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Student Culture vs Group Work in Computer Science *

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ABSTRACT

The feedback we get from business professionals is that although our students are competent technically, they are lacking in crucial teamwork abilities. Adding more project-based classes and mandating collaborative homework has not solved the problem. We need substantial curricular adjustments to remove the impediments to cooperation that were discovered in an in-depth analysis of the Computer Science student culture.

INTRODUCTION

Companies have complained for years that our graduates, despite their technical proficiency, lack the interpersonal and teamwork skills necessary for employment. At first, we tried to address these concerns by instituting project-based learning and making group projects mandatory across all disciplines. Unfortunately, the situation did not improve after the adjustments were made. The same complaints are being voiced by business leaders, and there is evidence that students are becoming less technically proficient as they rely more and more on the work of their peers to pass their classes.

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At first, we offered a technological fix in the form of a system to aid in the development of fundamental abilities necessary for productive group work [8]. Our goal was to create a system wherein students may be assigned to a simulated large-scale project in an effort to limit their reliance on their classmates. At first, each student would create their own unique module and integrate it with preexisting code written by the teacher. As time went on, students were left to depend on student-created modules instead of the instructor's original code.

We began conducting ethnographic observations and in-depth interviews with students in three undergraduate courses (Data Structures, Principles of Programming Languages, and Introduction to Compiler Construc- tion) to establish a benchmark against which to evaluate the system's impact. Based on what we discovered, we started to wonder whether a purely technical approach might be more suitable. Students already had a predisposition toward working together, and the tasks only served to cement that view. Avoiding reinforcement and instead working to lessen prejudice were essential steps in helping students develop more effective group work abilities.

We begin our study by making some general remarks on group work and the importance of collaborative competence, which is the missing component according to our advisory boards. The results of our investigation on the current student culture are then presented. These demonstrate a profound prejudice towards teamwork, which cannot be remedied by just offering group work chances. We conclude by outlining three initiatives that have helped us enhance academic cooperation via the introduction or adjustment of new practices.

STRATEGIES FOR TEAM PROJECTS

When a team is tasked with doing something, they might choose one of four common approaches:

It's segmented sequentially, so I work on it for a time and then give it to you.

We divide it up into parallel segments, and each person is responsible for a different one.

We all do it and then choose the best outcome or we pick the best individual and let them do it.

We are working together on this, and our communication is constant.

In the first three scenarios, everyone is basically on their own. Our children enjoy independent work (Section 3.1), thus whenever they are

When assigned a job, individuals will use one of these three strategies whether or not the instructor intends for them to do so. They argue that it is irrelevant how things are accomplished. The quality of the solution is evaluated based on how effectively it addresses the issue.

One of our coworkers said, "In my experience industry uses parallel seg- mentation, so why are you worried about improving collab- oration?" when we tried to convey this to him. Technical prowess will triumph over all other strategies except teamwork. Our boards of directors believe our students are ready for the technological difficulties that lie ahead. Therefore, if our coworker's observation were right, we wouldn't be receiving feedback from business regarding students' inability to collaborate. As described in Section 3, the findings indicate that the area of weakness is in the field of cooperation.

A lack of collaborative abilities manifests as a "inability to work in groups" since cooperation is essential to the achievement of any of the four group strategies. In the first three, the group must decide (or be told) how its individuals will function independently. This strategy will fail if that consensus isn't reached (or imposed).

Collaboration is valuable because it helps people avoid the third level of ignorance [2]: It's a method for learning new information that no one knows they don't know. The inability to adequately explain a project means that, while working alone, each member of the team may encounter challenges. Working together, we can fill in the gaps and make sure everyone has the same understanding of what has to be done.

Collaboration in class discussion groups is another great way to practice critical thinking skills. Members learn from one another and get insight into other points of view and ways of thinking. They gain the ability to make sound decisions faster and with more consistency than those who study the same information on their own [1].

Therefore, it is in our best interest to enhance the collaborative abilities of our students, even in the absence of pressure from our respective industry advisory boards. Hear the words of one Intro to Compiler Construction student:

Having worked with various compiler tools in the past gives me confidence in my knowledge of the subject matter, but my other students will be the ones to assist me succeed academically. I depend heavily on the four or five individuals who can be counted on without fail to do a task as a group. Without them, I wouldn't be able to succeed in class.

