Managing Students in Hybrid Software Project Classes

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***Abstract*—This innovative practice paper describes the authors' experiences introducing active learning methodologies into a hybrid undergraduate software engineering project course. On our campus hybrid courses have both in-person and online students participating in a single course taught by the same instructor. The project team adapted the face-to-face class activities to accommodate the idiosyncrasies of an online course delivery environment. Using active learning and authentic assessment techniques, the authors sought to improve the levels of engagement exhibited by online students. The students in this course learn to use agile software engineering practices to deliver incremental software prototypes. The online and in-person students were surveyed at the conclusion of their course to measure their perceived levels of engagement with course activities. Data was collected from two recent offerings of this course. The results suggest that the neither the in-person or online students were not significantly different from one another on most survey responses or most performance measures.**

Keywords—project-based learning, authentic assessment, hybrid instruction, project management

I. Introduction

Many instructors are frustrated when trying to engage students in the subject matter they teach. Some students avoid reading the textbooks required for their classes and may not complete the homework assigned. The look of disengaged students can be observed in many courses across all STEAM disciplines on most college campuses. The authors have noticed higher levels of engagement when students participate in class activities rather than passively listening to lectures. These activities may include games, discussions, role-play, peer reviews, and group problem solving or design exercises. Since the return from the Covid lockdown engineering programs have been pressured by student demands to offer project courses completely or partially online. At the authors' institution asynchronous online student sections are often merged with an in-person sections of the same course taught by the same instructor. Online students must be allowed complete all course requirements outside of the scheduled in-person class time.

The authors felt it was desirable to create activities that engaged online students and allowed them to experience a level of active learning comparable to the experiences enjoyed by students attending the in-person section of the same class. This can be challenging for instructors teaching project courses which emphasize the use of active learning techniques and project-based learning. Activities developed for the face-to-face delivery of software engineering topics often need modification to accommodate online students. For example, an online student may need to complete a single person version of an activity completed by in-person groups or they may need to contribute asynchronously to the development of a group artifact online.

Students learning software engineering principles and practices may find it difficult to apply them in the development of complex software projects. Software engineering involves acquiring application domain knowledge to understand the client's needs. The authors believe that the capstone design course should not be the only opportunity for students to manage complex software development projects. This paper describes the authors' approach to teaching a hybrid software engineering project course which makes use of a flipped classroom model that relies on active learning and the use of authentic assessment practices (e.g., reflective writing and peer assessment).

A. Active Learning

Engineering educators regard experiential learning as the best way to train the next generation of engineers [1]. It is reasonable to believe that the soft skills practiced in active learning classrooms can improve the capabilities software engineering students and better prepare them for their capstone projects [2]. Active learning is "embodied in a learning environment where the teachers and students are actively engaged with the content through discussions, problem-solving, critical thinking, debate, and a host of other activities that promote interaction among learners, instructors and the material" [3]. Prince defines active learning as any classroom activity that requires students to do something other than listen and take notes [4]. Active learning opportunities can complement or replace lectures to make class participation more interesting to students. Active learning using a flipped classroom approach can also foster developing an attitude of life-long learning among students [5].

Active learning helps students develop problem-solving, critical reasoning [6], and analytical skills, all of which are valuable tools that prepare students to make better decisions, become better students, and better employees [4]. Raju and Sankar undertook a study to develop teaching methodologies

that could bring real-world issues into engineering classrooms [7]. The results of their research led to recommendations to engineering educators on the importance of developing interdisciplinary technical case studies that facilitate the communication of engineering innovations to students in the classroom.

Active learning helps students learn by increasing their engagement in the educational process [8], [9]. The group work that often accompanies active learning instruction helps students develop their soft skills [10]. Some instructors believe that the project activities inherent in real-world software development encourage students to improve their written and oral communication skills [11].

Day and Foley used class time exclusively for exercises by having their students prepare themselves through the study of materials provided online [12]. Research suggests that the success of flipped classroom approaches depends on the nature of the course being taught. The investment in time required for instructors to develop quality out-of-class materials and in-class active learning experiences can be substantial [13]. The instructor time commitment becomes greater if both in-person and online students are in the same course.

The investigators chose to make use of a flipped classroom approach for the project courses discussed in this paper. Students viewed short video lectures and completed any textbook readings before beginning the class activities.

