Strategies for Effective Group Project-Based Courses

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The Traditional Classroom

- We are all familiar with it.
- It involves: whole-class instruction, recitation, homework problems, quizzes, tests
- That is the way we were taught and the way we assume teaching is to be done.

The Work Environment

- Companies typically organize employees into project teams with team leaders.
  - The teams meet and discuss their tasks
  - Then break the problem into parts.
  - And interact throughout the design and implementation to arrive at a total solution

- Each worker has a value to the company according to one’s productivity in such an environment.
- Quite different than the classroom environment.
- According to companies that interview on campus, they prefer students who have exposure to group work.

Overview of where we are going.

- How we are implementing group projects in certain courses.
- We present some problems and pitfalls encountered along the way
- Conclusions and Future Work.

Our First Project-Based Course

- CS 426 -- Senior Projects
  - *Supervised group or team projects with emphasis on implementation of engineering design.*
- Started when the department was created.
- Over the years it has been integrated with Software Engineering into a year long sequence.

- Initially:
  - The groups were selected by the students, and
  - the project was identical for each group
    - This allowed the instructor to interact with and monitor the groups very easily.

- Now:
  - The groups are still selected by the students
  - and the projects are selected by the students
    - But this must be done very early to allow the design process in Software Engineering enough time.
    - Therefore, the professor has several hand for those that can’t make up their minds on what to do.

The Next Step

- The trend has been toward more group projects in graduate courses.
  - Part of this comes from the need expressed by employers.
  - And part from the fact that the projects can be larger and more meaningful (therefore more educational).

Graduate Courses

- Modeling and Simulation
- Genetic Algorithms
- Neural Networks
- Fuzzy Systems
- Advanced Operating Systems
- ...

- A purely hands-on course is usually not sufficient.
  - So Lectures must cover the basic theories, methodologies, and derivations of equations during the first half of the course.
  - During this time the students plan their projects and contemplate which methods to use.
    - This places them in some interesting problem solving situations, since there are times where multiple methods may be equally valid.

Mixed Graduate/Undergraduate Courses

- Artificial Intelligence
- Compiler Construction
- Image Processing
- Internet Programming
- Operating Systems
- ...

Projects in Undergraduate Courses

- There are several things we learned while integrating group projects into undergraduate courses that are different from graduate and mixed courses.

- These relate to the setup and initialization of the project and the group.

- Typically projects in these courses are smaller, in both scope and time requirements.
- Therefore, these projects must be more structured removing a lot of the preliminary decision making from the students.
- Let’s look at some examples.

- In our CS I and CS II courses there is a 3 week project at the end of the semester to tie things together.
  - CS I -- the project is individual (get the students used to projects)
  - CS II -- it is a small group within the same lab. (get the students used to groups)
- But because these are large lectures, everyone is given the same project.

- In Programming Languages the students are given more flexibility.
  - They can choose their own project as long as it covers some topics given by the instructor.
- This class has also integrated more accountability than the Graduate Courses.
  - Bi-weekly milestone reports.
  - Individual reports at the end of the project.
    - Covers the amount of work done by yourself and all the other team members.

- Other Instructors have assigned group roles to assist training the students to work in groups
  - Team Leader:
    - Planning meetings, directing discussion and research
  - Team Administrator:
    - ensuring that timetables are met, typing the reports, handing in the completed project.
  - Team Critic:
    - editing reports, critiquing the logic, and ensuring the reasonableness of the conclusions.

- Some professors have brought in professors from the psychology department
  - to discuss group dynamics and problems that can develop in a group.
- The students then use this information
  - to designate the group tasks for each member
  - as well as dealing with problems within the group.

Crucial Issues

- From both the Instructor's and Student's perspective:
  - Selecting the group size
  - Selecting the groups
  - Selecting the project topic(s)
  - Coordinating (monitoring) the tasks
  - Doing the project
  - Writing it up and presenting it

Some Problems

- Conducting project-based courses can be difficult your first few times. Because the problems that arise are different.
- A group cannot agree on a topic (or maybe just how to implement it)
- They don't get started until it is too late.

Some Problems (cont.)

- A Group has personnel problems and can’t work together.
- One (or more) member is not contributing
- A Group’s final project will not work.
- ...

Dealing with Problems.

- When you begin, you can limit the problems by eliminating the options, similar to the way we have done in our Undergraduate courses,
- But as you expand there are thing that you can do to help limit the problems that arise:

- Project Proposals.
- Times set aside for faculty to meet with groups (intermediate reporting)
- Student Self-evaluations and Team member evaluations on the project
  - Sometimes they are done more often than just at the final.
  - Always announced at the beginning of the project.
- Sometimes you have to break up groups.

Results

- Probably the most interesting thing that we have seen from the use of group projects is the effects on outcomes other than achievement:
  - friendship and interaction among students
  - self-esteem, academic self-confidence
  - attitude towards the class and instructor
  - ...

Conclusions

- Group learning methods have achieved some impressive results.
  - Do not view it as a wholesale replacement of the whole-class instruction model we have used in the past.
  - But instead a variation to it that is interspersed in the beginning courses while the core knowledge is being learned
  - And a major tool for application of knowledge in advanced courses.

Conclusions (cont.)

- Cooperative learning may be more feasible and valuable in certain classes than others.
- But all students need to be trained how to
  - share
  - listen
  - integrate the ideas of others
  - and handle disagreements.