The Ecology of Learning: The Impact of Classroom Features and Utilization On Student Academic Success

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Purpose of Study

• Estimate the impact of physical classroom attributes
  – Natural lighting (i.e., presence of windows)
  – Room size (i.e., square footage/meters)
  – Class size (i.e., number of students in room)
  – Classroom density (sq. ft/m per student)

• Estimate the impact of classroom utilization
  – Time of class attendance (e.g. morning vs. afternoon)

• …on student academic success in terms of
  – First-year cumulative grades/marks received
  – Second-year retention (subsequent re-enrollment)
Research on the Ecology of Learning in Higher Education

- A few studies on class size (Pascarella & Terenzini, 2005)
- No studies in the past 15 years on the influence of classroom physical attributes or class timing/scheduling
- More developed research at the primary/secondary school level (e.g., class size, density)

Reason for limited insight
- Paucity of available/accessible data on physical attributes of instructional space
- Data collected/maintained by facility management, not shared with academic researchers

Reason for optimism
- Mounting use of centralized data systems (ERPs, warehousing)
Data Assembly

- Extraction of data from facilities management office
  - Class section file containing class id, room id, location, scheduled time, room capacity, physical attributes
- Merging with individual student course history and class roster files
  - Compilation of single-record-per-student file, containing average metrics for first year of attendance (e.g., avg room size)

Conceptual Approach

- Input-environment-output (I-E-O) model based on Astin (1993)
- Statistical control of covariates for
  - Student demographic background
  - Pre-university academic preparation
  - First-year university experience
  - First-year curricular experience (special focus on math and English)
- Gauging first-year cognitive growth via
  - Standardized university entry tests
  - Cumulative first-year grades/marks
Control Variables

- **Demographic**
  - Gender
  - Ethnicity/race
  - Age
  - Parent income
  - Residency

- **Academic Preparation**
  - Entry test scores (ACT/SAT)
  - AP credits (y/n)
  - Preparation index

- **Campus Experience**
  - On-campus living (y/n)
  - Varsity athlete (y/n)

- **Financial aid**
  - Remaining first-year financial need ($1K, constant 2005)
  - Pell grant 2nd year offer
  - Inst'l aid 2nd year offer

- **Academic Experience**
  - Course load (credits)
  - Number of science classes
  - Average grade awarded in classes taken

- **Core Curricular Exp.**
  - English/math highest course completed and grade/mark received in first year

Statistical Methods and Cohorts

- Influence on first-year grades/marks (GPA): *OLS regression with covariate block entry (mediated eff.*)
- Influence on second-year retention: *binary logistic regression with covariate block entry (mediated eff.*)

Data quality confirmed via:
- Collinearity diagnostics (VIF < 3, VD matrix < 0.8)
- Regression diagnostics (std residuals <3, Cook’s D no visual separation, Mahalanobis distance)
- Cross-tabulation with program major variable to obviate data sparseness in logit models

- Student cohorts: 2001-2005 new first-year students, i.e. ~9,100 cases (or 95% of total first-year population net of outliers/listwise deletion of missing cases)
Restricted Model Excluding First-Year Covariates:
Variables with Significant Correlation ($\alpha \leq .05$)

- Room size (100sqf)
- Classes after 1pm
- 50%+ windows
- Acad prep 1st Q
- Acad prep 2nd Q
- Acad prep 3rd Q
- AP credits
- Income unknown
- Out-of-state
- Non-local resi
- Hispanic
- Male
- Age 19 or older

Effect on 1st Year Grades/Marks (4-point scale)

2nd Year Return Odds Ratio

% Δ:
-0.5
-3.0
3.0

Income low-mid
Income unknown
Non-local resi
Asian
Hispanic
Full Model w/ Math Focus: Variables with Significant Correlation ($\alpha \leq .05$, demographic, acad prep not listed)

- Lived on campus
- Rem need ($1K$
- Pell Grant 2nd Y Offer
- Inst Aid 2nd Y Offer
- 1st year grades (GPA)
- Math: adv B+
- Math: rem <C

No significance associated with ecology-related variables

2nd Year Return Odds Ratio

Full Model w/ English Focus: Variables with Significant Correlation ($\alpha \leq .05$, demographic, acad prep not listed)

- Lived on campus
- Rem need ($1K$
- Pell Grant 2nd Y Offer
- Inst Aid 2nd Y Offer
- 1st year grades
- Engl: rem 102 compl
- Engl: 102 <B

No significance associated with ecology-related variables

2nd Year Return Odds Ratio
Findings

- Natural lighting (windows) of classrooms shows significant correlation with academic performance, but no consistency in results (Collins, 1975, found no connection)

- Room size is negatively correlated with academic performance (cognitive gain), but of small effect size (corroborating evidence in Becker et al., 1973)

- Taking classes in the afternoon, as opposed to in the morning, shows negative correlation with academic performance

Findings

- No significant correlation, associated with class size or classroom density in estimating academic performance or second-year return (corroborated by Holliman & Anderson, 1986)

- But spatial density showed negative correlation in pre-college studies (Maxwell, 2003; Evans et al., 2001)

- Physical attributes of classrooms and timing of classes do not correlate with first-year student retention

- Academic experience in core courses are key indicators of cumulative cognitive gain

- Cumulative cognitive gain is key to student persistence in higher education, overriding financial need and socio-demographic background
Limitations and Future Direction

- Study is based on first-year students only
- No control variables to gauge student social integration on campus
- Findings are largely exploratory due to paucity of research in this area
- Greater focus on ecological factors in the learning process is needed, particularly with the proliferation of new instructional technology (multimedia classrooms, distance learning etc)

A Reminder

“Recent attempts to create new teaching and learning facilities on university campuses have often resulted in celebrated architecture that has proved to be educationally problematic. [T]he design and development of new spaces, or the refurbishment of existing classrooms and other formal and informal teaching and learning settings, are fundamentally educational concerns impacting directly on the student learning experience.” (Jamieson, 2003)
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