

# Patterns of (Non)Interaction: CS Student Accounts of How They Actually Accomplish Group Assignments

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## Abstract

Group work is receiving increasing attention and support as a valuable component of computer science construction. Yet such work is at odds with the culture of programming, which emphasizes the importance of solo work and individual skills. This study interviewed 37 students enrolled in 3 mid-level programming classes to investigate more closely the patterns students adopt when completing group assignments. Responses illustrate tactics that allow students to complete group tasks but often maintain a reliance on individual accomplishment. Five patterns of communication behavior in student groups are identified for future empirical research.

## 1 Introduction

An emerging instructional theme in computer science and engineering is the ability of students to work effectively with their peers in small groups. The importance of group work to the various computing professions was noted as early as 1975 [1] and has been detailed in various case studies [4,6]. Indeed, in all sciences, expectations for collaboration and interdisciplinary work are increasing [8].

Recently, some attention has been given to the inadequacies of traditional computer science curriculum for developing in students skills of communication and interaction, essential for working with others. [7]. One step toward improving student competencies in group work has been to increase the number of student experiences with working in peer groups. Past several years of the proceedings are evidence, increasing number of faculty are assigning group work.

Some of these efforts, such as pair programming, structure the ways in which students interact to complete an assignment together. Many, however, do not. A common assumption is of a correlation between the spirit of an assignment and the actual practices used to complete the assignment. In other words, if a set of students is given a single project to complete for a single shared grade, the spirit of the assignment is that the students will work *together* as a group to complete the project.

Several factors work against this assumption. First is the attitude of the students themselves. The culture of computer science is highly individualistic and competitive [2]. Second, developing the foundational skills of computer programming seem well suited to solo activities. Computer science emphasizes structured processes, prefers low ambiguity, and values principles of 'good engineering practice' [2]. Students rarely receive formal or systematic training in the skills needed for effective group collaboration or teamwork. Finally, theory and research that has investigated the dynamics of small group behaviors points to the significant level of effort required for effective teamwork [5]. The ability to work with others consists, in truth, of skills to be learned systematically. We should expect that students, when lacking such skills or unwilling to put forth the required level of effort, will attempt to circumvent group work, despite the spirit of these assignments. Indeed, previous evidence we have collected indicates such circumvention to be likely [3].

If students do not complete assignments in the spirit of collaboration and teamwork, what do they do? This paper presents the results of a qualitative investigation of student attitudes and practices with regards to group work. The study is one part of a larger project that is developing a computer-based tool repository to increase the ability to introduce more complex tasks earlier in a computer programming curriculum. Researchers interviewed students in three mid-level programming courses offered through the computer science department at the University of Colorado. Data were collected for the following questions:

- Do students prefer working individually to working in groups? We expected that most students would prefer not to work in groups for course assignments.
- How do students organize their work in groups? We expected that students aim to reduce workload demands of the assignment, and to minimize the risks to success posed by depending on others.
- Do students see the ability to work in groups as a skilled competency?
- Do students perceive the ability to work effectively in groups as important?

Results confirm the assumption that student behavior in instructor assigned groups is contrary to a spirit of interdependence and collaboration. At the same time, students believe group work to be important for them in terms of succeeding in a computing profession.

## 2 Methodology

Students enrolled in three mid-level courses (Data Structures, Programming Languages, Honors Programming Languages) in an undergraduate computer science curriculum were targeted for participation in this study. Students were enrolled in these courses during the Spring 2001 term, at the University of Colorado. Through a random selection process, 60% of approximately 200 students were sampled and contacted for a 45 minute interview. Responses were received from 37 students, who were interviewed for this study

A member of the research team with no connection to the computer science department conducted the interviews. Interviews were scheduled at the students' convenience, and all were held on campus. In order to ensure confidentiality and candid answers, the interviewer made clear to the students that the course instructors would not be informed of which students were contacted for the study or which responded. Nor were results of the interviews shared with the instructors until the term was completed.

Interviews used a standard but open ended protocol covering various issues concerning educational and professional background, study habits, reactions to elements of the class and the curriculum, and preferences for working with others. Questions concerning group work asked students (a) whether they had previous or current experience with completing course assignments in small groups, (b) whether they would choose to work in a group if given that choice, (c) whether they thought it was important to learn skills for working in groups, and (d) where in the curriculum they thought group work was appropriate.

Interviews were audiotaped and transcribed. Analysis proceeded qualitatively, using inductive procedures for

discovering themes and patterns within student responses. A qualitative approach was chosen because it best meets the objectives of the study. First, our desire was to explore the actual practices used by students in conducting group work, rather than determine whether students used particular practices identified a priori. Patterns identified here may be useful later as a categorization scheme. Second, the core of the study is to check, empirically, certain core assumptions being made in our larger study as well as by other efforts to promote increased levels of group work within the computer science curriculum. Correspondence between the researchers' and subjects' views would support the validity of these assumptions.

## 3 Results

Only two respondents indicated no previous experience working in groups. A few respondents described experience working in groups in industry, but most were limited to their experiences in school. Overwhelmingly, these experiences with group work were informal and unstructured, occurring in shared learning spaces such as computing labs. In these situations, respondents described asking other students for advice on intractable problems, or otherwise discussing course assignments that instructors had not intended as group work. Less than a majority of the respondents described experiences in formal group assignments.

