Collaborative Learning in STEM Positively Impacts Student Outcomes

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Introduction

Collaborative learning is an interactive pedagogy shown to improve learning and reduce failure rates among undergraduates in STEM courses.[1] The structure of this approach can vary greatly, as courses can devote any amount of class time to collaborative learning. Collaboration with classmates can influence a student's perception of their learning environment with implications for their pursuit of a discipline.[2,3]

Over 850 undergraduate students across STEM classes at Duke were surveyed to investigate the intersection of structure, course-related attitudes, and identity. Preliminary data suggest that students in courses with more collaborative learning perceived higher motivation, interest in STEM, and sense of belonging. This has implications for improving student retention rates and leads to further discussions on innovative techniques for more inclusive classroom environments.

Methods

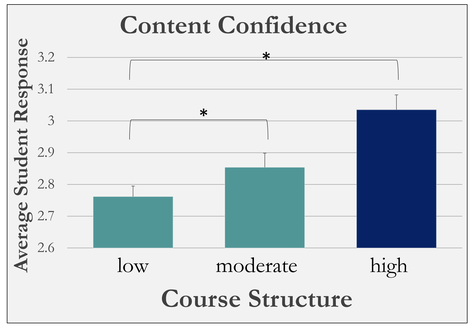
- **Sample size:** 51 courses, 889 Duke students
- **Measures:** student perceptions of course structure, course-related attitudes, and learning outcomes
- **Analysis:** ANOVA with Tukey post-hoc tests

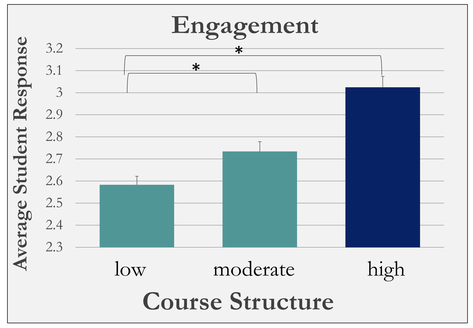
Structure is defined as the percentage of time students spend talking in class (Table 1). White and Asian students are classified as well-represented in STEM fields, and Non-White/Non-Asian students are classified as underrepresented in STEM fields.

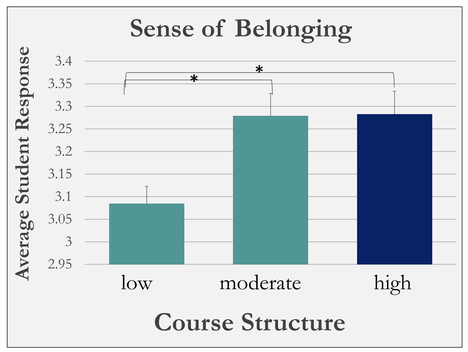
Table 1: Course structure attributes (Eddy & Hogan, 2014).

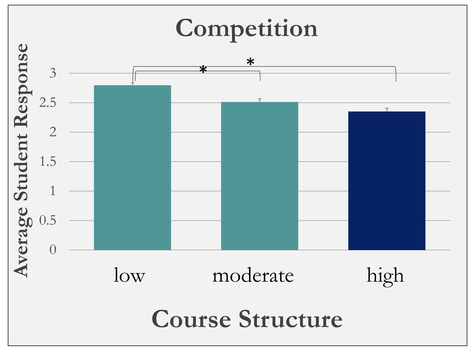
Structure	Percent of time spent talking in class
Low	<15% of course time
Moderate	15-40% of course time
High	>40% of course time

Effects of High Structure on Outcomes









* p-value ≤ 0.001

Table 2: Higher structured courses increase students' desire to **retain a STEM major**, especially for **underrepresented students**.

Desire to Retain Major	Ethnicity and Course Structure								
	--White/Asian--			--Mixed Race--			--Non-White/Non-Asian--		
	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
Increased	91	62	**57**	15	7	**12**	27	11	**12**
Decreased	37	18	**7**	6	2	**1**	10	2	**1**
Unchanged	201	89	82	25	16	8	32	21	17

Table 3: Higher structured courses increase students' **self-efficacy**, especially for **underrepresented students**.

Self-Efficacy	Ethnicity and Course Structure								
	--White/Asian--			--Mixed Race--			--Non-White/Non Asian--		
	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
Increased	149	85	**84**	20	9	**13**	30	19	**21**
Decreased	101	30	**13**	16	8	**4**	27	5	**1**
Unchanged	79	54	49	10	8	4	12	10	8

Results

Students in classes with high structure reported the following:

- **Higher levels of engagement**
- **Learning more factual knowledge**
- **More confidence in content knowledge**
- **Greater ability to apply, analyze, & synthesize knowledge**
- **More belonging & greater sense of community**
- **Lower sense of instructor support**
- **Increased levels of stress**

Self-efficacy also became higher for both under-represented and well-represented students (Table 3).

Discussion

Our study investigated the impact of collaborative learning on students' perceptions of their classroom experiences. Pressures among students taking STEM classes cultivate a palpable level of anxiety. This can reduce enthusiasm and engagement, negatively impacting retention rates. Adopting collaborative learning can **alleviate these stressors** and foster a more positive classroom environment. Collaborative learning has the potential to **reduce achievement gaps** and **increase self-efficacy** for underrepresented students in STEM.

Motivation, a greater sense of belonging and higher confidence in learning course content can affect retention, and thus, pursuit of a career in STEM.

Future Research

- Investigate impacts of collaborative learning among engineering students.
- Compare objective learning outcomes to perceived learning outcomes.
- Examine the impact of collaborative learning among underrepresented students in STEM courses.

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