B. Student Engagement

Student engagement refers to the degree of interest and attention shown in course activities. Student engagement can be a predictor for course completion and retention rates [14]. Active learning techniques such as think-pair-share exercises [15], pair programming [16], peer assessment [17], and flipped classrooms [18] have been demonstrated to increase student engagement [8]. Many of these interventions are used for introductory level instruction, primarily to address broadening participation in large classes [19].

In software engineering courses, the use of real-world, community-based projects may be an effective way to engage students with meaningful problem solving while teaching them software engineering concepts [20]. Students often become more invested in their projects when they see that their products are more than simply paper designs. We designed the daily course activities help students practice skills they need to complete the larger team projects.

C. Project-based Learning

Problem-based learning or project-based learning (PBL) has consistently demonstrated it can lead to positive learning outcomes such as self-directed learning habits, critical thinking skills, and deep disciplinary knowledge while engaging students in collaborative, authentic learning situations [21]. While PBL was first incorporated into medical school curricula in 1969, it is currently used in a wide variety of courses [22]. For instance, within the field of engineering, Warnock and Mohammadi-Aragh investigated the impact of PBL on student learning in a biomedical materials course and found that students made significant improvements in their problem-solving, communication, and teamwork skills [23].

PBL has been used in senior level engineering courses with the same positive results [24]. Although students in one PBL software engineering course reported that the projects were more time intensive than a typical course project, they were receptive to the approach since they thought it was related to the professional environment and provided them with opportunities to relate theory and practice. This contrasted with students taught using a traditional lecture and project approach to the course who viewed completing a traditional course project more negatively [25]. Each of our project courses contains a significant group project that requires several weeks to complete.

D. Assessment Using Peers

Use of peer review and peer evaluation can be helpful in engaging students with each other in hybrid (online or in-person) project courses. Peer review is the act of having classmates read what other students have created and responding to them in terms of its effectiveness. The reviewer finds the strengths and weaknesses of the draft deliverable and suggests strategies to improve the work product [17]. Having students peer review student presentations (either live or recorded) is one way to help keep them engaged with the course delivery. Peer reviews can be used to supply feedback on draft documents or project prototypes prior to their final submission for grading by the instructor.

Peer evaluation is a collaborative learning strategy that asks students to reflect on contributions made by colleagues on group work. Peer evaluation encourages students to critically examine the work of peers and reflect on the quality of the work. It often involves the use of a detailed rubric or checklist as a guide [17]. Peer evaluation is an important strategy to keep student team members honest about their contributions to team deliverables. Students on project teams in our courses evaluate the contributions made by each team member when submitting a milestone document or a software prototype.

E. Authentic Assessment

It is difficult to use traditional paper or digital tests in hybrid classes containing both in-person and online students. Authentic assessment is one way to assess students without relying on closed book tests. Authentic assessment involves activities that are challenging. The outcome of these activities should be a product or demonstrable behavior. The activities should be designed to ensure transfer of knowledge [26].

Use of authentic assessment involves having students solve real-world problems which have ambiguous answers. Real-world problems are often complex and require actionable solutions from students. Authentic assessment requires elevated levels of student engagement as students evaluate their own performance.

In classes that emphasize project-based learning, student activities involve group projects of all sizes and durations. In engineering, reports (both written and oral) and prototypes are the most common work products. It makes sense to have students develop progress report memos, lab reports, posters, and reflection pieces describing their lessons learned following textbook readings and learning activities [27]. These assessment

activities should be short, frequent, and have low stakes graded work products the students complete every few class periods.

F. Reflective Writing

Research on student learning shows many benefits to the use of reflective writing in clinical or professional experiences. This suggests its use as an authentic assessment technique. Students asked to reflect on their learning experiences are better able to retain and transfer their learning to new contexts. The act of reflecting requires retrieval, elaboration, and generation of information can make learning more durable for students [28].

Promoting reflective thinking is important to helping learners develop strategies to apply added information to unpredictable situations in real life. Knowledge is created through the transformation of experience. Reflective writing could be one method for promoting reflective thinking that allows learners to consider their experiences and transform them into knowledge that can be applied in new contexts. Reflective writing is an effective method for promoting metacognitive thinking. Reflective writing can be a useful tool for communication between students and mentors in experiential learning activities [29].

Reflection provides opportunities for students to think about their performance, consider which strategies were effective, and contemplate how to improve their process. In work contexts, individuals who engage in reflection have lower error rates when learning new skills [30]. In asynchronous on-line courses, student reflective activities are important since students and instructors do not have opportunities for face to face communication. If gathered over a period time, student writings can guide instructors in refreshing course content. If reflections are collected over the course delivery, students can use them to monitor their own progress. In face to face classes, reflective writing can be used to initiate in-class discussions in small group activities [31].

