Exploring Undergraduate Teaching Assistants' Influence on Student Science Identity and Persistence in STEM Coursework

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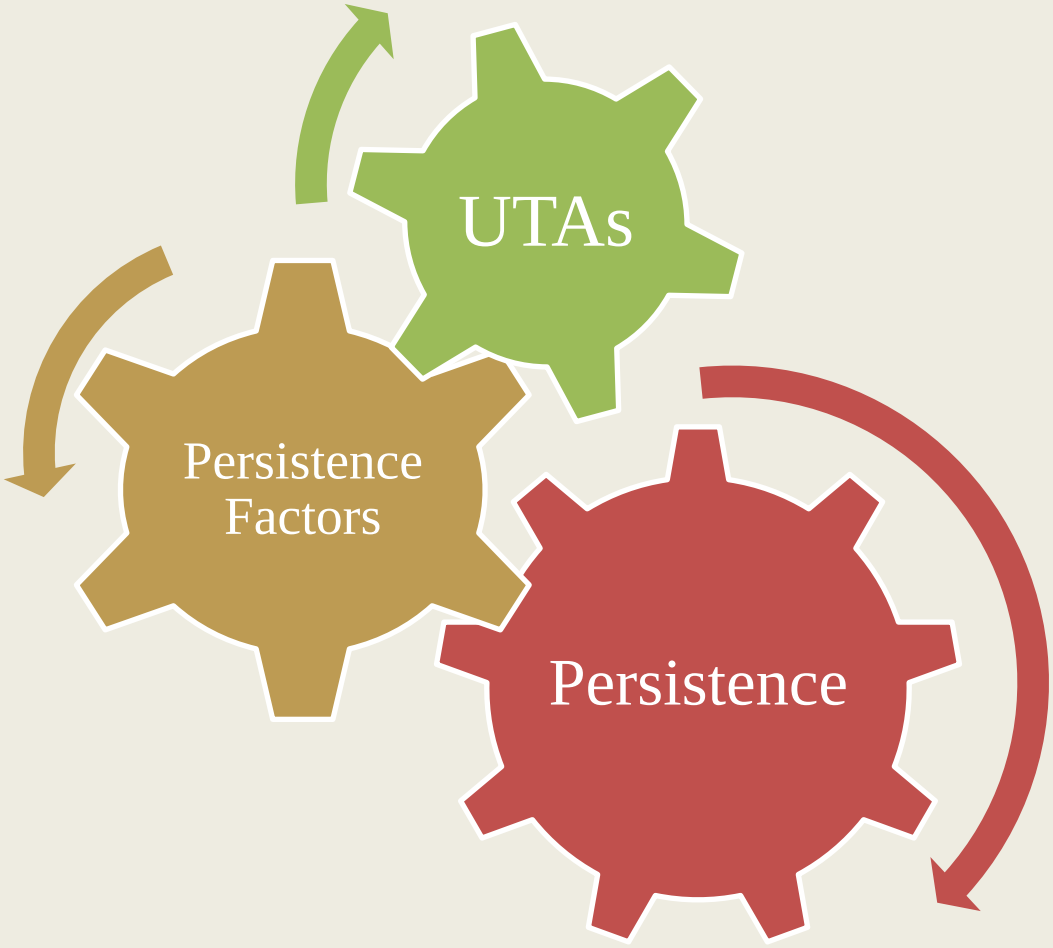
Our Challenges

- Many capable students leave STEM majors within the first two years of beginning undergraduate work
- Net loss of STEM majors may affect number of qualified K-12 science teachers

Addressing Challenges

Trained and supported undergraduate teaching assistants (UTAs) to engage with students to strengthen factors that may increase persistence



STEM Persistence Factors

- **Reasons students give for leaving STEM majors:**
  - Academic achievement[1]
  - Mediocre instruction and novice-expert interaction [1,2,3]
- **Predictors of Persistence:**
  - Performance/Competence [1, 4]
  - Affect: interests, motivations, beliefs[5,6,7]
  - Recognition by self and significant others: mothers[8] ; friends[9]; and teachers[10]

