# Understanding factors that influence STEM persistence among introductory laboratory students: a longitudinal study at a Hispanic Serving Institution


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## STEM PERSISTENCE AMONG PEER STUDENTS

STEM persistence refers to the continuous progression of a college student majoring in STEM, eventually graduating as a STEM professional, and entering the STEM workforce.

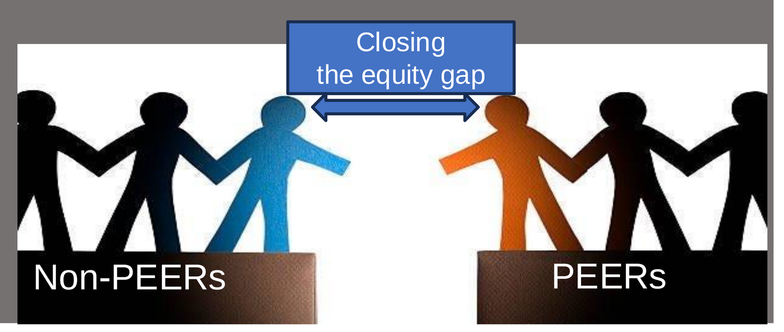
The Term **PEER** (Persons Excluded due to Ethnicity or Race)[1] is a more inclusive term for Underrepresented individuals.

**Rationale of the Study**

- **Participating in undergrad research and training initiatives as a college student can have an impact on STEM persistence in college and beyond, for both PEERs and non-PEERs.[5,7,9]**
- **Science self-efficacy, identity, and community values strongly predict students' intention to persist into STEM careers, especially among PEERs.[4,6]**
- **The integration of scientific research elements into courses has been demonstrated to enhance the equitable access to participation in science practices.[3]**

Research Question:

Does a science-practice based laboratory curriculum influence undergraduate STEM persistence?




## VARIABLES

**The consented students' demographic and enrolment data was collected through institutional data (UAIR).**

**Outcome Variable: STEM Persistence**

Definition:
If student started college as a STEM major AND:
1. Kept enrolling as a STEM major
OR
2. Graduated in STEM

Outcome indications:
1. Indications that were considered for the data analysis:
**Y = The student persisted**
**N = The student did not persist**

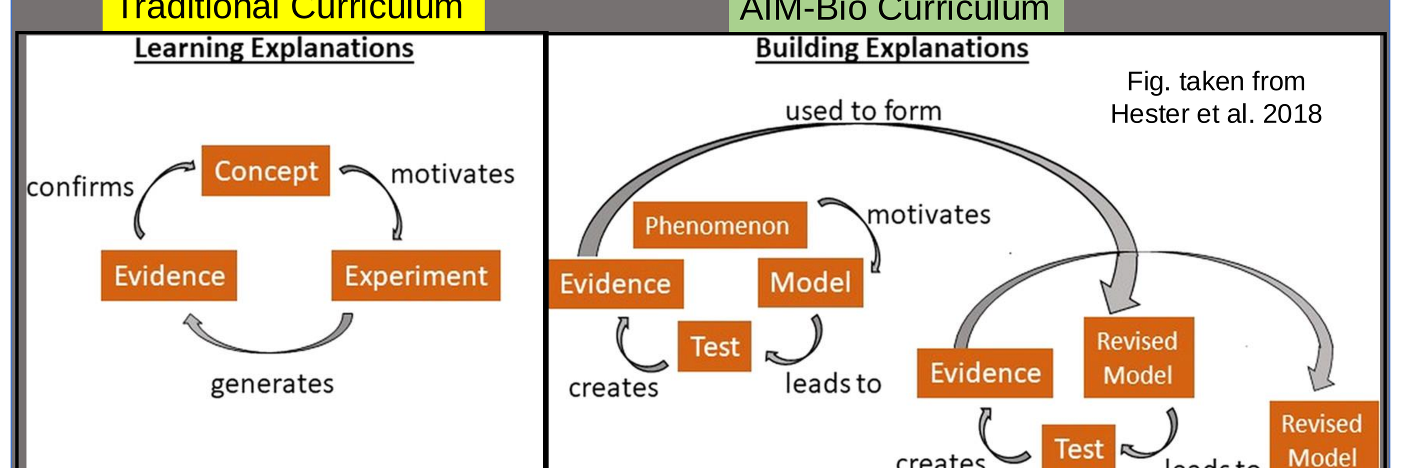
2. Indications that were eliminated for the data analysis:
O = The student started college as a Non-STEM major

