DEVELOPMENT OF UNDERGRADUATE TEACHING ASSISTANTS AS EFFECTIVE PEER LEARNING ASSISTANTS IN STEM COURSES

STEPHANIE B. PHILIPP, THOMAS R. TRETTER, CHRISTINE RICH

UNIVERSITY OF LOUISVILLE

LOUISVILLE, KENTUCKY

NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

RIO GRANDE, PUERTO RICO

APRIL 2013

Project supported by

National Science Foundation
WHERE DISCOVERIES BEGIN

SIGNIFICANCE AND PURPOSE

Significance: Develop approach to strengthen undergrad STEM student retention

Study Purpose: To examine the development of undergraduate teaching assistants (UTAs) who were prepared and supported as learning assistants in introductory STEM courses

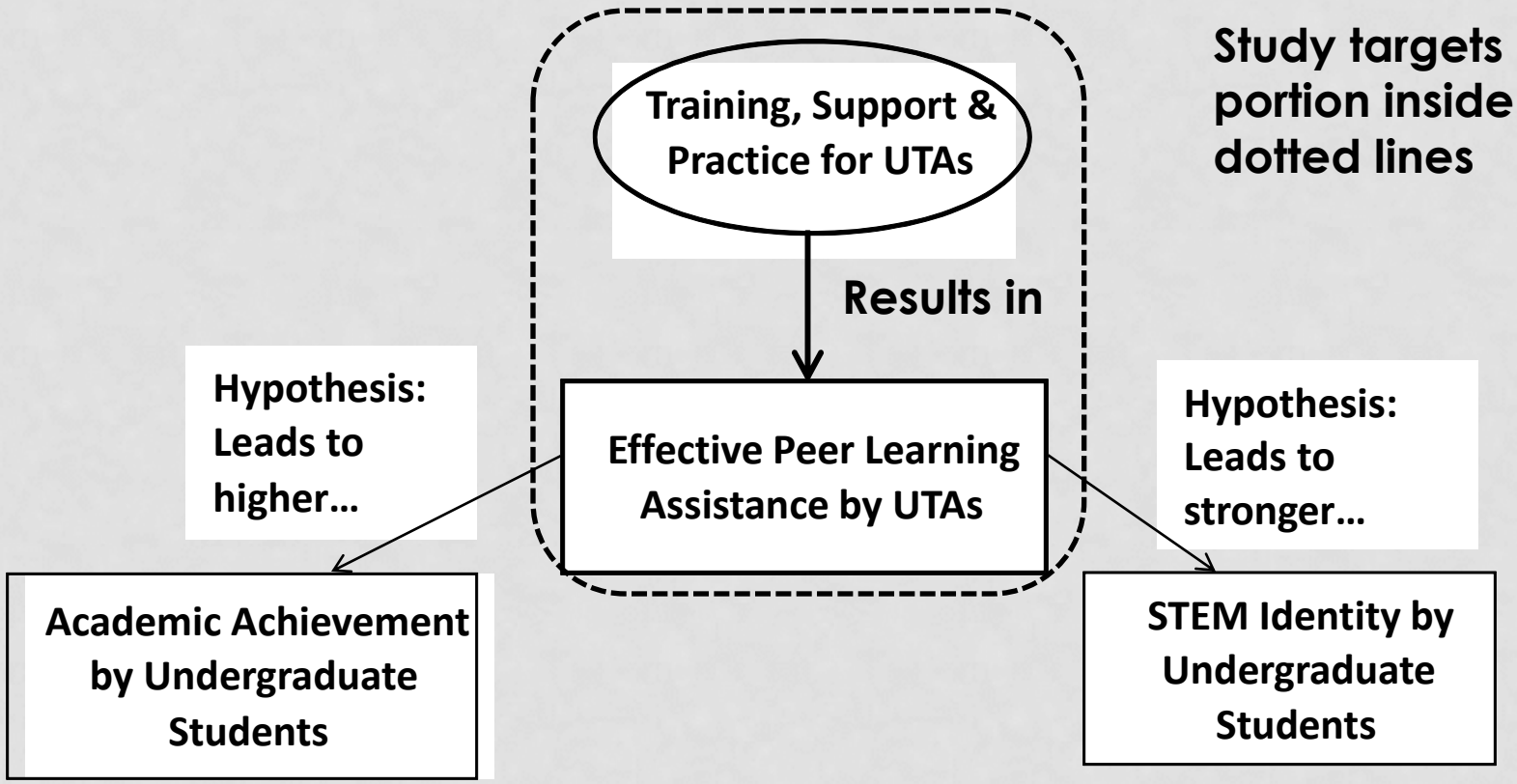
FACTORS THAT IMPACT STEM STUDENT RETENTION

- First year or gateway experiences
- Hierarchical nature of STEM programs
- Student achievement
- Learning environment

STRUCTURES NEEDED FOR CHANGE

- One aspect of pedagogy or curriculum;
- An extended period of time;
- Performance evaluations and feedback to the participants in the program;
- Practice of new concepts and skills and reflection on practice;
- Flexible solutions aligned with cultural and organizational norms.

