

# APPOINTING TEAM LEADS FOR STUDENT SOFTWARE DEVELOPMENT PROJECTS\*

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## ABSTRACT

Team-based software development projects can be an important component of an undergraduate computer science experience. Student teams sometimes fail, however, due to inadequate initiative, communication, and organization. Students used to individual work often do not recognize the extent of the coordination required to get their team operating in tandem, and in many cases may be reluctant to initiate such coordination for fear of appearing “bossy” to their teammates.

We attempted to solve some of these problems by appointing a “team lead” to each project team in a pair of junior-level design courses. The role of the team lead was described as an organizer, initiator, meeting planner, and central point of communication with the instructor. The idea was that explicitly designating one group member to monitor project management tasks would improve communication and awareness within the team, while relieving team members of the awkwardness of volunteering themselves. We found that there were a variety of ways that teams interpreted and applied this role, but that on the whole it did in fact result in high-performing teams. Students themselves (in anonymous surveys) reported that their level of communication and awareness of project status was high throughout the semester, and believed that the concept was helpful to their team's performance.

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## INTRODUCTION

Group work is an important part of the software development process. Engineers in the workforce will nearly always work in teams to build substantial products, and the skills required for effective teamwork and communication are both non-trivial and non-technical. Hence it seems wise to incorporate team project experiences into computer science curricula. It is our experience, however, that many undergraduate project teams simply do not function well, leaving in their wake incomplete work, frustrated students, and a non-optimal educational experience.

We believe one important reason that team-based projects fail so often is students' uncertainty regarding team roles. Teams call for leadership (or at least organization and direction) in order to function effectively. But two opposite problems often sabotage it. Often, students are reluctant to assume a leadership role for fear that their peers will judge such attempts as effrontery. They are anxious to be liked by their classmates, and wish to avoid "sticking out" by asserting themselves relative to other group members. In other situations, the opposite problem occurs: more than one team member may try to assert control over the direction of the project, and in an incompatible way. This has the potential to destroy team camaraderie and leave some members sulking and unproductive.

As a result, it is common to find a team with several gifted, competent members who nonetheless fail to reach their objectives because they face a sort of leadership paralysis. Team members don't communicate or coordinate with each other nearly enough, because such attempts risk coming across as "forward." As the semester progresses, vital tasks that are easy enough to accomplish are missed or forgotten, simply because everyone was assuming that someone else was handling it. And by its very nature a group project, since it involves multiple contributors and distant deadlines, will often be put off relative to a students' individual work in other courses if no one is taking the initiative to identify tasks, set deadlines, and hold members responsible.

## THE APPROACH

To counter these difficulties, we tried an experimental approach in our 2008 offerings of two different junior-level courses (Object-oriented Analysis and Design, and Introduction to Databases.) Both courses have as their centerpiece a semester-long team project. The instructor not only chose the project teams (following the advice of [5] and others), but also explicitly designated one member as the official "team lead." This choice was made unilaterally based on the instructor's prior experience with the students in other courses, and was influenced by such factors as quality of work, promptness, social skills, and demonstration of responsibility. The precise duties of the team lead were spelled out to the entire class at the beginning of the term, and included initiating communication, planning meetings, maintaining an ongoing list of tasks and assigning them to members, and providing a focal point of communication with the instructor. It was emphasized to all that the team lead was not expected to complete *more* of the project than anyone else, nor were the leads necessarily viewed as the strongest class members technically. Rather, they were simply designated facilitators of communication and coordination among the team.

Our goal was to eliminate the power vacuum by deliberately assigning a student to fill that vacuum. This way, no student could be accused by their peers of self-promotion; after all, they were simply following the instructor's direct instructions. Our hypothesis was that by having a student specifically charged with administrative functions, team dynamics and productivity would be enhanced, leaving students to reach their full potential as developers.