In active learning, students working in small groups or by themselves, are required to summarize the lessons learned from each hands-on assignment. If students are assigned to read a textbook before coming to class, it may be helpful to have them summarize their reactions to the reading in writing. Writing critiques of student presentations in-class also encourages the development of critical thinking, which is a valuable life-long learning skill. It can be time consuming for instructors to grade large numbers of reflection documents, so this effort can be reduced by making use of peer evaluation strategies or allowing the submission of group reflection documents.

II. COURSE OVERVIEW

One of the authors teaches an undergraduate software engineering course CIS 375. This course is offered in-person on campus and merged with an online section that allows enrolled students to complete the course requirements asynchronously online. We determined that a PBL (project-based learning) approach was well suited for the delivery of junior level software project courses. We use the class activities to motivate students to design software products and use software engineering techniques to solve real-world programming problems. The investigators included small group activities with the expectation that students would provide written or oral summaries (either live in-person or virtually using video) of the strategies used to complete their tasks and their lessons learned. Online students need to complete group work asynchronously. We require both groups of students to reflect on the lessons learned from design exercises either in writing or orally. We shifted to authentic assessment techniques to allow the use of more frequent, lower stakes graded activities in our courses.

The junior level software engineering course, CIS 375 (Software Engineering 1), offered by the Computer and Information Science (CIS) department is organized as a fifteen week, four credit-hour course, meeting two days a week. The in-person meetings are recorded and made available for viewing after the class meetings end. Students in both sections had access to prerecorded video lectures. Students are allowed to enroll in the asynchronous section of CIS 375 and complete the course activities by themselves at home. For most online students, viewing the video lectures and reading the textbook were their primary sources of instruction. A week-by-week listing of the topics and activities appears in an earlier paper [32].

Prior to attending class meetings, the in-person students were expected to read the sections of the required course textbook [33] and view two 20-minute video lectures created as part of the weekly course module. The online students were expected to do the same. The activities in CIS 375 are often small group software design, project management, or problem-solving activities. Online students were asked to complete similar activities at home by themselves.

A. Use of Teams in Hybrid Classes

Two big questions that need to be answered when assigning group project work in hybrid courses are: 1) how to involve online students in project work and 2) how to assess the contributions of individual team members to the final project deliverables. There are several factors that affect how these questions may be answered: 1) project origin, 2) appropriate team sizes, 3) team formation strategies, 4) progress tracking, 5) presentation of deliverables, and 6) some type of reflection opportunity.

We believe that allowing students to select their own projects and have some control over selecting the members of their team helps to give them a sense of ownership over their project. In some classes, students propose project ideas, and the class votes on which projects to develop. The winning proposal author manages the recruitment process to staff their project teams. For in-person classes the classroom can be organized like a job fair. This allows students to complete their project teams quickly. For hybrid classes, Google sheets and email need to be used to help students select projects and team members, especially since each team needs to contain both in-person and online students. To make this process work a little easier when online students are involved, the instructor might have students complete a Google sheet where each students lists their skills and project interests.

Our experiences suggest that for team projects lasting more than six weeks it is important to include regular checkpoints to ensure students are progressing in ways that will allow on time completion of their project. Students are asked to create a list containing the features and milestones needed to complete their project. Agile developers call this list the project backlog.

Students are asked to share the updates to their backlog list every two weeks along with a Gannt chart showing tasks assigned to each team member as they work to reduce the size of the backlog each week. It is important to provide team members with ways to hold each other accountable if people fail to complete their assigned tasks. Peer review and peer evaluation may be helpful ways to hold team members accountable.

B. Holding Team Members Accountable in Hybrid Classes

Peer reviews can be used to supply feedback on draft documents or project prototypes prior to their final submission for grading by the instructor. It has been our experience that students need to be taught how to provide feedback and that they will get better over time if rewarded for supplying meaningful feedback to content creators. We have occasionally had the document author's (team or individual) send the names of their useful reviewers to the instructor. We typically award students two points for each useful review and one point for each ordinary review.

