# Abstract

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This article describes an innovative approach to using Project Managers in the classroom that has positive effects on everything from individual student participation to group project disposition and presentation.

# Keywords

Classroom, Software Engineering, Software Project Management, Group Work

# Introduction

There is a significant amount of research which shows the importance of project management within software projects [CITE], in the classroom [CITE], and within student projects [CITE], but on many cases instructors are unsure how to approach the matter. Universities have identified the need for courses covering process and project management in many disciplines, including

Because process is a major focus of the Software Engineering curriculum [CITE], Project Management has been included as a required course in many Software Engineering programs. While Project Management principles and practices are always a part of these classes, many do not include the practice itself. Practices of encouraging students to complete exercises in artifact creation are common, but many classes neglect to include the hands-on leadership and planning elements that makes Project Management a discipline rather than a collection of methods. In many cases project management falls to the instructors themselves[CITE], and this is carried out either through direct and frequent intervention with student groups or through heavily structured assignment descriptions.

At the Rochester Institute of Technology (RIT), we have offered an upper division Process and Project Management class within the Software Engineering (SE) major since 1998 with a wide focus including process methodologies, team development, and project management fundamentals. A project component has always been a significant part of this course, bit its primary focus has been delivery of project artifacts.

In this paper, we describe an innovative approach to including a hands-on Project Management experience within the project component of the course. Under the supervision of the instructor, who serves as an advisor, students are given the opportunity to volunteer as Project Managers (PMs) for the main group project. These PMs are given traditional expectations in managing their group’s deliverables and dynamics, but are also expected to participate in a separate PM-only group that enhances their learning experience as well as that of their team members.

This updated project format has been included in several class offerings and has experienced substantial success. Students have stated that it not only increased their knowledge and application of Project Management as a discipline, but it gave them an opportunity to interact with Project Managers as a group member or vice versa. Results, in many cases, have far exceeded expectations, and student feedback has shown praise for both the interactive nature of the project and the resulting final presentation.

The remainder of this paper is organized as follows. Section XX includes a description of the Process and Project Management course, including its purpose, structure, and components. Section XX describes the project, including its former state and changes that have been made to meet specific learning objectives. Section XX describes the results, including examples from recent implementations of the project changes. Section XX includes both quantitative and qualitative student feedback. Section XX describes related work. Section XX discusses planned or proposed future work related to the project, and section XX provides a final summary.

# About the Course

Although students are primarily Software Engineering majors, Process and Project Management is also offered to other majors, including Computer Science, Computer Engineering, and Game Design. The only prerequisite is an introduction to software engineering course, a survey course which includes basic concepts core to the major. In this prerequisite, students have been introduced to some of the themes of Process and Project Management, such as teamwork and roles, an introduction to software development process methodologies, and basic scheduling and task management.

There are three primary learning outcome goals of this course: to introduce students to the core concepts and artifacts of Project Management, to continue to reinforce the Software Engineering process including process models, and to demonstrate the importance of process and Project Management in the students’ chosen discipline. Lectures and texts enhance the concepts with case studies and real-world examples, striving for both present and future relevance. In addition to process, covered concepts include classic mistakes (and antipatterns), team development, specific Software Engineering models (waterfall, agile, etc.), risk management, estimating and scheduling, quality and metrics, communication management, and process maturity models.

The Software Engineering department considers this 3-credit course the core class in the process track (one of two major tracks) taken by all students in the major. This class is a prerequisite to other classes, such as Software Process and Product Quality, and Trends in Software Development Processes. Methodologies and processes taught in this class are also a required implementation in the Senior Project class immediately preceding graduation. The department understands that a strong foundation in this area is a vital part of students’ future success and the resulting reputation of the college.

Software Engineering majors typically take this course in their third year, and it often directly proceeds or follows students’ required one-year cooperative internship (co-op). For many students, this time period is a watershed moment, as upper level courses and co-ops often have the effect of encouraging the student to realize their area of focus and concentration. Though not always an explicit minor, students naturally begin to specialize in areas such as testing, design, enterprise or web systems, process and project management, or other related disciplines.