Respondents generally were equivocal when asked if they would choose to work in a group if given a choice. Approximately 25% indicated they would not choose to work in a group. Yet most of these did admit that they may need to work in groups in industry. A smaller number of students were enthusiastic about working in groups if given a chance. The perceived advantages were to improved quality of the product, and greater satisfaction ("fun") in the process.

Most students responded that their choice to work in a group depended on other factors. The two main factors identified were the nature of the task and the abilities of the other team members. Group work was justifiable if completing the task individually was not possible or clearly not as effective. That is, presumption was given to working individually. Further, group work could be tolerated if it would not be a burden or would not stand in the way of individual accomplishment. This became particularly clear as students accounted how they (1) believed solo learning had to be prior to working in groups (not seeing the possibility for learning to take place in groups) and (2) saw the tasks related to group work as being tangential or otherwise not related to the substance of the course. A clear theme was that respondents viewed coding and programming as solo activities. Essentially, they did not see the sense of programming in groups (the

exception to this was pair programming, which was offered as an option for student work in one of the sections).

Results confirm our expectation that students generally prefer to work solo rather than with others. Our more specific interest was discovering patterns of behavior that students exhibit when required to complete assignments with others. Data suggest the existence of four distinct patterns of behavior. Given this small size of the sample, we recognize we cannot make claims regarding frequency of these patterns in relation to one another. We offer these as an initial list of categories, useful for later empirical investigation.

In three of the patterns, students work together to complete the task. Pattern I is *collaboration*, represented by a recognition of the interdependence among the group members, by interaction during the accomplishment of group work itself, and by the pooling (rather than the segmentation) of abilities. As described by one respondent:

“Tasks, division of tasks, it’s a lot and also you have someone there to bounce off your ideas of how you are going to design the program. Two brains are better than one because one will say, oh, while you’re designing this, but you have to remember this. And then you’ll say that’s right, and then we go and add a node. And I think it’s much more efficient.”

The next two patterns maintain the involvement or responsibility of all group members in accomplishing the task, but they do not conform to a spirit of collaboration or of learning from interacting with others. Pattern II is *sequential segmentation*, in which groups break up the assigned task into parts that are then completed sequentially by solo efforts, accumulating into the final finished product. A respondent related:

“The most common way we break up work in the group at school is that we would only work on one piece at a time. I’d take it for a couple of days and fix part of it and then we would meet back up and say, okay, I’ve done this, and the next person would take it home and work on part of it.”

Pattern III, *parallel segmentation*, is almost identical to II. Here, segments of the tasks are completed at the same time by various group members working solo, and all parts are assembled at the end to form the finished product:

“... if you get three or four people and you have to get this project done, unless you divide up the work equally, like if you said, ‘you get this half of the program and you do this half of the program,’ and most of the time for school programs it doesn’t work real well because this program is supposed to do one thing. So it’s kind of hard to do collaborative programming.”

In the last pattern of behavior, the task itself is transformed or redefined such that a group task transforms to an

individual task. Pattern IV is *natural selection*, in which group members agree to allow one person to take on the responsibility for the group. Students attributed this to significant discrepancies among the abilities of various group members. One student described an experience of being the member selected to do the task:

“It was more they would say they didn’t know how to do this, do you have any ideas, and I would say, well, we can do it like this. So it was more and more, you know, toward the end of the semester, I was just saying, well, let’s do it this way and get it done.”

Another described the experience of being ‘selected out’:

“You know, I find there’s really quite a gap between my ability and most of the students, so I feel embarrassed in a group, that I’m not contributing. Or, you know, it’s just it becomes clear you’re not a contributor and then the efficient thing to do is to get somebody else to do it, and you just don’t get the experience of doing the work.”

#### 4 Analysis

Results suggest that interaction processes vary among student groups in some significant ways. Groups are not uniform in the way they approach task work, nor can the differences be attributed simply to any one factor (such as ability or motivation). Rather, students do approach group assignments in a rational manner. One contribution of this study is that it begins to unpack these variations. The results also instruct us as teachers to be more careful and precise in what we expect group work to look like on the behavioral or interactional level; are we concerned simply with introducing students to the idea of depending on one another, or do we wish for students to engage in some specific type of interaction as they work together?

The results also challenge our assumption, strongly represented in the literature, of the dichotomy between individual and group work. This is perhaps a false dichotomy. Rather than seeing student behaviors in patterns II, III, and IV as the circumvention of true group activity, the patterns indicate that students are consistently rational and focused on task completion. Students may not respond appropriately to the assignment, when viewed from the instructor’s goal of improving student ability to work in groups. However, they do respond appropriately to the requirements of the task, given the nature of the available resources, in particular the collective abilities of the group members.

#### 5 Conclusion

Student behavior in working with others on shared work assignments varies considerably across groups. Self-reports reveal that students actively avoid working together to complete group tasks. The assignment of group work

may be insufficient for ensuring that students receive a genuine collaborative or even interactive experience. This study sheds light on why group assignments may fail in computer programming courses, and suggests specific patterns of interaction to be investigated in future research.

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