CULTURE AMONG STUDENTS

According to the definition given by [author cited], an occupational community is "a group of people who consider themselves to be engaged in the same sort of work; whose identity is drawn from the work; who share with one another a set of values, norms, and perspectives that apply to but extend beyond work related matters; and whose social relationships meld work and leisure" [13]. According to this definition, it is clear that college students are part of a professional community

Work cultures, including task rituals, behavioral expectations, and routine work practices, are developed and maintained through communities of practice. Obviously there is a cultural mismatch [5]; if the atmosphere of computer science students encouraged teamwork, we wouldn't be hearing that our graduates are lacking in that area.

Effectively addressing this mismatch requires familiarity with the culture that distinguishes the students' occupational community [15]. Over the course of our three-year experiment, we put trained ethnographic observers in two classrooms every semester and conducted over 130 interviews with students. All of these responsibilities were handled by research assistants at the Department of Communication who are not affiliated with the CS De- partment, and participants' anonymity was guaranteed at all times.

Our interviewers used a predetermined process to learn about each student's computing history, employment experience, perspective on group projects, and overall academic approach. The interviewers asked the students open-ended questions and gave them room to elaborate. Between 45 minutes and 2 hours were devoted to each interview. The method of analysis was based on a modified version of Bantz's [3].

The interviews and observations have shed light on the students' underlying occupational community practices. Important conclusions are summarized here; for a full study, please refer to [12].

Preferring to do things by yourself

The vast majority of our survey's respondents said they prefer to crank out projects alone. Their main argument was that they deserved all the credit for their efforts and none of the blame. This is crucial since each project is treated as a "product" [6]. This is your chance to show your professor that you've got what it takes to obtain the "right" answer and, in turn, a decent mark.

Neither exposure to teamwork nor professional background had a role in explaining the preference for solo effort. Although participants' desire for autonomy over their work was the most often cited reason for avoiding group projects, other reasons, such as avoiding interpersonal issues and needing to drag along less capable group members, were also highlighted.

Given the significance of a student's GPA in campus life and its usage as a first filter by businesses seeking interviews, this behavior is not unexpected. Procrastination

Every single kid shared a tale of procrastination on schoolwork. This practice was often framed as a strategic gamble, in which the person purposefully delayed getting started on the task but ultimately triumphed over it due to their superior skills. Many of the unsuccessful outcomes in the tales had a similar thread: the student had overestimated their competence or misjudged the enormity of the work at hand, both of which contributed to their procrastination.

Participants could not offer a coherent rationale for their procrastination, despite the fact that there are advantages beyond the satisfaction of "pulling it off": Peers who have already attempted the task may be able to provide more insight, or the instructor may provide some helpful pointers in response to queries asked during class. A shift

be made to the task itself, rendering previous efforts useless or obsolete.

When people put off working together, it's because they don't want to take the time to talk to one another.

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Experimentation

The kids' attitudes about their homework were another frequent theme. Most students didn't bother to listen to their teachers when they said they should attempt to define the issue before looking for a solution. The kids often used the phrases "diving in" and "tinkering" to describe their approach to homework.

The amount of "patterns" a person has at their disposal is the defining element, according to a thorough survey of programmers across all stages of development [10]. In this way, an expert may perceive an issue as a sorting assignment, whereas a beginner may merely see a set of facts that has to be summarized. Taking this into account, the "tinkering" routine is typical of most forms of schoolwork: It is unlikely that a student would have relevant patterns previously established before being given an assignment since it would defeat the purpose of the exercise. Due of their inability to see patterns, individuals can only get a true comprehension of the issue by working to resolve it.

Group discussion is a strategy that may be utilized to increase the amount of patterns at one's disposal since each member of the group offers a unique set of patterns to the discourse. The pooled expertise of the group may help choose where to focus studies for maximum effect. carelessness with procedure

The kids generally did not care about procedure. They believed that all procedure was established by the faculty, rather than being generated by individual assignments. They had no qualms about disregarding it, justifying their decision by saying that their independence gave them more options for dealing with the issue. They felt they could maximize their time and effort on the task and earn the greatest possible mark as a result of this leeway

Students are correct in their assessment that much of the work they are given may be accomplished without any knowledge of the steps involved. It may take more time to finish and the output may not be of the finest quality, but frequently the differences are negligible enough that mastering the process does not seem to be worthwhile. The fact that students see their homework as a product rather than an opportunity to learn has intriguing repercussions.

When everyone has their own opinion about the best method to get things done, collaboration becomes challenging.

Combativeness

The vast majority of computer science majors openly express their beliefs and dismiss those of their colleagues. According to their accounts, individuals find it far simpler to grasp the course materials than their peers. Words like "challenging" often pop up in their descriptions of past projects. As for how their classmates feel about the identical tasks, they use terms like "difficult" to describe it.

