Effects of Classroom Structure on Functional Role Specialization in Engineering Classrooms

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Introduction
Recent calls for engineering education reform have been targeting promotion of student interest, engagement, and retention. (ASEE, 1996) As a result, multiple engineering programs have restructured certain key aspects of their curricula to include Project-Based Learning (PjBL) (Richardson, 2002). However, the specific structure of a PjBL experience plays a major role in determining student perceptions of course goals, which then influences students’ goal orientations (Harmon, James, and Bryant, 2007) and role specialization among group work environments.

Research Questions
1) How do students’ perceptions of the course goals influence roles and task differentiation within collaborative work environment? 
2) What factors of the classroom environment influence these perceptions?

Methodology
• Part of larger mixed-methods study.
• Data Collection: Purposive sampling (Patton, 1990); Semi-structured open-ended, 1 hour interviews.
• Study Population: 2 small technical undergraduate institutions – Tygon and Liger College, 12 first year engineering students from each college.
• Data Analysis: Grounded Theory (Glaser and Strauss, 1967)

Course Description

Tygon Design
- Class Structure: Projects in groups of 2-6 students
- Machine Training: None
- Influences on Team Assignment: Student interest and feedback from previous group work
- Project Clients: Fourth-graders
- Assessment: Letter grades
- Faculty Intervention: None

Liger Design
- Class Structure: Individual and group project (group of 4 students)
- Machine Training: Basic
- Influences on Team Assignment: Student interest and balanced gender ratios
- Project Clients: Not-for-profit organizations
- Assessment: Pass/No Record grading
- Faculty Intervention: Continuous throughout semester

Client
• "It'd really like to get a working prototype just because we're doing it for someone in need. And she intends to use our prototype instead of, maybe, giving it to them and then manufacturing it. She actually plans to just use our prototype for things." - Kyle
  - Students express excitement about designing for people in need (Intrinsic Motivation)
  - Some students report anxiety about fact that product will be used (Performance-Avoid Orientation)
  - Many students focus on producing excellent prototype (Performance-Approach Orientation)

Assessment
• "I make sure we have meetings in the week so that we can work on things we need... We have deadlines, we have to have a presentation... And basically do things step-by-step, along the design process, so make sure we don’t miss anything. Because apparently following the design process is a very big part of our grade on this project, so we need to make sure that we do things right like that." - Betty
  - Students seem to follow certain steps only for the purpose of getting a certain grade (Extrinsic Goal Orientation)
  - Students express anxiety about attaining good grades and wish that the evaluation were less harsh (Performance-Avoid Orientation)

Faculty Intervention
• "...we needed to work in the workshop to cut wood and stuff... I don't know how to use the machines, and I don't really want to. The guys [...] were doing it, and me and the other girl were working on the tech report, and she female professor came up and said: 'If you know you don’t have to work on the tech report if you’re girls.' I actually thought about it before, [...] I really didn't want to work on the wood stuff in workshop." - Lorene
  - There is only one reported faculty attempt to intervene in the gender role assignment within group work environment.
  - Being passive, this intervention did not succeed in changing the student's behavior.

Discussion and Recommendations
Our analysis of the Engineering Design classroom structures at Liger and Tygon College indicates that the specifics of PjBL implementation affect student perceptions about the courses. We determined the aspects of each course that shaped the way students approach their own learning. At Tygon, having a not for profit client seemed to be positively correlated with development of intrinsic motivation towards a project while at the same time turning students towards a performance-approach orientation. At Liger, the task of designing for a general user group allows students to focus on the design process. More notably, the course assessment methods significantly influence development of student goal orientations while the faculty interventions, or lack thereof, may play a role in shaping student role specialization. We recommend that institutions seeking to incorporate PjBL into their curricula consider the ways in which the instructors assist students and aid the shaping of their learning goals to maximize student motivation and retention. 

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