Peer evaluation is an important strategy to keep student team members honest about their contributions to team deliverables. It can be a simple system like having each student team member upload a document with anonymous ratings (0 = nothing and 5 = great) for each team member. Students can be asked to rate their own level of participation and their teammates. It might be good to supply a list of each team member's contributions to the team deliverable. The participation scores can be averaged for each person. Team members with low participation scores can be given reduced grades on the team project. For projects which include the delivery of a running software product I have the team meet and complete a set of timecards that document tasks completed by each team member and the time spent on each (Fig. 2) based on the group consensus.

Oral presentations of work products (both group and individual) are frequent in our in-person classes. Online students need to submit videos of their presentations. To ensure that they get meaningful feedback on their presentations class members are assigned the task of providing peer feedback on other students' submissions.

C. Use of Reflection in Hybrid Classes

In asynchronous on-line courses, student reflective activities are important since students and instructors do not have opportunities for face to face communication. If gathered over a period time, the student answers can guide instructors in refreshing course content. If reflections are collected over the course delivery, students can use them to monitor their own progress. In face to face classes, reflective writing can be used to initiate in-class discussions in small group activities.

Reflective writing can take many forms: lab notebooks, project change logs, minute papers, or project postmortems. We might simply ask our students to answer three questions when they reflect on their work after completing a project milestone (document or prototype): What went right? What went wrong? What lessons learned or process improvements are suggested? Students need to be told that reflection involves more than simply reporting what happened. The lessons learned type questions attempt encourage students to think critically about what they experienced.

III. STUDENT ASSESSMENT

The authors created two research questions to compare the students taking recent offerings of CIS 375 under the in-person (FF) delivery of active learning materials to students taking the same courses under asynchronous online (AO) delivery.

RQ1: Does the delivery mode (FF or AO) affect student performance in taking either offering of CIS 375?

RQ2: Does the course delivery mode (FF or AO) affect student perceptions of engagement as reported on surveys taken in either offering of CIS 375 ?

RQ1 examines differences in student performance based on assessment measures in each course offering. RQ2 examines differences in student perceptions of engagement at the end of each offering of CIS 375.

A. Student Performance

Each of the course assignments (lab writeups, reading reflections, documents, and final project) was evaluated using Canvas rubrics designed by the instructor for each type of submission. Each rubric contains two to ten criteria, each scored from 0 to 5 (Fig. 1). The total course grade was based on the points earned on all assignments, including peer evaluations on the project performance score cards (Fig. 2).

Table I compares FF and AO students from Fall 2022. Table II compares FF and A0 students from Fall 2023.

TABLE I. CIS 375 STUDENT PERFORMANCE FALL 2022

	FF (N=32)	**AO (N=18)**
Average Course Grade	94.8%	94.6%
Average Number of Late Assignments per Student	5.00	6.72
Avergae Number of Missing lab Assignments per Student	1.84	1.61
Average Number of Mssing Reflectionss per Student	1.69	0.78
Avergae Prototype Score (40 max.) per Student	39.88	37.56

TABLE II. CIS 375 STUDENT PERFORMANCE FALL 2023

	FF (N=35)	**AO (N=12)**
Average Course Grade	97.1%	96.9%
Average Number of Late Assignments per Student	2.34	3.83
Avergae Number of Missing lab Assignments per Student	0.86	1.41
Average Number of Mssing Reflectionss per Student	0.94	0.17
Avergae Prototype Score (40 max.) per Student	39.86	40.00

No statistical comparisons of student performance on the individual course assignments were made between students in the in-person (FF) section and the asynchronous online (AO)

section in either offering, Students were allowed two skip 2 of 21 lab write-up and 2 of 18 reading reflections.

In both offerings of CIS 375 the student sections (FF and AO) worked independently of each other with the students in-person completing the class assignments in-class or at least discussing them heavily before submitting together as a group. The online students worked independently and submitted their work without much or any interaction with their peers. The term projects in CIS 375 were completed by teams composed of both in-person and online students.

For Fall 2022 (Table I), students in the FF section had slightly better overall grades (94.8% vs. 94.6% respectively) than students in the AO section of the course. The FF students had a higher number of missing labs (1.84 vs. 1.61) and reading reflections (1.69 vs. 0.78). The in-person students had fewer late assignments (5.00 vs 6.72) and slightly higher prototype contribution scores (39.88 vs. 37.56). One-tail Student t-tests comparing the FF and OA students revealed that the only significant difference between these groups at the 95% confidence level was for the number of missing reading reflections which favored AO students (1.69 vs 0.78).