CONCEPTUAL FRAMEWORK



THEORETICAL FOUNDATION: VYGOTSKY ZPD & MKO

UNDERGRADUATE TEACHING ASSISTANT PROGRAMS

Carefully selected undergrad STEM majors act as learning assistants for less experienced students

- Small cooperative learning groups
- Support available to all students to avoid stigma
- Faculty mentoring and support of UTAs
- Learning benefits for both UTAs and students
- UTAs have visible role as learning assistants but not overburdened with teaching new material or grading duties

SOLUTION APPROACH INCORPORATING LITERATURE EVIDENCE

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

- NSF DUE STEP 5 year program
- Selected UTAs specially trained and supported to serve as effective peer learning assistants and facilitate a positive learning environment
- Small learning group context decided by department
- Cross-college collaboration between science, mathematics, engineering, and education departments

RESEARCH QUESTIONS

1. What peer learning assistant skills did the UTAs consider to be most important for being an effective UTA?

2. In what ways did UTA peer learning assistant skills change over the course of the semester?

3. In what ways did the UTAs' recognize deepening of content knowledge and/or self-learning approaches as a result of their experience?

METHODOLOGY

- Research Design Elements
  - Single, non-comparison group with retrospective post-treatment data collection
  - Quantitative and qualitative data collected near end of semester experience
  - Likert-item survey and open-ended guided reflection
- Sample
  - 112 UTAs over 2 semesters (Spring and Fall 2012) from 9 STEM departments
  - GPA > 3.0, teaching interest statement, and faculty recommendation

TREATMENT

- Content Knowledge Support (STEM faculty)
  - Content unpacking
  - Awareness of common misconceptions
- Pedagogical Training (Education Faculty)
  - Questioning practice
  - Metacognition
  - Formative assessment
  - Active learning strategies
- Structure
  - 3-day workshop prior to semester
  - Bi-monthly seminars and reflections
  - Stipend and course credit

INSTRUMENTS

- UTA Experience Survey
  - 21 Likert-type items (5 = strongly agree to 1 = strongly disagree) with 87% response rate, completed last seminar
  - 10 items were determined to address research questions
  - Adapted from previously published peer leader survey (Hug, Thiry, & Tedford, 2011)
- UTA End of Semester Reflection
  - Structured written reflection protocol of ten open-ended prompts relating to UTA experience (88% response rate)
  - Submitted online before last seminar
  - 6 prompts aligned with research questions

DATA ANALYSIS

- UTA Experience Survey
  - Principal components analysis
  - Varimax rotation with Kaiser Normalization
  - Kaiser criterion (eigenvalues >1) to determine number of components to retain
  - Scree plot evaluated
  - A measure (on a 1-5 scale) of UTA self-rating on the retained components was calculated by applying the means for each item with the weighting of each item per component.

DATA ANALYSIS

- UTA End of Semester Reflection
  - Random stratified sample independently read and analyzed by two researchers
  - Identified and categorized all statements relevant to research questions
  - Researchers agreed on 82% of identification and categorizations
  - Reconciled differences and established consensus on explicit criteria for identification and categorization
  - Split remaining reflections and categorized statements independently
  - Descriptive labels were developed and assigned to capture inferred or explicit meaning

RESULTS
UTA EXPERIENCE SURVEY

Descriptive Statistics for UTA Experience Survey

(4 and above = "agree")

Item	Mean	S.D.
Q1 Improved teaching skill	4.39	0.64
Q2 Confidence helping students	4.29	0.65
Q3 Effective facilitation	4.00	0.65
Q9 Improved understanding of others	4.11	0.64
Q11 Improved communication skills	4.19	0.64
Q12 Improved cooperation with others	3.67	0.67
Q15 Understand discipline concepts	4.52	0.56
Q16 Ability to answer student questions	4.43	0.52
Q17 Skills necessary to be effective UTA	4.10	0.81
Q18 Increased discipline knowledge	3.82	0.99

RESULTS
UTA EXPERIENCE SURVEY

Rotated factor matrix with factor loadings highlighted

	Factor		
	1	2	3
Q1 Improved teaching skill	.695	-.008	.275
Q2 Confidence helping students	.174	.199	.598
Q3 Effective facilitation	-.067	-.052	.821
Q9 Improved understanding of others	.707	-.091	-.207
Q11 Improved communication skills	.687	.246	.075
Q12 Improved cooperation with others	.771	.000	.014
Q15 Understand discipline concepts	.162	.674	.496
Q16 Ability to answer student questions	-.110	.696	.254
Q17 Skills necessary to be effective UTA	.043	.765	-.138
Q18 Increased discipline knowledge	.519	-.383	.227