**Incoming Variables**

| | |
|---|---|
| Curriculum | AIM-Bio (Treatment Group), Traditional (Control Group) |
| PEER status | PEER, Non-PEER |
| First-Gen status | First-Gen, Not First-Gen |
| Sex | As defined by UAIR: Male, Female |
| Year | At the time of intervention: First, Second, Third, Fourth, (4+n)th year |

## INSTRUCTIONAL CONTEXT

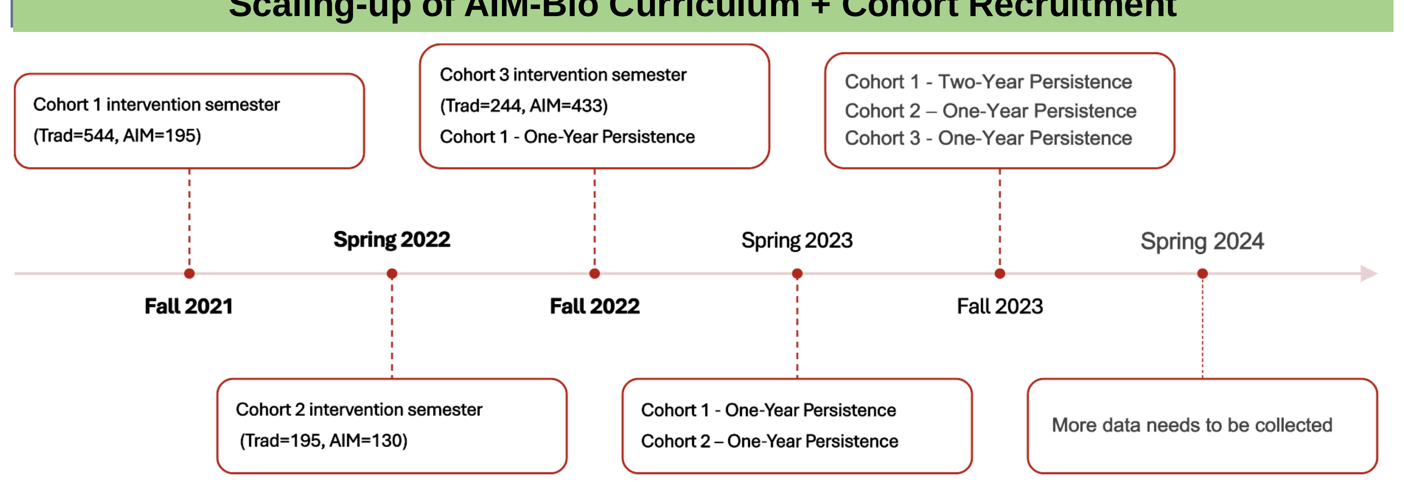
- **MCB 181L is an Introductory biology laboratory course implemented at the University of Arizona (A Hispanic Serving Institution) offered through Department of Molecular and Cellular Biology.**
- **MCB 181L is offered in two different curriculum settings:**




- **Authentic Inquiry through Modeling in Biology (AIM-Bio) focuses on students working together to engage in scientific modeling within a classroom environment, integrating authentic science practices.[2,8]**

## DATA COLLECTION

**Scaling-up of AIM-Bio Curriculum + Cohort Recruitment**




The students enrolled to either AIM-Bio or Traditional curriculum sections through **blinded-selection**.

**Group 1 (N = 1742)**
- Everyone who consented
- Institutional data

**Group 2 (N = 1500)**
- STEM major at timepoint = 0
- Enrollment data present for at least one year

**Group 3 (N = 1253)***
Completed all surveys mandatory for course-completion

*Poster presents data analysis from Group 3

## ANALYTICAL APPROACH

**Step 1: Identify and explore potential input variables**

Microsoft Excel, RStudio
Python: Pandas package

**Descriptive statistics particular to the incoming variables**

| Incoming variables | AIM-Bio (n=556) | Traditional (n=697) |
|---|---|---|
| First Generation Status | 26.1% | 25.8% |
| Female Students | 74.6% | 69.3% |
| First and Second Year Students | 68.0% | 66.1% |
| PEER | 38.1% | 37.9% |
| Hispanic and Latinx | 27.3% | 28.6% |

**Step 2: Verify non-collinearity of input variables**

RStudio: car package

- Curriculum
- PEER status
- Sex
- Year
- First-Gen status

Are these variables truly independent?