The instructor closely monitored team effectiveness throughout both semesters, and distributed anonymous surveys after finals week to elicit student feedback about the team lead concept and how it was perceived. Out of 40 students between the two courses, 25 completed this survey, eight of whom were team leads. We present these findings later in this paper.

## **RELATED WORK**

Several studies have involved assigning differing roles to the members of a student project team in computer science courses. Our “team lead” role is most similar in spirit to that described by Rutherford: “The team leader is the person who brings the team together, presides at meetings, mediates disagreements, and interfaces with other parts of the organization.”[5] While Rutherford's study involves role affinities with various personality types, and aims at generating heterogeneous teams, our goal is rather to address certain logistical issues that arise among teams that have no appointed leadership.

Two of the roles defined by Coppit and Haddox[2] are “managers” and “technical leads.” In their scheme, managers are responsible for communicating with the customer, setting milestone goals and deadlines, and running meetings. A student designated as a manager has a purview that crosses between multiple smaller development teams. He or she focuses solely on administrative issues and performs little to no actual software development. Technical leads, on the other hand, are associated with a single team. They are hands-on leaders who run the meetings for that smaller team, assign specific work tasks, perform quality control on the artifacts that group produces, and resolve technical difficulties. Our approach synthesizes features of both of these roles in the “team lead” role. Since our teams are small (only three members) the administrative overhead is smaller than in Coppit's scheme, leaving the student assigned as team lead the majority of their time to perform ordinary software development tasks.

This is reflective of the approach followed by Dubinsky[3], where role-performance tasks are added on to the typical development activities of the appointed individual. In this way, the team lead is a peer with additional responsibilities, rather than an overarching manager. Dubinsky's scheme is considerably broader than ours, however, defining a dozen different roles and spreading their ownership across all team members, and does not focus on the effect of the team lead role in improving student communication, initiative, and accountability.

Unlike Beranek[1], who focused on informal roles that emerge naturally within software development teams, we had the course instructor assign the team lead role explicitly and unilaterally. This is because we predicted that if we had instructed teams to select their own team lead, students would have been reluctant to volunteer for fear of looking presumptuous to their peers. We do not doubt that a team leader will sometimes

emerge naturally from within a project group – in fact, we have observed this – but our intention was to address the “power vacuum” problem in situations where this *doesn't* occur.

In our approach, the instructor chose teams, and team leads, mostly based on previous experience with the students involved (ours is a small institution, in which an instructor has already worked with the majority of the students in a junior-level course by the time they reach that course.) Other strategies for choosing team leads could be applied instead, for instance administering surveys (as in [1]), personality inventories ([5,6,7]), or learning styles ([4].)

None of the studies here referenced have focused in particular on student opinion as to how a team lead enhances (or fails to enhance) communication, timeliness, and organization within a group. This was the aim of our investigation.

### **POSSIBLE OBJECTIONS TO THE APPROACH**

Before we began, we anticipated – and attempted to counteract – several possible objections to the team lead approach. These included:

1. *Grading would be difficult to apply fairly.* Since some students had team lead responsibilities and others did not, it might be assumed that equitable grading measures would be elusive. In fact, we did not find this to be the case. Partly this was due to the fact that we issue team grades for our team projects. Except for minor adjustments (made in response to end-of-semester peer- and self-evaluation forms), the grade for a team project is awarded in a lump sum to all members of that team, regardless of their particular contribution. Hence, the amount of work a particular student does – whether administrative or technical – is not singled out anyway: all that matters is whether the team achieves its objectives. As to whether the team lead ended up completing a larger share of the work, this effect was present but modest: only 7 out of 25 survey respondents reported that the team lead had performed more than their fair share.
2. *Students will feel singled out (or not singled out) unfairly.* We worried that with this approach, some students would feel slighted that they were passed over for the team lead role, or that some team leads would feel inadequate to the task. Happily, this was also very rare. On a 6-point Likert scale, 6 out of 8 team leads responded with a 5 or 6 (“agree” or “strongly agree”) to the statement, “I felt honored to be selected as team lead.” (This increases to 8 out of 8 if “slightly agree” is included.) And only 2 out of 17 non-leads agreed or strongly agreed with “I wish I had been chosen as team lead instead.” These students appeared to view the team lead role as a special honor that they would be happy to receive, but also happy to go to one of their peers instead.
3. *Students will be confused about what the “team lead” role entails.* We anticipated this difficulty, and so spent a good bit of time in the opening lectures emphasizing what a team lead *was*, and was *not*. This seems to have been effective: on the surveys, 19 out of 24 respondents agreed or strongly agreed that they understood the role of the team lead. We believe this clarity is essential to the concept, as we elaborate on below.