While most students will not become Project Managers, we do expend effort to allow students to see the value in the discipline and its individual practices. While half of the class time is devoted to lectures, the remainder is reserved for reinforcing activities, discussion, and group work time. Students are graded in several criteria, including short quizzes, three exams, individual and group activities, and a large group project. Class size is typically 20-35 students.

# About the Project

This course has always had a major project component. Previously, the project was similar to other classes in that groups were assigned and each group was required to complete a paper and present it to the class at the end of the term. The paper to be turned in was basically a project plan with components such as a risk table and schedule based on a chosen methodology. Some interactive components were present, such as sectioned drafts that correlated with subjects covered in class and a cross group feedback opportunity.

The primary deliverable is a project plan based upon a problem statement provided by the instructor at the beginning of the group project portion of the course. While the problem statement has varied, the deliverables have remained consistent: an overview and scope, list of functional and nonfunctional requirements, methodologies overview, schedules and their justifications, risks, metrics, and lessons learned. Deliverables are turned in three times, with each building on the previous draft. Groups participate in cross-team feedback with other groups, and a 10-15 minute final presentation takes place during the last week of the semester. Opportunities for group members to provide feedback on each other’s performance are in week 12 and at the end of the semester.

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| --- | --- | --- |
| Week | Activity/Deliverable | Details |
| 6 | Project Begins | Required Deliverables and Due Dates Set |
| 9 | Draft 1 Due | Document Outline, Risks, Scope, Requirements |
| 12 | Peer Evaluation 1 |  |
| 13 | Draft 2 Due | Updates to Draft 1, Process Methodology, Estimating and Scheduling |
| 13 | Cross-Group Feedback | Feedback Effort is Graded |
| 14 | Final Version Due | Updates to Draft 2, Lessons Learned |
| 15 | Group Presentations |  |
| 15 | Peer Evaluation 2 | Completed After Final Presentation |

Because of its similarity to other paper-based group projects, students were familiar with and competent at completing the assignment, but many felt that it was merely an extension of individual assignments and treated it as such. It had become evident that student groups were dividing work ineffectively and inconsistencies in both the content and flow of their papers and the final presentation were a byproduct of this ineffectiveness. These symptoms and the desire to allow students to have a PM-led experience prompted us to make some changes to both the project and its disposition.

The first significant change was the inclusion of a formal PM role within the group project. Students are notified on several occasions prior to beginning the project that the final project teams are to be led by a voluntary PM. At the same time, students are told that this PM will have the opportunity to earn a higher grade, as peer evaluations are a significant part of the grade, and good leadership is rewarded by those who recognize it. Additionally, potential PMs are asked to review the written PM Activity Guide and to note potential team members – an opportunity to be afforded to them later group assignment efforts later in the semester.

Selection of the PMs takes place at the start of the project roughly one third of the way through the semester directly after the first midterm. The process is public by show of hands and is continued until the appropriate number of PMs have volunteered. Students and instructors are rarely surprised at who has chosen to volunteer, as many have worked together in previous classes or even in the early part of the current class. In the past, there have always been an appropriate number of volunteers, and rarely have any volunteered who did not receive the opportunity to participate as a PM. Previous efforts have always yielded between 1/4 and 1/5 of the class – an appropriate number, as 4 or 5 students per group is desirable.

The second change has been to treat the PMs as a separate group, requiring them to cooperate in several separate activities. The first activity exclusive to this group is the formation of the teams that they will lead. This takes place immediately after selection of PMs is completed and is a private negotiation process between PMs (private, as not to embarrass team members chosen later). As the semester progresses, PMs are called together weekly to check progress, answer questions about upcoming deliverables, and to mutually benefit each other in these exchanges. Attendance checking becomes group based; PMs are asked if any of their group members are missing, and, if so, whether they had indicated to the group their expected absence. At the end of the semester, PMs are required to evaluate each other in the areas of teamwork, knowledge and skills, dependability, initiative and creativity, adaptability and flexibility, and delivery of results.