Note. Items loading on each factor are highlighted inside boxes

RESULTS
UTA EXPERIENCE SURVEY

Three factors explained 57% of variance

UTA Self-Ratings for Factors Post-Semester (n=97)

Factor	Mean (SD)
Improvement of Teaching Skills	4.04 (.70)
Content & Teaching Effectiveness Endpoint	4.34 (.64)
Teaching Self-Efficacy	4.12 (.65)

(5=strongly agree, 4=agree, 3=neutral, 2=disagree, 1=strongly disagree)

RESULTS
UTA END-OF-SEMESTER REFLECTION

RQ1: Important Peer Learning Assistance Skills Frequently Reported by UTAs

RQ1: Important Peer Learning Assistance Skill	**Frequency mentioned (out of 99)**	**Representative Quotes**
Engaging teaching	37	..able to incorporate some real-life scenarios which made the material a bit more interesting and applicable [Spring 2012]
Patience	35	Patience – you have to be willing to understand that not everyone has had the same background [Fall 2012]
Develops student rapport	27	Be approachable for a student to ask questions and the students must feel comfortable with the instructor. [Fall 2012]
Content Knowledge	24	You must certainly know the material! [Fall 2012]
Enthusiastic about subject	22	..need to be passionate about what they are teaching [Spring 2012]
Adaptable teaching styles	21	An effective instructor must be able to change their teaching approach when they identify that it is not effective for a student [Spring 2012]
Assesses prior knowledge	19	[use of] a pretest to see where everyone stands in these courses [Fall 2012]

RESULTS
UTA END-OF-SEMESTER REFLECTION

RQ2: Change in Peer Learning Assistance Skills

RQ2: Peer Learning Assistance Skills Change	Frequency mentioned (out of 99)	Representative Quotes
Improved public speaking skills	40	I personally do not like getting up in front of people I do not know, and talking to them. This experience helped me get much more comfortable in these situations. [Spring 2012]
Improved explanatory skills	23	This position forced me to take what was in my head and put it into words. [Fall 2012]
Improved questioning skills	15	I'm already learning how to ask the right kinds of questions [Fall 2012]
Improved other pedagogical strategies	15	My experience has helped me learn more about the strategy of wait time [Fall 2012]
Improved communication skills	10	I learned how to communicate effectively when trying to describe a process [Fall 2012]
Improved metacognition skills	8	Thinking about thinking was something new that I had never thought about before. This helped me determine how my students learned. [Fall 2012]
Increased Patience	7	This program helped me with my patience while teaching someone. [Spring 2012]

RESULTS
UTA END-OF-SEMESTER REFLECTION

RQ3: Deepening of Content Knowledge and of Self-Learning Approaches

RQ3: UTAs' content knowledge and/or self-learning approaches deepen	**Frequency mentioned (out of 99)**	**Representative Quotes**
Self-learning approaches	61	[UTA experience] has allowed me to understand the process of learning as opposed to just learning knowledge…I am more conscious of how I come to understand a topic. [Fall 2012]
Content Knowledge	50	While you're teaching others a subject it parallels topics that are being brought back up in current [upper level] courses; therefore you are not only benefitting the students, you are benefitting yourself. [Fall 2012]

DISCUSSION
RESEARCH QUESTION 1
IMPORTANT STEM TEACHING SKILLS

Vygotsky's ZPD

- Engaging style
- Clear, realistic examples
- Knowing the content at an appropriate depth
- Adapt teaching to students' needs

Vygotsky's MKO

- Patience
- Ability to build rapport
- Interacting with learners in enthusiastic and appropriate ways

DISCUSSION
RESEARCH QUESTION 2
CHANGE IN LEARNING ASSISTANT SKILLS

Across the multiple data sources, the UTAs strongly reported improvement in their own teaching skills.

- Weighted means for Teaching Skills and Teaching Self-Efficacy factors were above 4 ("agree")
- Key skills Improvement mentioned by UTAs
  - Public speaking
  - Clear explanations
  - Questioning
  - Pedagogical strategies emphasized in seminar

DISCUSSION
RESEARCH QUESTION 3
RECOGNIZING DEEPENING OF LEARNING

- Content knowledge deepened
  - Current coursework
  - Professional preparation and testing
- Self-learning approaches
  - Process of learning
  - Identification with faculty

CONCLUSIONS

- UTAs recognized importance of strong content knowledge, but collectively put other skills higher (engaging teaching, patience, develop rapport)
- UTAs were very focused on the learning of their students rather then on demonstrating their own mastery of content knowledge
- Most universally-noted change was on UTAs own content knowledge depth and self-learning
- UTAs did not recognize "increased" content knowledge but did recognize deepened content knowledge

- Step 1 of Conceptual Framework appears successful – next step is to seek evidence of impact on students