## FINDINGS

**Interpretations of the role.** As just mentioned, students felt fairly certain about how to interpret the team lead role. This was in spite of the fact that there was some obvious variation in how groups understood the concept. Most team leads played the role of an organizer: someone to take initiative, spur the team to action, and plan ahead. One student's survey comment is reflective of many: "A group lead's role is to start and maintain the group's momentum. He or she starts the conversation about meeting times and sharing emails/AIMS. He or she only assigns tasks if members are reluctant to account for all of them, but the group lead definitely keeps the group on schedule once the tasks are assigned."

The written survey comments reveal that most team leads did not view themselves as ultimately responsible for the project's success, any more than their teammates were. In most cases they did not feel compelled to act as policeman and "nag" their colleagues into completing their work, either: their role stopped at identifying the task and assigning it. There were some differences here, however, and a minority of team leads did feel responsible for following up on assigned tasks and pestering their teammates into completing them. On the other end of the spectrum, some team leads reported that their teammates were so self-motivated that they essentially never had to act as team lead at all: the team carried itself. One comment read, "It's a good idea to have a team lead. If the team works really well together and are all responsible workers, then the team lead can fade into the background and mostly operate on the same level as his/her teammates. However, if the team does not work well together, or is not always on-task and responsible, it is important to have a team leader who is officially tasked with getting everyone working and coordinated." The lesson we learned here is that a one-size-fits-all approach is neither desirable nor necessary. Most teams seem to be able to adapt the team lead role in a way that works best for them.

It is worth noting that one survey comment we received said the team lead concept "caused my team lead to do almost the entire project which was not appreciated." This was definitely not typical of the responses (only 2 of 17 non-team-leads reported that their lead "took on too much responsibility"), yet it does illustrate the possible ramifications of appointing an overzealous student as team lead. Although some flexibility in interpreting the role is advisable, instructors must caution students about the intended bounds of that role.

**Enhanced communication.** From the instructor's point of view, communication among team members was almost uniformly excellent throughout the semester, in situations where this is often a problem. Weekly or bi-weekly face-to-face team meetings were reported by 23 of 24 respondents. And in *addition* to those meeting times, students claimed very frequent team communications via a variety of methods: 21 of 24 met face-to-face with another team member at least weekly, 17 of 24 communicated via e-mail, 8 of 24 via online chat, and 11 of 24 via phone. Synthesizing these figures, it appears that most students communicated directly with their fellow team members about the project on the order of three times per week or more.

It is difficult to determine how much of this was influenced by the presence of the team lead, but anecdotally we can report that it seems to be an improvement over many teams (without leads) that we have assigned in the past. The students themselves noticed a modest effect. On the 6-point Likert scale, 11 out of 24 agreed that “having a team lead caused our group to communicate more effectively than we would have otherwise.” However, 8 students answered “slightly agree” to this item, which if included would raise the total to 19 out of 24 that agreed somewhat. It appears that the presence of the team lead has a beneficial though not decisive effect on the effectiveness of communication.

