the problem and about 69.8% of the students are able to multiple solutions for the identified business problem. Although 78.5% of them have the required technical knowledge to solve the identified business problem, they can make use of available resources to help them. 88.5% of them are happy with the final solution that their team has developed and delivered. This answers RQ3 on the students' ability to integrate their knowledge and work together for final submission.

With the COVID-19 situation, students have to communicate with each other via online means, The use of online communication did not affect the quality of their communication and students are able to use these as an alternative channel of communication for their project.

Students were also asked to provide a self-evaluation of their individual contributions to the group project in the survey. 84.9% can confidently work on their part independently and research on possible solutions for their given scope of work. As this is a group project, there are substantial parts that will require integration of the different pieces. This answers RQ4 with the fact that all students worked towards the success of their group project.

Besides the survey as above, students are required to complete a peer evaluation which allows them to provide qualitative feedback about their team members. The results can be found in TABLE VII. The students (143) are asked to evaluate their team (including themselves) in five areas on a scale of 1 to 10. It is found that students work well in their teams with the scores for all are above 9.3.

TABLE VII. SUMMARY OF GROUP PROJECT SURVEY RESULTS (MIN: 1 MAX: 10)

Areas of evaluation	***Description***	**Average score out of 10**	***Average per group***
Team Player	Cooperation with others, helpfulness, adhere to the agreed delivery	**9.37**	**9.42**
Communication Skills	Ability to present ideas effectively, open-minded on contrary viewpoints	**9.35**	**9.40**
Quality of Work	Ability to stay focus and deliver quality results, meet or exceed the agreed goals	**9.33**	**9.38**
Commitment to the team	Committed to team's continued success	**9.38**	**9.43**
Contributions	Problem identification, technology savviness, ability to deliver the result	**9.32**	**9.37**
Overall		**9.35**	**9.40**

B. Lessons Learnt

It is of no doubt that providing real-world project experiences to students is essential in their learning. However, to replicate such experiences within a course has its own challenges and potential failure points.

First, it is observed that while students can form their groups quickly, they spend a large amount of time trying to identify the business problem and its target users. The students' main priority was to design an impressive web application with fancy functionalities. They are not able to articulate the purpose of their design to a business problem and clearly identify the set of target users that will benefit from it. This will require course instructors to facilitate initial brainstorming sessions with each team to guide them. Some teams will require multiple such brainstorming sessions as they fine tune their teams' proposals.

Second, throughout the duration of the group project, students tend to be deeply rooted in searching for the best technical solutions without taking into consideration the process flow of using the web application, in terms of its usability and the design of the user interfaces. This surfaced during the solutioning phase.

Third, some publicly available APIs have limitations, in data availability and the number of calls. This may hinder the team to be able to demonstrate unique scenarios for their web applications. In such cases, the course team allowed students to create a simple database at the backend so that they can simulate the scenario on their web application.

For the project to be experiential, students are free to choose business problems from any industry. The range of ideas proposed came from music industries, social media platforms, finance, food and beverage and even social enterprise. It is therefore important for instructors not to limit students' choices and yet be able to guide them from multiple aspects of industry needs.

Fifth, course instructors need to be mindful of the workload of students, with many taking up to 6 courses per term. There are teams who are ambitious to develop industry-ready web applications which will not be viable given the limited time and resources. Course instructors will need to manage students' expectations and at the same time providing an experiential learning environment for students.

VI. LIMITATIONS

The students involved in the pilot phase are Year 2 students from the undergraduate program. The framework is designed on the assumption that all students have cleared all their previous courses and have acquired good background to be able to make use of resources and identify a real-world problem to solve in their group projects.

The group project is designed to be accomplished in 14 weeks with existing students already enrolled in this program. For the students to accomplish their group project, the students have to collaborate with their peers and communicate effectively and timely manner. The framework will need to be enhanced should there be exchange students joining the program where they may be working in different time zones.

The success of the group project for the students is based on their completed final product for submission. The framework does not measure the effectiveness of active learning in this learning process.

The use of real-world problem in courses are not limited to a course which spans across 14 weeks. There are also yearlong final year projects that are designed into many undergraduate programs. For this framework to work for a yearlong group project, there may be a need to increase the number of checkpoints and expansion of the Group Solutioning stage to include intermediate sharing and presentations. For tracking such larger scale projects, students may be tasked to make use of project management and tracking tools.

VII. CONCLUSION

The use of group projects in a course is not new teaching pedagogy but integrating it into a course assessment component has its own restrictions. In this study, we looked at related works and studies in group project learning and applied them to the context of a group project that has been designed to achieve the goals of experiential learning as well as meeting the university pillars of excellence in education teaching. The design of the group project is carefully crafted to include different stages that seamlessly achieve the goal of experiential learning. Students' feedback is sought through a survey and the results are presented which are discussed to further enhance the viability of the new framework.

While it is still better for real-world experience to be done at organizations or having industry partners' involvement, the Covid-19 pandemic may force universities to be creative in providing industry related projects to students. This may be the new norm moving forward. With limited resources from the industry, the EPL framework and active learning principles may be a starting point for other instructors who may want to try something similar in their courses. The well-defined stages help with the alignment in understanding between the instructors and students. The checkpoints and the use of Google Doc provide a means to track the progress of the group project where instructors can be actively monitoring.

Further work can be done to look at the correlation of the results of the survey with the students' grades achieved for their project. We can also look at designing suitable rubrics to evaluate each different stage of the experiential learning

process which will be a systematic way to evaluate students' achievement and learning at each stage.

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