Flipped Classrooms & Project Dojos for Enhancing Peer Learning in Classrooms

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Abstract

This manuscript reflects on a series of pedagogical interventions that included the use of flipped classrooms and Project Dojo sessions in the Information Technology Project Management course. The experimentation was based on cognitive perspectives on peer learning and the assumption that higher levels of meaning-making can be fostered through well-crafted and guided interactions among students. We position our approach with respect to successful peer-learning models in higher education and share lessons learned from the implemented peer-learning pilot program to inform the design and implementation of future course-based experiential peer learning.

Keywords: Peer-learning, Learning Dojo, flipped classroom

1. INTRODUCTION

Creating spaces for students to learn with and from each other can enrich students' learning experiences and relationships. Peer-learning experiences are commonly designed in a near-peer format within a given discipline in which tutors teach the learners. In classes, peer learning very commonly occurs through ad-hoc group activities or discussions or as in-class group work or longer-term group projects. Our approach in this study is based on three pillars: (1) students experiment with and practice the skills needed for group learning in a flipped classroom manner, and (2) students engage in group-based reflection and meaning-making, such as collaborative concept mapping, and (3) students complete projects in Dojo sessions, in which student interactions are observed and guided. Cooper (2012) has identified four major peer-learning design elements (Figure 1. a). Our experiment with flipped classes and Dojo sessions addresses the four components as follows:

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(1) **Classroom environment**: the environment was participatory and interactive. Throughout the semester students were consistently required to share reflections with learning partners and with the class. In essence, reflection and meaning-making were established as prioritized values in the learning process.

(2) **The role of technology** was prominent in skills, as students coded to experiment with project management techniques, wrote ReadMe pieces for each piece of code they developed, and shared that publicly on GitHub. The class used Azure as the DevOps platform, in which students could follow the learning plan and progress on the Kanban board. The course had a wiki page for the major terms used in the class, and students imported their work to the Azure environment through GitHub. The choice of Azure as the DevOps platform was purely based on ease of access (for students, free of charge).

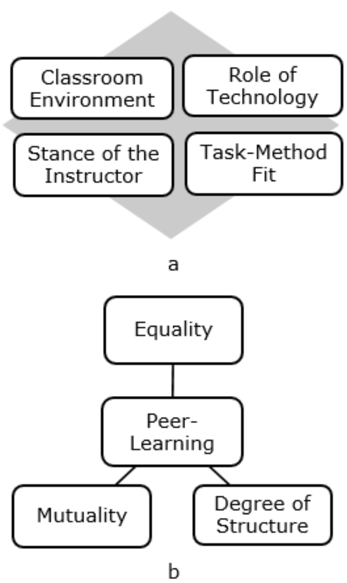

Figure 1: four considerations of peer-learning design (Cooper 2012) & three dimensions of peer learning (Topping et al. 2017)

(3) **Task-Method Fit**: depending on the cognitive requirements of the activities (recall vs analysis vs synthesis), suitable peer-learning methods must be used. Examples are reciprocal questioning (King 1990), collaborative concept mapping (van Boxtel *et al.* 2002), and Learning Dojos (Heinonen *et al.* 2013). In this study, Dojos are intensive deliverable-oriented work sessions that aim to enhance course-related skills within the context of a group project (Sato *et al.* 2018). Learning Dojos have been used in the IT field to create focused and intensive learning experiences that have an immediate impact on learning or job outcomes (e.g., Target Dojo).

(4) **Stance of the instructor**: the instructor must establish class structure and norms that are conducive to peer learning. This part requires allowing time and valuing discussion at group and class levels. It also includes the design of activities that systematically and continuously require students to brainstorm, collaborate, and engage in collective reflection on the learning material.