For Fall 2023 (Table II) students in the FF section had slightly better overall grades (97.1% vs. 96.9% respectively) than students in the AO section of the course. The FF students had a lower number of missing labs (0.86 vs. 1.41) and late assignments (2.34 vs. 3.83). The in-person students had slightly more missing reflection assignments (0.94 vs 0.17) and slightly lower prototype contribution scores (39.86 vs. 40.00). One-tail Student t-tests comparing the FF and OA students revealed that there were no significant differences between these groups at the 95% confidence level for any of these measures.

B. Student Engagement Survey Comparisons

We surveyed the students during the final weeks of each course offering, to gather the students' perceptions of their levels of engagement with the active learning materials. The students in all sections were asked a series of online questions designed by the authors to elicit candid responses. Students rated each statement on their perceptions of active learning and their engagement in the survey. Table III shows the comparisons between survey responses for FF and OA students for Fall 2022 and Table IV shows the comparisons for Fall 2023.

TABLE III. END TERM SURVEY STUDENT PERCEPTIONS OF ENGAGEMENT FALL 2022 FF VS AO

FF (N=30) AO (N=18) SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree						
Survey Statement		**SD**	**D**	**N**	**A**	**SA**
1. There were opportunities for me to actively engage in learning	**FF**	0	0	1 (3%)	8 (27%)	21 (70%)
	AO	0	0	2 (11%)	6 (33%)	10 (56%)
2. Course activities were useful way to learn	**FF**	0	0	0	13 (43%)	17 (53%)
	AO	0	1 (6%)	3 (17%)	5 (27%)	9 (50%)
3. Course activites let me apply what I learned	**FF**	0	0	0	10 (33%)	20 (67%)
	AO	0	0	4 (22%)	4 (22%)	10 (56%)
4. Course is an example of active learning	**FF**	0	0	0	5 (17%)	25 (83%)
	AO	0	0	2 (11%)	6 (33%)	10 (56%)
5. I felt more engaged during activites than lecture	**FF**	\ 0	0	0	11 (37%)	19 (63%)
	AO	0	1 (6%)	6 (33%)	2 (11%)	9 (50%)

TABLE IV. END TERM SURVEY STUDENT PERCEPTIONS OF ENGAGEMENT FALL 2023 FF VS AO

FF (N=33) AO (N=11) SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree						
Survey Statement		**SD**	**D**	**N**	**A**	**SA**
1. There were opportunities for me to actively engage in learning	**FF**	\ 0	1 (3%)	2 (6%)	8 (24%)	22 (75%)
	AO	0	0	2 (18%)	3 (27%)	6 (54%)
2. Course activities were useful way to learn	**FF**	0	0	7 (21%)	8 (24%)	18 (54%)
	AO	0	0	3 (27%)	3 (27%)	5 (45%)
3. Course activites let me apply what I learned	**FF**	0\	1 (3%)	4 (12%)	8 (24%)	20 (60%)
	AO	0	1 (9%)	1 (33%)	3 (27%)	6 (54%)
4. Course is an example of active learning	**FF**	0	0	3 (9%)	10 (30%)	20 (60%)
	AO	0	1 (9%)	2 (18%)	2 (18%)	6 (54%)
5. I felt more engaged during activites than lecture	**FF**	0	0	3 (9%)	3 (9%)	22 (66%)
	AO	0	1 (9%)	3 (27%)	3 (27%)	4 (37%)

The Mann-Whitney U test was used to compare in-person student responses (FF = Face-to-Face) to online student responses (AO = Asynchronous Online) on the student surveys in each course. For Fall 2022 questions 3 and 5 showed significant differences at 95% confidence level. For Fall 2023 student responses showed no significant statistical differences between the FF and AO at the 95% confidence level.

Students from both course offerings were asked what the most engaging parts the course were. The FF students in indicated that the course project, small group labs, and group presentations were the activities where they felt most engaged. The DL students indicated that felt most engaged with the course project and the opportunities to work with their FF teammates outside of class.

Students were also asked what the least engaging parts of the course were. Both FF and DL students indicated that the reading reflections were their least engaging activities. We suspect in part because they were not group activities. Both FF and DL students preferred the hands-on activities to watching video lectures at home.

IV. THREATS TO VALIDITY

We recognize that one of the limitations of this study was that we did not have a control group. We acknowledge that the same instructor teaching both course offerings may account for the small numbers of significant differences on the performance measures in CIS 375. The instructor practices mastery learning in project classes, which means students may resubmit their work for regrading after fixing any deficiencies. This tends to result in higher grades for student who exercise this option.