Working in isolation may lead to such actions. Everything is clear and straightforward, or so it seems

because one's own perspective is so limited. Unfamiliar and confusing concepts are dismissed as irrelevant. Since there is nothing upon which to agree, teamwork is challenging; conversations resemble the six blind men and the elephant.

Reluctance to help others

There was a lot of discussion on individuals' experiences of being rejected or unable to get the technical and emotional help they needed from classmates or teachers. We found no differences in this pattern of behavior based on gender.

Arguments like "if I help them, they won't get the benefit of working it out for themselves" are used to justify a lack of assistance. Explicit plagiarism rules that attempt to establish limits on collaboration and enforce them with severe penalties facilitate this practice. According to our findings, such regulations are equally significant in forming a preference for solo employment.

Refusing to supply or enable supportive behavior is detrimental to teamwork since it is such a crucial aspect in achieving team success [11].

A lack of enthusiasm Our data did not reveal any overarching interests among the participants, although this might be related to the nature of the classes we examined. The faculty sees the sophomore-level course Data Structures as a chance to teach the student more advanced programming concepts and to familiarize them with fundamental data structures like stacks, queues, and trees. The required course Principles of Programming Languages introduces students to the fundamentals of programming language design, with the goal of making it easier for them to learn new languages or choose the best language for a given problem. Students in the fourth-year optional Introduction to Compiler Construction apply what they've learned about languages to the process of creating a compiler from scratch. Students don't appear particularly interested in any of these classes; rather, they consider them as necessary evils on the path to graduation.

Working together may be challenging, particularly in the outset. There were several accounts of students' group efforts being ruined by interpersonal conflicts. Without a common drive, it's tough for a team to overcome obstacles like these.

INSPIRING TEAMWORK

We need to alter certain features of the kids' everyday environment if we want to see an increase in their capacity to work together effectively. Neither a course in group work nor instructions to tackle an issue

collectively will do this. This can only be achieved by mastering the en- culturation process and creating circumstances that encourage the growth of a cooperative culture.

Here, we'll go through the three interventions we've used most effectively with the children to shape their enculturation.

Talking it out in the classroom

As mentioned above, the majority of students preferred working alone due to the fact that group projects required them to delegate responsibility. As Bruffee [4] explains, that aspect of collaboration, and points out that collabo- ration also forces one to *accept* authority over the work of others. Students must be shown that collaboration offers advantages over working alone that outweigh the perceiveddisadvantages of yielding authority and accepting it.

Professors' behavior is an important component of the enculturation process, and thus professors ought to use a collaborative approach to the curriculum if they want the students to take collaboration seriously. The *conversational classroom* [14] is a strategy for demonstrating the advantagesof collaboration.

In the conversational classroom, the professor facilitates a discussion of the material relevant to a particular class ses- sion instead of giving a lecture over that material. Thus the professor is yielding authority over the flow of information to the students. They must accept this authority by preparing carefully, contributing to the discussion, determining how deeply to explore each issue, and deciding when to switch topics.

We have used the conversational classroom technique very successfully with classes of 80-120 students. Relative to tra- ditional lectures, it has improved students' performance as well as improving their collaborative skills. We have ob- served an increase in effective use of study groups by partic- ipants, and increased willingness to take part in classroom interaction in other classes.

Group decision-making

One of the recurring stories told by students to illustrate why they don't want to work in groups is the "failed deci- sion": The group talks around and around a question with- out coming to any conclusion and finally the narrator gives up on the group and solves the problem independently.

Two characteristics of the students' occupational commu- nity, their bold display of their own opinions and their willful disregard of process, play into this scenario. Because each participant is advocating their solution and disqualifying the solutions of others, little consideration is given to the criteria on which the decision should be based. Processes for effec- tive group decision making are available, but the studentsdon't believe that process is necessary. We need to change that perception.

After several unsuccessful attempts, we have developeda viable group decision making exercise illustrating the ef- fective use of process in a situation where that process is dictated by the problem. This exercise helps the students to move away from their insistence on individual freedom in all cases.

If you want to make a point, choose a problem that has nontrivial options and a wide variety of criteria. It is also crucial that the choice has real-world consequences for the students' progress in the course. Finally, students should have an opinion going into the activity. (This allows us to compare and contrast Section 3.5's standard emphasis on results with an alternative emphasis on criteria.)