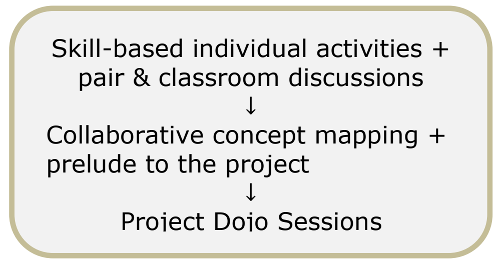

Figure 2: Major stages of the learning process

In their book on effective peer learning, Topping and his colleagues (2017) identified three characteristics of social learning activities (Figure 1b). ***Equality*** signifies the disparities among the levels of knowledge and skills. Peer tutoring is an example of a social learning activity that has a low level of equality because the tutor knows more and is more skillful in the topic than the learner is. In our experiment, the sequencing of skill-based individual activities, review, and prelude are applied to the project and Dojo sessions, so that equality is fostered. ***Mutuality*** can be defined as the extent to which cognitive load and work responsibilities are shared by the members of the group. Divide-and-conquer, which is commonly used by students in group efforts, requires coordination only at a few checkpoints during the semester. What differentiates Dojo sessions from common group projects is the immediacy of the work at hand, which requires real-time interactions with peers and demands continuous attempts to construct and maintain a shared meaning throughout the problem-solving efforts (Topping *et. al.* 2017). Students were specifically instructed not to pursue a divide-and-conquer approach to the project. ***The Degree of structure*** identifies the extent to which one guides students' interactions. A list of suggested questions was given in the prelude sessions; later, students engaged in collaborative concept mapping of the skills they learned. These activities were based on Piaget's

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premise that interactions must be guided and that action precedes meaning-making but does not guarantee it (O'Donnell & King 1999).

2. THEORETICAL UNDERPINNINGS OF THE COURSE DESIGN

This study's learning process (Figure 2) has been designed based on cognitive perspectives on peer learning (O'Donnell & King 1999), Kolb's experiential learning cycle (Kolb 1984), and ideas taken from Dojo in the IT field. Each of these three areas is discussed in the following subsections.

Cognitive Perspectives on Peer-Learning

The constructivist view of learning (Piaget 1970) states that learning is socially constructed during interactions and activities with others. Based on Piaget's theory, students each make meaning, discover problems, and resolve problems within their individual minds. Higher levels of cognitive processing and meaning-making can happen through interactions with more competent peers (Vygotsky 1978). Assuming that each student has competency that can complement those of others in a group within the context of the course, interactions that follow after individual meaning-making has occurred, become a more meaningful practice. Researchers believe that as educators use peer learning techniques, they must not lose sight of the interactions that occur between individuals within groups. System structuring and guiding the interactions are essential tools that an educator must employ judiciously (O'Donnell & King 1999).

Experiential Learning Cycle

The design of skill-based activities followed the first two phases of Kolb's model of experiential learning (Kolb 1984). As listed in Table 1, Python coding labs provided concrete experiments with the tools; students were engaged in pair reflections and then engaged in discussion at the class level. Abstract conceptualization and active experimentation were done during the project Dojo sessions (Kolb 1984).

Learning Dojos in the Information Technology Field

The Japanese word Dojo meaning "place of the way" and the corresponding concept of where martial arts are practiced has been appropriated by the Information Technology field to represent intensive deliverable-oriented work sessions that are guided and focused on team goals (Heinonen *et al.* 2013). While training Dojos were made more widely popular by Target dojos, Dojo and the similar concept of hackathons, have been used both as an extracurricular skill-building mechanism and as a pedagogical tool for enhancing the learning of skills in classrooms (de Oliveira *et al.* 2018).

Table 1: Learning phases & activities

Learning phase	**Description and process**
Concrete experiment first	Computer-based problem-solving labs: students read and watch the video lectures, then practice solving a problem using tools/techniques/programming (Appendix A. Figures 1 & 2)
Reflective observation	Individuals reflect on the activity, its application, and its place in the big picture. Then students discuss in pairs the use in project management. In the end, the class as a whole conducts a review. The instructor asks questions (King 1990) and facilitates the discussion.
Abstract conceptualiz ation: Review & Prelude	Student groups engage in collaborative concept mapping that happens after a set of concrete experiment sessions. The instructor provides a concept repository, models the activity, and provides feedback (Appendix A. Figure 3).
Active experiment ation: learning Dojos	Project sessions start with introductions and ice-breakers, students complete the project in an 8-day period, including three class sessions. The instructor provides guidelines for brainstorming and work processes and actively observes to counter the 'divide-and-conquer' culture.