**Awareness of project status and tasks.** Student awareness and engagement in the project was excellent. Nineteen out of 24 respondents agreed or strongly agreed with the statement “throughout the semester I had a good idea of what specific project tasks still needed to get done.” And 23 out of 24 agreed or strongly agreed with “throughout the semester I had a good idea of whether anyone was waiting on me to complete a particular task.” We were very pleased with this result, since in the past we have often observed teams letting important tasks “slip through the cracks” because everyone assumed another team member was handling them. Indeed, our survey asked students directly how often an important task was inadvertently missed, and 18 of 24 respondents answered either “never” or “seldom.” We attribute at least some of this success to the presence of the team lead, who was to be actively aware of the project status and needs.

## **CRITICAL FACTORS FOR SUCCESS**

Finally, we comment upon several factors that seem to be essential for the team lead approach to succeed.

**Choice of team lead.** First and foremost is selecting an appropriate student to fill each team lead role. Students certainly appreciated the importance of this. One survey comment said, “The team lead needs to be the most motivated and motivating person on the team.” Another wrote, “I think the team lead really was successful and helpful for my group. However, I can see the possibility of poor leadership hurting a team. When it's all said and done I think groups need leaders and in general they function much better that way, but you'll have to accept the times when it does not.” Unfortunately we have no guiding selection principles to offer here; our only method thus far has been intuition. Surveys and personality indicators ([1, 4, 5, 6, 7]) may be of use in cases where the instructor is unfamiliar with the majority of the roster when the term begins.

We would also comment that approaching potential students privately at the start of the term and asking them to consider playing the role can be very helpful. We have found that students warm up to the idea this way. In one case, a student we approached declined the offer, which was of course beneficial in the long run and would not have happened had the choice been handed down as a mandate.

**Clearly articulating what “team lead” means.** We have spoken earlier about the importance of clarifying the responsibilities of the role. It seems especially important to emphasize these points: (1) the team lead is not expected to complete a larger share of the

project, (2) the team lead is also another developer who should play an equal (or close to equal) part in design and implementation, (3) the team lead is not appointed to make decisions by fiat, but simply to organize and frame communications.

**Counsel team leads on problematic team members.** There will inevitably be conflict in just about any group scenario; the trick is helping undergraduate team leads, who have little experience in their roles, to properly handle it. There is a delicate balance here. On the one hand, the team lead may need a confidant, knowing that the professor is “on their side” and will listen empathetically to complaints. On the other hand, too much of this camaraderie can lead to other teammates viewing the lead as a “tattletale.” This topic deserves far fuller attention than is appropriate here; our only advice is for the instructor to make clear to team leads that he or she is available to advise them on handling difficult situations.

**Be willing to replace the team lead mid-semester.** One student captured an important point: “I think it worked really well, but maybe it would be good to have an emergency option of making someone else in the group team lead if the current leader has extenuating circumstances that are making it nearly impossible to function as group leader.” Whether due to extenuating circumstances or not, there will be times when a team lead does not function effectively. The first choice in these situations is of course to counsel the team lead and encourage them to alter their behavior. But when the project appears to be in jeopardy because of defunct leadership, we believe it is occasionally wise for the instructor to step in and appoint someone else. This happened twice in our experiment, and in both situations the move seemed to be for the best and was accepted graciously by students. Obviously there will be times when the situation is not so cleanly resolved, but based on our limited experience we can recommend that a re-assignment at least be considered.

## CONCLUSIONS

Though not a panacea, assigning a team lead to small software development projects can alleviate some of the problems encountered by computer science undergraduates. The advantage seems to be in explicitly identifying and assigning what an experienced team would already realize they need: an initiator, organizer, and focal point for communications. Our experience shows that team leads and non-leads alike normally react well to the appointment, understand what it entails, and adapt it to best suit their own team needs. Nineteen of our 24 anonymous survey respondents agreed or strongly agreed with the statement, “it’s a good idea to have a team lead on a project like this,” which we believe validates the approach to a considerable extent.

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