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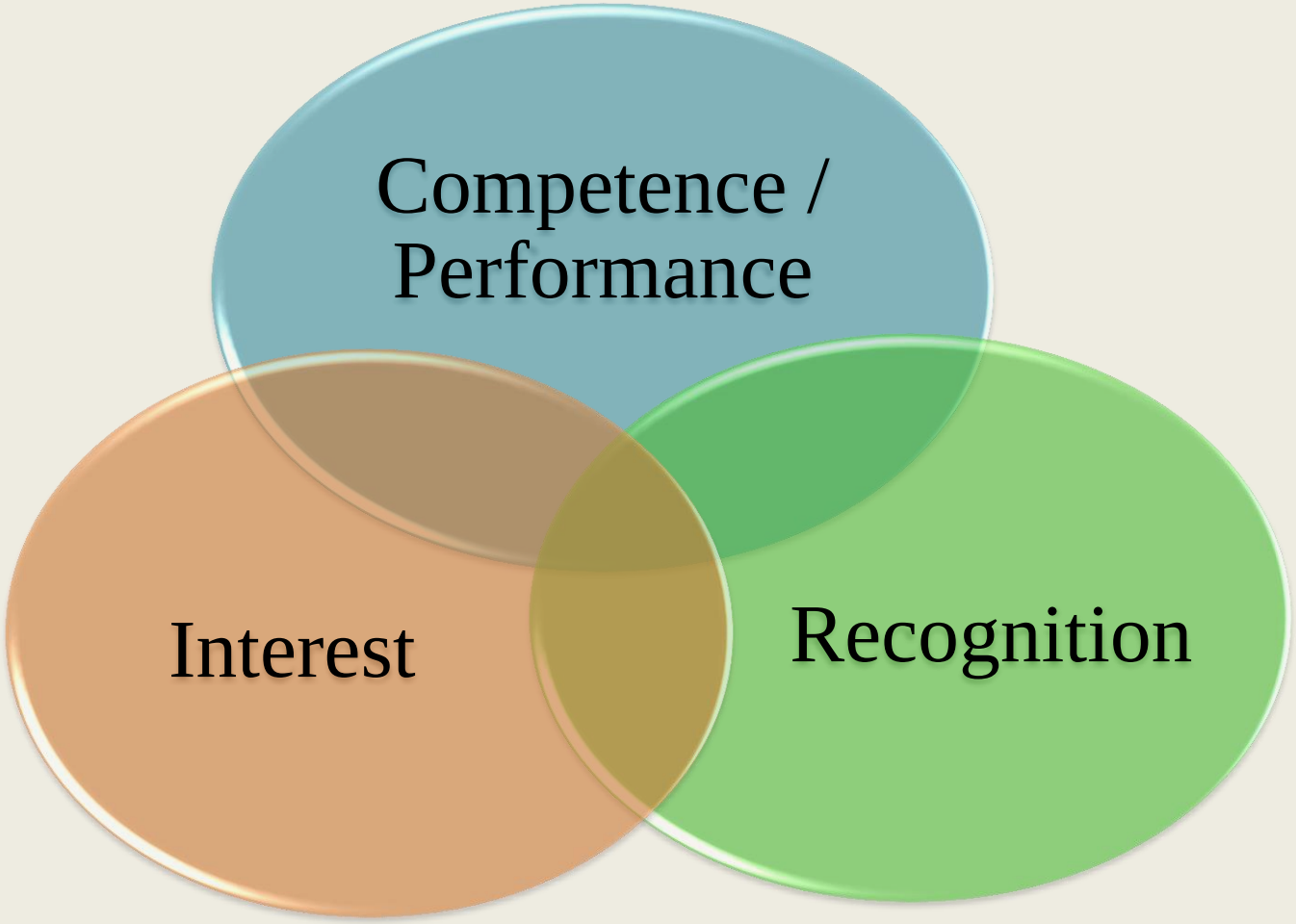
Science Identity Framework



Adapted from Carlone and Johnson (2007)[11] and Hazari, Sonnert, Sadler, & Shanahan (2010)[12]

Research Questions

1. How did the science identity of UTA-led undergraduates (new program) compare with that of GTA-led students (traditional program)?