Dojo sessions have also been employed to promote learning and practicing of agile skills (Sato *et al.* 2008). In general, the collaborative intensive goal-oriented Dojo sessions are believed to shorten the development cycle and improve the quality of the deliverables. In the context of this study, Dojo sessions were used to (1) improve, guide, and observe peer-learning practices in the group, (2) shorten the amount of time wasted on group coordination, and (3) counter the divide-and-conquer culture in group works. In contrast to the previous offering of the same course, in which group projects were given a 6-week time period, the group project in the current experimental study was given eight working days, including three 75-minute class sessions with the expectation that the majority of work was done during the class. The first project presented a case study of housing on the first Mars colony. The students were allowed to pick a

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focus area (e.g., living conditions) and asked to create a business case, receive approval, and compose a project charter for the project. The first project's deliverables were the business case and project charter (Appendix A, Figure 4); students were required to perform three agile ceremonies of setting daily goals, doing daily scrums, and performing retrospectives during the 8-day period (Appendix A. Figure 5), and students were given a series of discussion ideas to focus on and questions to answers for each in-class project dojo sessions (Appendix A. Figure 6). Students' interactions happened mainly on MS Teams to observe the level of engagement and assess group processes.

The aforementioned components of agile ceremonies, guided discussions, and observation of group interactions are consistent with the premise of this study that peer interactions must be well-structured, guided, and observed.

3. INSIGHTS FROM STUDENT REFLECTIONS

Students were asked to answer a series of questions about the python skill sessions, collaborative concept-mapping, and project Dojo sessions. As summarized in Table 2, among the three dimensions, the project Dojos were perceived as the most helpful by the students, followed by collaborative concept mapping, and then coding labs. The students were also asked to suggest areas of improvement and elements that need to be added or removed from each of the three components of the course design. We reviewed open-ended responses for the sentiment, and a summary is shared here.

The new method of intensive work in class during the Dojo sessions was received well by the students, as noted in several comments made in the open-ended questions of the survey: "*I really enjoyed the Dojo session and thought there was no wasted time in what we were doing";* and "*The hardest part of a group project is always the scheduling and getting everyone coordinated. By having almost all of the work done in class, this subverts the scheduling part of the process, and gives slackers no excuses to ghost the group*". There were notes from students explaining slacking has still happened and they suggested even more guidelines to counter persistent slackers.

Table 2: Students' perceptions of the course components

Activity	1-5 Likert scale (1: very negative, 5: very positive) N1=30; N2=30	Summary stats avg. (stdev)
Computer-based problem-solving labs	Impact of coding labs on the understanding of project management techniques	3.80(.81) 4.20 (.81)
	Impact of coding labs on the overall value of the course for you	4.03 (.81) 4.20 (.76)
	Impact of coding labs on your learning process	3.77 (.94) 4.23 (.73)
	Impact of coding labs on your view of the project management course as whole	3.97 (.72) 4.17 (.75)
Concept mapping activity	Impact of concept mapping on understanding the relationships among project management concepts, terms, and techniques	3.87 (.68) 3.94 (.81)
	Impact of concept mapping on creating a big-picture view of the course material	3.97 (.61) 4.01 (.75)
	Impact of concept mapping on your learning process:	3.87 (.68) 4.13 (.74)
	Impact of concept mapping on your ability to put together or synthesize what you've learned	3.87 (.86) 3.70 (.83)
Project Dojo sessions	Impact of Dojo sessions' structure/guidelines on group planning	4.33 (.66) 4.13 (.73)
	Impact of Dojo sessions' structure/guidelines on group coordination	4.30 (.70) 4.03 (.85)
	Impact of Dojo sessions' structure/guidelines on group productivity	4.23 (.73) 4.03 (.85)
	Impact of Dojo sessions' design/structure on members' collaboration level	4.07 (1.01) 4.23 (.82)
	Impact of Dojo sessions' design/structure on members' contribution level	4.13 (.90) 4.10 (.84)
	Impact of Dojo sessions' design/structure/guidelines on team's final deliverables	4.37 (.76) 4.17 (.83)