A few students in both sections (FF and AO) failed to turn in any reading reflections. This may be the reason for the significant differences between the evaluation measures for the FF and AO students in Fall 2022.

The pairing of an asynchronous distance learning section with a face-to-face section of the same course does not guarantee students received the same educational experience, The live class sessions were captured, verbatim on video, for later viewing online by the both the FF an AO students. This allowed AO students the opportunity to witness the live lecture and class activities as a virtual classroom observer.

AO students were not allowed to attend FF sessions in either 2022 or 2023. It is not clear how often AO students viewed the lecture capture videos. On the final survey most AO students indicated they viewed 5 or more class recordings but this could not be verified. It is possible the asynchronous students experienced more uncertainty when attempting to complete the activities alone.

One area of uncertainty when measuring the student responses is the unknown amount of interaction between students in the two sections in the same course. Students in the CIS department know each other from other classes that they have taken together. Even though a student registered in the asynchronous online section was not allowed to attend any in-person class meetings, it is quite possible that a friend from an in-person course section may have shared their course experiences with them giving them additional insight into group activities completed in the classroom.

Student engagement can only be measured indirectly in online courses using surveys and course analytics. In previous studies conducted by the authors, direct observation of student behavior was used to provide insight into the levels of engagement of in-person students. We could not include direct observation of students in the A0 sections, the average number of late and missing assignments is the best we could do.

V. CONCLUSIONS AND FUTURE DIRECTION

In this paper we demonstrated that it is possible to offer software project courses to online students without significant loss of student satisfaction or perception of engagement. We take this as evidence that it is possible to manage a hybrid software project course and keep most online students engaged. We credit the active learning components of the classes and the levels of student interaction that accompany them for making this possible. The active learning components of the course, the hybrid project teams, and peer evaluation work also should be credited with the success of the project work.

The use of reflective writing as an alternative to traditional testing was well received by the students. Both FF and AO students read the textbook and were forced to interact with it every week. This was not true in previous course offerings.

The short, daily lab write ups and weekly reding reflections provided students with many opportunities for the instructor to provide feedback on their work. This also allowed the instructor many opportunities to identify student issues before the end of the semester. We encourage instructors to develop authentic assessment practices and modify them as needed to manage their hybrid course deliveries to achieve higher levels of student satisfaction and engagement.

It may be important to continue developing ways in which asynchronous students are encouraged to participate in more experiences with face-to-face students outside formal class meetings. We are continuing to search for additional authentic assessment techniques that will help to catch slackers early during team project work. While we emphasize agile software development in our courses the assessment and management techniques we used could be adapted to fit other engineering process models.

We are continuing to develop tools to provide scaffolding assistance for student activities for both FF and AO students. One of the authors also teaches senior design courses and game design courses using active learning and authentic assessment. The current plan is to make use of the revised modules in the Fall 2024 hybrid offering (FF and AO) of CIS 375.

VI. ACKNOWLEDGEMENT

This project was partially supported by a grant from the University of Michigan-Dearborn Hub for Teaching and Learning Resources Creative Teaching Fund.

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Topic	Feedback	Rating
1. What did you find interesting about the reading? Why?		0-4
2. What parts of this chapter do you feel would be challenging in a professional environment? Why?		0-2
3. Did your perception of the chapter material change after you read it? What did you view differently?		0-2
4. What do you consider the key take away from this chapter? Why?		0-2

Fig. 1. Sample Reading Reflection Rubric

Developer Name:			40 max
Team Meetings	Points	#	Earned
daily stand-up held (1 point per meeting attended)	1	0	0
backlog item moved to done (1 point for each item personally completed)	1	0	0
Software Development (must earn at least 5 points from this group)			
Programmer or UI/UX Programmer			
Programmer - 1 user story implemented as solo developer	5	0	0
Prorgammer - 1 user story completed using pair prorgamming (3 points each)	3	0	0
UI/UX - key screen implmented	3	0	0
UI/UX - key screen wire frame	2	0	0
Repository Manager, Document Manager			
Document manger - one hour of work	1	0	0
Repository manager - one hour of work	1	0	0
Tester, QA			
QA work - one hour of work	1	0	0
tester - test case written	1	0	0
tester - written test case executed and documented	1	0	0
		Total =	0

Fig. 2. Final Project Prototype Score Card