2. Which factors relate to students persisting in STEM study, that is, enrolling in the second semester of general chemistry required for their major?

Study Context

Partnership for Retention Improvement in Mathematics, Engineering and Science (PRIMES)

- Long-term (5 year) funded program for interested faculty and introductory level STEM students
- Trained and supported undergraduate teaching assistants (UTAs)
- “Business as usual” graduate teaching assistants (GTAs)
- Introductory level course (1st semester general chemistry for STEM majors)
- Recitation sections (29) of a large course; cooperating lecture instructors; common textbook and final exam

Study Context

Undergraduate Teaching Assistants (UTAs)

- Selection process
- Pre-semester workshop, bi-monthly seminar series, activity planning sessions
- Pedagogical strategies: questioning practice, metacognition, formative assessment
- Practice and reflection

Graduate Teaching Assistants (GTAs)

- Traditional TA pool
- No formal pedagogical training taken during semester
- Met as needed with instructors
- Similar content knowledge test scores as UTAs
- Declined to be interviewed

Research Design

- Quasi-experimental, untreated control group with post-test (survey) only
- **Treatment group**: 284 undergraduate students in 14 recitation sections led by a trained and supported UTA
- **Control group**: 310 undergraduate students in 15 recitation sections led by a traditional graduate teaching assistant
- Assignment of students and TAs
  - Students enrolled in recitation section before TA assigned
  - Honors and night course sections not included in study
  - TAs assigned to recitation sections balanced over 4 course instructors, time of day, and day of week

Data: End of Course Survey

- Given to all students in recitation sections
- 5 point Likert response format[13]
- Principal Components Analysis to create **scales**
  - Varimax rotation for ease of interpretation
  - Component retained if eigenvalue > 1
  - Four components explained over 69% of variance:
    1. Perceived TA Impact on Academic Success (10 items, α =.95)
    2. TA Rapport-Building Skills (4 items, α = .77)
    3. Student Science Recognition (3 items, α = .84)
    4. Student Science Interest (3 items, α = .82)

Items Measuring TA Impact on Academic Success

1. Course was enjoyable
2. Course was a valuable experience
3. TA had strong content knowledge
4. TA gave clear explanations
5. TA led effective discussions
6. Overall TA was excellent
7. TA gave choices for learning
8. My success in future courses is due in part to TA
9. My grade is higher due in part to TA
10. I understand more content due to TA

(Autonomy support: Black & Deci, 2000; Deci, 1975)

Items Measuring TA Rapport-Building Skills

1. I am able to be open with TA
2. My TA encouraged questions
3. My TA cares about me
4. My TA tries to understand me

(Autonomy support: Black & Deci, 2000; Deci, 1975)

Comparison of Mean TA Impact and TA Rapport Scores

	GTA	UTA				
Variable	**Mean (SD)**	**Mean (SD)**	**df**	**t**	***p***	**Cohen's d**
TA Impact	26.79 (6.64)	30.15 (6.02)	399	5.355	<.001	0.53
TA Rapport	9.92 (1.92)	10.64 (1.89)	410	3.856	<.001	0.38

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Measuring Science Identity

Recognition (survey)

1. I am a science or math person
2. Family/friends think I am science or math person
3. I want others to see me as science or math person

Interest (survey)

1. I am interested in experiments
2. I am interested in talking to others about science or math
3. I want to know more about science or math

Performance/Competence

- Final Exam Grades
- College GPA
- Math ACT / SAT Scores

Comparison of Mean Student Science Recognition and Student Science Interest Scores

	GTA	UTA				
Variable	**Mean (SD)**	**Mean (SD)**	**df**	**t**	**p**	**Cohen's d**
Student Science Recognition	9.94 (2.14)	10.44 (1.63)	374	2.64	.04	0.54
Student Science Interest	9.83 (2.14)	10.12 (1.82)	391	1.49	.353	-

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While UTA-led students had stronger Science Recognition scores than GTA-led students, there was no significant difference in Science Interest scores between student groups.

What variables are related to TA Impact and TA Rapport Scores?