The sentiment was generally positive for the collaborative concept mapping activity, as shared by the students: "…*I thought it was a great way to wrap up a lot of the concepts that we've been talking about and I thoroughly enjoyed working*

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with my group."; and "*I think the mapping activity was good, It made us take a wide look at everything we had covered in class and was good for me to see what I had picked up in class and what I needed to do more studying on*." However, there was also the desire to spend more time on the activity, to allow students to continue working on it as homework, and to do the activity longer: "*I would add more days in class working with a concept map, because I think it helped me understand how all of the concepts fit together.*"

Students' perceptions on Python skills labs were generally mixed, however skewed toward positive as noted in these comments: *"I would add more python coding labs. While they seemed difficult initially when being talked about they turned out to be very fun and easy to do."; and "… they were pretty cool and felt very beginner friendly".* There were concerns with the speed of the in-class exercises, prior coding experiences, and not fully understandings areas of code: *"… maybe do some more hands-on exercises to improve python skills*. "; and "*Make it not so rushed, everything has been moving so fast…".* The comments suggest the need for a more structured approach to labs, in which before and after the skills sessions students can engage in small activities to help them feel more comfortable during the sessions and also guide them on how to advance the work they do in the speedy work during the class. The course is taken by different majors within the information systems field as an elective and the preferences for a coding-heavy or coding-light experience are shown clearly in the mixed comments.

In the most recent delivery of the course, we further evolved the course components with the intent to accommodate the mixed preferences of students for coding, adjust the design of the concept-mapping sessions, and improve the Dojo sessions according to frequent themes that emerged from students' perceptions. More challenge activities (optional follow-up work) were added to the computer-based problem-solving labs. We also increased the frequency of the concept-mapping sessions and added group ground rules to counter the presence of bystanders (students who attend the sessions and sit with the team but do not contribute). Sample rules are: "… (2) to earn your participation points you must actively participate. Just being in class and staying on phones or not participating does not count. (3) Your peer interactions and work during the sessions will be closely observed; do all the heavy lifting in groups, small details can be polished or individual pieces can be worked on between sessions. (3) practice democracy and hearing other ideas: the Dojo sessions should not be focused on one person's idea, you must strive to be a team member, share your ideas, and also actively listen to others' ideas…".

4. CONCLUSIONS

Creating relationship-rich educational spaces can lead to higher levels of cognitive processing. Although individuals make meanings in their own minds, peer interactions impact the cognitive processes within individual minds (Piaget 1970, King and O'Donnell 1999). In this manuscript, we positioned our experiment in relation to the peer-learning literature that is focused on design elements in classroom settings. We presented the design of classroom activities to enable peer learning in a systematic, guided, and IT-enabled structure. We described the three major components of the design and students' perceptions of them. We believe that a subset of Information Technology courses can be excellent vessels through which peer-learning skills can be implemented, practiced, and improved. We also believe that enhancing peer learning is a fruitful effort with impacts that can last beyond the scope of a given course.

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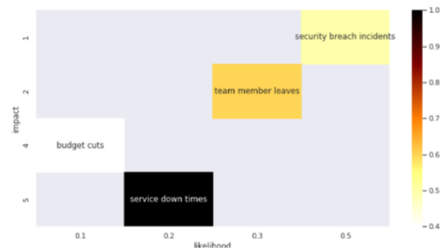
Appendix A

Example of Skill-based activities for Phase 1 & 2 of the Experiential Learning Cycle (Kolb 1980)

Risk Heat Map

Individual work: After you created the risk pivot table and heatmap using Seaborn package and the code guide do the following:

1. Reflect on a project you have done in the past, and the top risks involved with the work, add those to the map after qualifying the likelihood and impact on the project's processes and outcomes.
2. Reflect on a given risk (e.g., security breach), could the same risk be assessed and qualified differently across two organizations? Or in two different projects?