Our group decided to tackle the issue of choosing an abstract syntax tree (AST) for a compiler development project. This tree serves as the primary data structure for all of the calculations necessary to carry out semantic analysis and translation. The difficulty of such calculations and the availability of standard modules are both functions of its structure. The whole class had to reach a consensus on this, and they all had to

focused on a single AST that would serve as the foundation for all of their future work.

Each student was then requested to give a specification of an AST for a language they were unfamiliar with after they had acquired expertise with semantic analysis. All pupils had access to these suggestions. The assignment for this week required students to utilize the tools [9] to construct a tree construc- tor based on one of the offered trees (either their own or someone else's). The pupils could now make a decision based on sufficient data.

During the next class time, an outside facilitator led a group discussion in which the students and teacher collaborated to establish criteria for selecting an AST. It's important to note that the topic of debate was not the selection of a tree. The purpose of this activity was to demonstrate that the factors used in making a choice are crucial. These standards were derived from course material and were applied to the task of choosing an AST.

The criteria established during class were input by the facilitator into a web-based decision support system [7] after class ended. Each student then had two days to submit a weight for each criteria that reflected their own personal assessment of the weight that criterion should be given in making the decision. They were also asked to rate how well they thought each of the suggested trees met each of the requirements, and to record that rating as a numeric value.

After the evaluation period ended, the best-performing tree was chosen by the decision support system to serve as the foundation for the compiler the students would develop over the rest of the semester. In light of new information, modifications to the tree were allowed provided they were supported by a majority of participants and would improve the tree's rating on the agreed-upon scale.

Decreasing Value of Assignments

Students often request heavier workloads on the grounds that their current tasks "take so much time" to complete. It seems to reason that anything is a product if its importance in the overall grade increases in direct correlation with the amount of effort invested in it. Professors emphasize the importance of assignments in determining a student's overall grade because they perceive them as a product.

The professor's tendency to deliberately discourage student cooperation increases when assignments have a heavy weighting. There is concern that if collaborative tasks are strongly weighted, less competent students will be able to coast through with the help of their more capable peers.

In response to these issues, we have reduced the assignments' relative importance in numerous courses. No adjustments were made to the actual assignments as a result of this shift. Instead, we've put a lot of thought into making it clear on the course websites and in class that the assignments are not considered final products and that their main purpose in carrying any weight is to motivate students to complete them.

The learning goals for each assignment are outlined, and the "background" section provides links to relevant literature and summarizes any relevant prior knowledge. procedure brought on by these kinds of issues. Including questions regarding intermediate outcomes helps ensure that the learner is following the correct procedure. Assignments are due every week to prevent students from putting them off. (It helps them find a routine for organizing their time.) Deliverables are required every week for longer projects. We define the term "orders of ignorance" [2] and argue that homework helps students become aware of concepts they don't yet fully grasp. Although we don't make it mandatory for students to work together on most assignments, we do stress the importance of teamwork and encourage them to do so. We discuss how little the assignments really matter in comparison to the time that students spend on them, drawing parallels to time spent reading, in class, or in the professor's office. Due of the lightness, students are encouraged to experiment with new methods, with nothing to lose if they fail.

This tactic has met with considerable success. Students still spend a lot of time in the lab, according to interviews, but they frame their experiences there in terms of learning rather than clock time. In spite of the fact that the majority of the grading relies on an individual test [14], average marks are higher due to the substantial cooperation that extends from assignments to study groups.

11. CONCLUSIONS

Improve students' ability to work together productively is a goal shared by educational researchers and the members of our industry advisory boards. Initially, we tried implementing group projects and assignments in response to employer concerns, but we still received complaints.

Task rituals, behaviors, and work norms have been uncovered via in-depth analysis of our students' occupational community's culture. methods that work against teamwork. Normal classroom practices, such as lectures and homework, tend to reinforce these inhibitions and make it hard to break the cycle.

In this research, we provide three overarching recommendations for enhancing students' enculturation via group work:

Having less formal lectures and more informal discussionsIntegrating teamwork practices into technical tasks

Seeing tasks as learning opportunities rather than final goods

Professors, it seems, can no longer act as if they know everything. Professors should function as conversation facilitators and sources of knowledge in both factual and process areas after giving a syllabus outlining the structure of the content and suitable readings and a set of assignments to provide the students the required experience. Our longitudinal research demonstrates that, despite students' initial resistance, these methods ultimately result in improved academic outcomes and higher levels of student satisfaction. The resistance to them lowers and the advantages accrue sooner in a course owing to carry- over from prior courses as students who have experienced them go through the curriculum.

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