Linear Regression (backwards entry)

Variables tested	
ACT Math score (student reported)	TA Rapport score
Number of STEM AP courses	Science Recognition score
Parent education level	Science Interest score
Gender	TA type (GTA = 0; UTA = 1)

Regression Results

TA Impact on Academic Success: Significant Variables

- TA Rapport rating (β= .683, $p < .001$)
- Having a UTA (β = .160, $p < .001$)
- Being a female student (β= **-** .137, $p = .001$)
- Number of AP STEM courses taken (β= .099, $p = .012$)

TA Rapport Building Skills: Significant Variables

- Recognized as a "science person" by self and others (β = .207, $p < .001$)
- Having a UTA (β = .178, $p = .001$)

Measurement of Persistence

- Course: 1st semester general chemistry
- Many STEM majors require 2nd semester general chemistry also
- How many students required to take 2nd semester actually enroll in course?
- How does this enrollment differ between UTA-led students and GTA-led students?

Measurement of Persistence

- 343 students required to take 2nd semester general chemistry:
- 135 out of 189 **UTA-led** students (71%) enrolled
- 82 out of 154 **GTA-led** students (53%) enrolled
- Proportionally more UTA–led students enrolled in 2nd semester

$$(\chi^2 (1, N = 343) = 12.07, p = .001).$$

Logistic Regression Analysis of Persistence

Predictor	B	S.E.	Wald	df	Sig.	Exp(B)
TA Type Code (GTA = 0; UTA =1)	1.160	.319	13.191	1	.000	3.188
Final Exam(%)	.025	.009	7.008	1	.008	1.025
College GPA	1.064	.251	17.943	1	.000	2.899
Math z-score	1.313	.252	27.188	1	.000	3.718
Parent Ed (no college=0; college = 1)	-.920	.387	5.652	1	.017	.398
Constant	-4.989	.813	37.695	1	.000	.007

Summary

- UTA-led students were not significantly different from GTA-led students on final exam grades, course grades, and Science Interest
- UTA-led students gave their TAs higher scores for TA Impact on Academic Success and TA Rapport-Building Skills
- TA Impact on Academic Success score was positively related to TA Rapport-Building Skill Score, having a UTA, and number of AP STEM courses taken, each after controlling for all other variables.

Summary

- TA Rapport-Building Skills score is positively related to Science Recognition score, and being in a UTA led recitation section, each controlling for all other variables
- UTA-led students reported higher Science Recognition than GTA-led students
- UTA-led students three times more likely to enroll in a required 2nd semester general chemistry course than GTA-led students, controlling for all other variables

Conclusions

- In comparing two groups of students similar in competence, performance and science interest, science recognition was the factor of the science identity model remaining for comparison
- Recognizing oneself and being recognized by significant others as a ‘science person’ is impacted by social relationships between the student and important others, such as instructors and TAs.
- UTAs may impact students more strongly due to recent experience in the same general chemistry program and use of research-based pedagogical strategies.
- **Connection warranting further study:** Students who had UTAs (in general, rating their TAs as more effective, reporting a greater student-TA rapport, and recognizing themselves more strongly as ‘science people’) were three times more likely to persist in a STEM program of study.

Time for questions…

Thank you!

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Linear Regression: TA Impact on Academics

Variable	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Constant	2.603	1.445		1.802	.073
TA Type (GTA = 0; UTA=1)	2.158	.535	.160	4.034	.000
TA Rapport	2.381	.139	.683	17.142	.000
Gender (0=male; 1=female)	-1.912	.542	-.137	-3.530	.001
Number of STEM AP courses	.469	.185	.099	2.538	.012
R^2	.561				
F	94.11				.000

Predictors of TA Rapport Building Skills

	Unstandardized Coefficients		Standardized Coefficients		
Predictor	**B**	**Std. Error**	**Beta**	**t**	**Sig.**
Constant	7.576	.652		11.61	.000
TA Type (0=GTA; 1=UTA)	.687	.218	.178	3.15	.002
Student Science Recognition	.230	.062	.209	3.70	.000
R^2	.520				
F	13.52				.000