Partner work: with a partner, examine your map and discuss the following questions. Be ready to share with the class at the end.

1. Explain why a heatmap could be useful during the project's lifecycle?
2. What do you think would happen if risks are not qualified for their likelihood and impact?
3. How are the concepts of risk qualification and heatmap similar to the steps we applied in the decision matrix to compare alternative project solutions?
4. Some organizations add a 3rd dimension to their risk qualification process and that is 'Maturity' level, i.e., maturity of organizational processes for dealing with risk of that kind, how would you use maturity to advance your risk management process?
5. And when during the project life cycle would you think the map is created or revised?

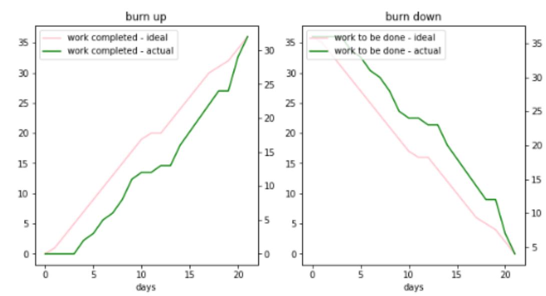
Figure 1: Risk assessment and risk map

Burndown/up Chart

Remember last week we talked about velocity as the total work done during a given timebox, the total work can be measured in the number of story points completed.
Burndown charts follow progress of the work in each day, keeping track of the work that has been completed in a given day.
In this data example, we have the

- ideal work progress
- actual progress
- cumulative work done (under ideal/actual scenarios)
- work left to be completed (under ideal and actual scenarios).

Note that we used planned vs. actual cost in our earned value analysis, there is a similar concept here.



read the data

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt

from google.colab import drive
drive.mount('/content/drive/')

%cd /content/drive/My Drive/

myData=pd.read_csv('/content/drive/My Drive/BDU.csv'

myData.shape
myData.head(2)
```

plot them

```
fig, (ax1,ax2)= plt.subplots(1,2, figsize=(40,10))

ax1.set_xlabel('days')
ax2.set_xlabel('days')

#they both show up on the same chart
# work completed under idea scenario
ax1.plot(myData.Cideal, color='pink',label='work completed - ideal')
ax3=ax1.twinx()
# work completed under actual scenario
ax3.plot(myData.Cactual,color='green', label='work completed - actual')

ax2.plot(myData.Lideal, color='pink',label='work to be done - ideal')
ax4=ax2.twinx()
ax4.plot(myData.Lactual, color='green', label='work to be done - actual')

ax1.set_title('burn up')
ax2.set_title('burn down')