Metric used: Variance Inflation Factor (VIF)

- Curriculum *(VIF = 1.01)*
- PEER status *(VIF = 1.08)*
- Sex *(VIF = 1.01)*
- Year *(VIF = 1.03)*
- First-Gen status *(VIF = 1.09)*

**Step 3: Run Generalized Linear Models (GLM)**

RStudio:
lme4 and fastDummies package

STEM Persistence ~ Incoming Variable + (1 | Section), family ="binomial"

STEM Persistence ~ Curriculum + Incoming Variable + Curriculum*Incoming Variable + (1 | Section), family ="binomial"

STEM Persistence ~ Curriculum + PEER + Sex + Year + Curriculum*PEER + Curriculum*Sex + Curriculum*Year + (1 | Section), family ="binomial"

First, the incoming variables were run one at a time

Second: incoming variables were run with Curriculum and looked for interaction effect with Curriculum.

Third, we ran all the incoming variables without and with First-Gen variable

**Step 4: Follow-up analyses on GLM results**

Python:
Statsmodels package
Two-sample Z-proportion tests

RStudio:
MASS package
Calculating odds ratios

## RESULTS

**Logistic regression results when incoming variables are run one at a time with one-year STEM persistence as the outcome**

| Student Group | Incoming variables | | | | |
|---|---|---|---|---|---|
| | Curriculum | PEER | First Gen Status | Sex | Year |
| All Students | Not significant | Being PEER significant at p<=0.1 (negative estimate) | Being First Gen significant at p<=0.05 (negative estimate) | Not significant | Not significant |

**Logistic regression results when incoming variables + Curriculum interactions are run with one-year STEM persistence as the outcome**

| Student Group | Curriculum * PEER | Curriculum * First_Gen | Curriculum * Sex | Curriculum * Year |
|---|---|---|---|---|
| All Students | Being PEER significant at p>=0.01 (negative estimate)<br>Interaction between being AIM and PEER is significant at p>=0.05 (positive estimate) | Being First Gen significant at p<=0.1 (negative estimate) | Not significant | Not significant |

**Logistic regression results when all incoming variables are run together with one-year STEM persistence as the outcome**

| Student Group | Everything + First_Gen |
|---|---|
| All Students | Being PEER significant at p<=0.01 (negative estimate)<br>Interaction between being AIM and PEER significant at p<=0.05 (positive estimate) |
| All PEERs | Not significant |
| All Non-PEERs | Not significant |

### Follow-up analyses

**Two-sample Z-proportional test: One-year STEM Persistence percentages (*p<=0.05)**

| Student Population | AIM-Bio | Traditional | % difference |
|---|---|---|---|
| All Students | 95.0% (528/556) | 94.7% (660/697) | 0.3% |
| All PEERs | 95.8% (203/212) | 91.3% (241/264) | 4.5% |
| All Non-PEERs | 94.5% (325/344) | 96.8% (419/433) | -2.3% |
| All Hispanic | 96.1% (146/152) | 90.5% (180/199) | 5.6%* |

**Two-sample Z-proportional test: Two-year STEM Persistence percentages (Cohort 1 only)**

| Student Population | AIM-Bio | Traditional | % difference |
|---|---|---|---|
| All Students | 82.0% (100/122) | 76.8% (315/410) | 5.2% |
| All PEERs | 81.3% (39/48) | 69.8% (111/159) | 11.5% |
| All Non-PEERs | 82.4% (61/74) | 81.3% (204/251) | 1.1% |
| All Hispanic | 83.9% (26/31) | 70.5% (86/122) | 13.4% |

The odds ratios of One-year STEM persistence.

Increased odds of STEM persistence are highlighted in green.

| Student Groups | Being AIM-Bio | Being PEER | Being Hispanic | Being First-Gen | Being Male |
|---|---|---|---|---|---|
| All Students | 1.053 | 0.662 | 0.869 | 0.580 | 0.884 |
| All PEERs | 2.153 | NA | 0.869 | 0.969 | 1.447 |
| All Non-PEERs | 0.572 | NA | NA | 0.400 | 0.593 |

Although, all two-year STEM persistence differences were not statistically significant, trends from data available thus far suggest an increasing positive impact of AIM-Bio over time.

## CONCLUSIONS

- Being a PEER student is a **significant negative predictor** for STEM persistence.
- Interaction between the AIM-Bio curriculum and being PEER had **a significant influence on one-year persistence**.
- **Hispanic student groups who took the AIM-Bio curriculum showed higher one-year persistence rates** compared to the control group.

## FUTURE DIRECTIONS

- Incorporating quantitative survey metrics to the GLMs
- Connecting the quantitative data points to qualitative data to help make sense of the story of STEM persistence
- Conducting Structural Equation Modelling to help understand mechanisms of STEM persistence

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