The final and possibly the most unique change to the project relates directly to the separate PM-only group. As a group, the PMs are expected to initiate a way of differentiating the final presentation. Because each group is completing a project with the same guidelines, case study, and deliverable, the final presentations can be both repetitive and rather difficult to grade, with later-presenting groups unfairly benefiting from the insights or mistakes of their predecessors. Relating to their task of differentiation, some guidelines and previous examples are given, but the task is intentionally left up to the PMs. They are required to meet twice near the end of the semester and to provide a meeting summary to the instructor.

Benefits to this differentiation are seen in both the presentation itself and the engagement of the students both before and after the presentation. Because of the requirement to be different than other groups, group members are forced to prepare something other than a rehash of their paper, and during the presentation itself students are more likely to listen, participate, and learn because the other groups’ presentations are each significantly different.

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| --- | --- | --- |
| Week | Activity/Deliverable | Project Manager Responsibility |
| 6 | Project Begins | Volunteer as PM, Roster Selection |
| 7-11 | Weekly Check-Ins | Cross-Team Problem Solving |
| 9-14 | Deliverables Due | Manage Group Schedule, Division of Work, and Accountability |
| 12-14 | Presentation Differentiation | PMs Meet at Least Twice, Provide Summary to the Instructor |
| 15 | Group Presentations | Report Order of Presentations to Instructor |
| 15 | PM Peer Evaluation | Completed After Final Presentation |

PM volunteers, PM rosters chosen, PM as group, final presentation

PM volunteers are mentioned throughout the first part of the course.

Students are given the opportunity to experience PM or being part of a team led by a PM

# Project Results

Class dynamics have been positive since the implementation of the project changes. The grouping of students as the application and combining of concepts becomes a more prominent part of the course has allowed students to participate in class activities as larger units rather than individual students. The instructor has been able to call on groups rather than individuals to answer a question, resulting in less individual embarrassment or awkward class flow and in more positive cooperative effort.

Because of the group selection technique, instances of a ‘super group’ or a group that is left over after others have banded together is less common. Although there are still occasionally instances of groups that perform slightly better or worse than their peers, final grade distribution typically indicates that groups have a good mix of students. In many instances, the PMs apply the teaming principles learned in the first part of the course not only to group management, but also to consideration and selection of the team members themselves. Overall, this results in more diverse, and therefore more consistently successful, groups.

The experience within the group project has also had positive effects on the students individually. In many cases, students have discovered or cemented a desire to pursue Project Management as their chosen field, and have attributed that choice at least in part to the class project experience. Additionally, many students have reported that lessons learned within their group were immediately applicable in co-ops or other classes, and viewed group work differently than they had before. Both PMs and group members have indicated that the experience also made them better team members, as they had a greater knowledge of the responsibilities of a PM and were able to assist in ways they previously had not even considered.

Diversification of the final presentation has also had surprising effects. The PM groups, tasked with working together to make the final presentation more interesting and less repetitive, have come up with some very innovative ways of doing this. Some of the best results have come from simple ideas like combining all groups slides into one deck for presentation – eliminating much of the downtime between presentations and the advantage that later presenting groups hold over their predecessors. PMs have served as timekeepers for other groups, ensured that their team members are paying attention, and in some cases have reviewed each other’s planned presentation against the published rubric beforehand.

The most typical mode of diversification has been to either divide the presentation by subject area (risks, methodology, etc.) or to focus more on what each group has done differently rather than repeating similar parts of their project implementation. Possibly the most surprising and imaginative result was a project management play depicting the project’s progress through its planning stages – including 5 minutes in Shakespearian English, video projector sets, and a “process methodology smack-down”. In all cases, the resulting presentations were more interesting and required students to be more engaged in both their preparation and implementation.

Student feedback has been generally positive, and is discussed in the next section.

# Student Feedback

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In a voluntary survey given at the end of the semester, students were asked to compare previous group work issues with those encountered during this class. Issues reported as previously common but reduced for the duration of this project included poor time management and organization, lack of leadership, issues with division of labor, communication breakdown, and failure of teammates to show up to meetings.