h1, l1 = ax1.get_legend_handles_labels()
h3, l3 = ax3.get_legend_handles_labels()
ax3.legend(h1+h3,l1+l3,loc=2, prop={'size':20})
h2, l2 = ax2.get_legend_handles_labels()
h4, l4 = ax4.get_legend_handles_labels()
ax4.legend(h2+h4,l2+l4,loc=2, prop={'size':20})
```

Figure 1: Burndown/up charts

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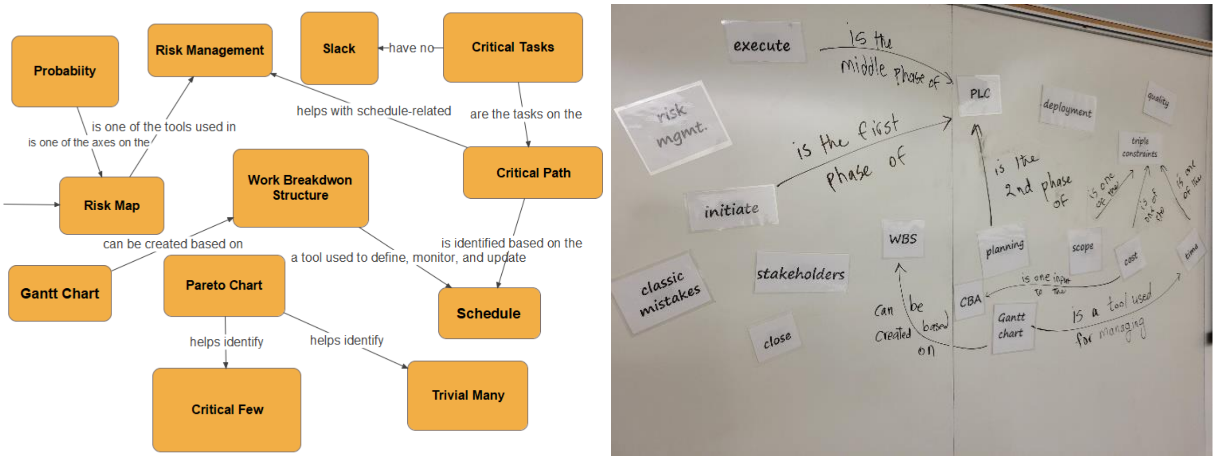

Figure 3: left: Part of the deliverables from the collaborative concept mapping activity – right: whiteboard modeling and practicing connecting concepts and labeling links

Design, Implement, and Assess an **Information Systems** to Support Housing on the Human Colony on Mars (description on page 2)

Deliverable 1 – Business Case

1- **Write a business case for the project**
   a. List 2-3 MOV
   b. List two alternative solutions
   c. Discuss advantages and disadvantages of the two alternatives
   d. Perform cost-benefit analysis on the two alternatives
   e. Create an alternative analysis schema to compare the alternatives
   f. Perform alternative analysis and make a recommendation

Deliverable 2 – Project Charter

2- **Write a project charter for your proposed/approved solution**
   a. Use master chef project charter as a reference (simplify when needed)
   b. Include in- and out- of scope items
   c. Include phases and major deliverables
   d. Discuss stakeholders and their role in your project
   e. Include a risk map
   f. Attach a WBS & Gantt chart
   g. Include brief statements about any other project management knowledge area not listed above

Figure 4: First project deliverables

Agile ceremony	description	frequency
All your group communication must happen on MS Teams chat. I will observe your communication for assessing group processes.		
Daily scrums	5-7 minutes quick check-ins, sharing progress & obstacles	6: once every week day
Retrospective	review & reflect, identify areas of improvement	once
Setting daily goals	have small goals for each day during this 1-week, example: write a 50-minute description or create a table with initial numbers	6: once every week day

Figure 5: Agile ceremonies projects

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Topic	questions/discussion ideas
focus area	What area of housing or what subsystem would you like to focus on? You can pick a subsystem and base your business case upon date; you don't have to address all their needs. Example: new constructions, rental management, maintenance, personnel, living conditions monitoring (oxygent,..)
Measurable Organizational Values	Think about the subsystem, with your information systems project in place, what would you be able to improve? Would you make anything faster, or more reliable, easier, more efficient, reduce cycle time, latency, or make more of something or offer more of a service ? see the impact areas from the book (at the bottom of this page) and brainstorm what your proposed system will be able to achieve? Make sure each MOV has a metric (how you measure progress), quantify goals (x% increase/decrease), then associate a time frame to the goal (when would you anticipate achieving it?)
Alternative solutions	You are in charge of the information systems project so the alternatives you're coming up with are alternative ways of doing the information systems project, would you think your organization has the skills to develop the system in-house? If not these are other possibilities; ● Purchase an already existing product and customize it: this is a good option when the system you're trying to build is not unique, it's a type of system that is used in many different organizations. ● Outsource the whole system ● Outsource parts and develop in-house: sometimes the parts that work with proprietary data/knowledge are developed in house

Figure 6: Sample discussion ideas for dojo sessions