Students were also asked for general feedback on the group project. Some of their responses were as follows:

“I really like how the project managers volunteered for the position, because it meant that they were willing to put forth the effort to manage the group, and as a result I felt more motivated to participate as a member. “

“The use of project managers helped keep our group on track, moving forward and not waiting until the last minute to start working on each section.”

“The project managers were helpful because it gave our group a certain line of communication with the professor, which was more helpful than individually having questions answered.”

“I liked the idea of all of us presenting one big presentation with each group in charge of a specific part.”

“I think the use of Project Managers really helped highlight the things we were learning in this class – at least that was the experience I had in my group. When you have a proactive PM who is good about getting people to show up to meetings and actually getting their work done, it becomes much easier to complete a project, and do it well.”

Students were also asked questions related to learning, project success, and engagement with the field of Project Management. Questions were answered using a standard Likert scale. Table XX lists statements and the percentages that agreed. Respondents comprised of 90% or greater of classes surveyed. 21% of respondents participated as a PM.

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| --- | --- | --- | --- | --- | --- | --- |
| The Field of Project Management | Agree | | Undecided | | Disagree | |
| PMs | Group | PMs | Group | PMs | Group |
| The use of Project Managers in this course enhanced my understanding of Project Management as a discipline. | 100% | 85% | - | 9% | - | 6% |
| The use of Project Managers has increased my interest in the field of Project Management. | 100% | 85% | - | 9% | - | 6% |
| Use of a Project Manager | Agree | | Undecided | | Disagree | |
| PMs | Group | PMs | Group | PMs | Group |
| The Project Manager group made time management and transitions between presentations easier or less intrusive. | 100% | 91% | - | 6% | - | 3% |
| The opportunity to participate as a Project Manager increased my overall satisfaction with the course (even if I did not choose to participate as a Project Manager) | 100% | 73% | - | 27% | - | 0% |
| Overall, the use of an assigned Project Manager/Team Coordinator improved group dynamics. | 88% | 84% | 12% | 13% | - | 3% |
| Overall, the use of an assigned Project Manager made my group project more successful. | 100% | 91% | - | 6% | - | 3% |
| Diversification of Final Presentation | Agree | | Undecided | | Disagree | |
| PMs | Group | PMs | Group | PMs | Group |
| I feel that I learned more from diversification of the groups' presentations than I would have if each group had presented similar material. | 88% | 87% | 12% | 13% | - | - |
| My preparation and engagement for the presentation was more interesting because of diversification of the groups' presentations. | 100% | 87% | - | 10% | - | 3% |
| Other groups' presentations were more engaging because of diversification of the groups' presentations. | 88% | 82% | 12% | 18% | - | - |

# Related Work

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# Future Work

This updated project format has been successfully utilized in several sections of the Process and Project Management course, but there are enhancements planned for future sections. One of the main objectives moving forward is to provide a group project environment that more realistically simulates both the actual and the ideal project in the real world soon to be encountered by the students. Related to this, the structure of the deliverables could be organized differently, with more guidance related to individual parts, such as sample risks, less reliance upon the instructor to define what should be included in functional and nonfunctional requirements, and the possible introduction of a mid-project requirements change.

One risk that has not yet been encountered is a lack of or too many volunteers for the role of PM. This may require more explicit definitions of both the role and contingencies. The role the PM plays with their group could also be more explicitly defined by requiring agendas, meting minutes, and lessons learned at regular intervals throughout the class.

Given that the PMs in the class are relatively inexperienced leaders, surprisingly few issues have been encountered related to this. The negotiation process by the PMs to select team members is not well documented and can vary with personalities and circumstances. The meetings between the PMs in preparation for the final presentation have not encountered any issues, no group has expressed the wish to expel their PM, and no PM has dropped the class or explicitly chosen to discontinue the role as of yet. While these risks are minimal, mitigation and management strategies should be put in place in case they are encountered.

Use of an explicit PM role and deliberate differentiation of the final presentation is something that could be adapted for use in other courses, especially those that have similar projects conducted by multiple groups. As an example, in a class where multiple groups have solved the same problem, the final presentation could, through interaction between groups, completely omit problem definition and focus on what was different between the groups’ results.

# Summary

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