Partnership and pedagogy

Admissions, assessment, and curricular reform for improving diversity in STEM

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AAC&U • Atlanta • November 2014

sites.duke.edu/aacu

For discussion

Ability to…	Where are your students? (Preparation)	Where is your institution? (Readiness)
to interpret and use quantitative information		
to conduct a literature search productively		
to produce a thorough lab report		
to		
to		
to		
to		

Session learning outcomes

- differentiate *student deficit* and *institutional readiness* models in STEM teaching and learning
- describe how an institutional readiness model of curriculum development may address the variability of student outcomes in STEM more effectively,
- articulate specific opportunities for cross-institutional and interdepartmental collaboration in the interest of understanding pre-matriculation factors,
- identify types of curricular change and assessment methodologies that may be transferrable to your home institutions, and
- identify possible unscripted challenges and barriers to intra-institutional collaboration.

What's the issue?

General, national consensus that students with less preparation in STEM in secondary schools have lower rates of persistence in STEM programs in college.

- Duke Chemistry faculty observed that students in lowest quartile of SAT-Math scores have lowest outcomes (grades, persistence).
- The highest rate of loss of student interest in STEM coursework occurs during the first year of college. [1, 2]
- When a student changes his or her mind about pre-health study, chemistry is cited 4 to 5 times more often than the next two highest contributors (biology and math) as the subject that contributes to this decision.[3]

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1. P. A. Daempfle, An Analysis of the High Attrition Rates Among First Year College Science, Math, and Engineering Majors. *J. Coll. Student Retention* **5**, 37 (2004).
2. E. Seymour, Why Undergraduates Leave the Science. *Am. J. Phys.* **63**, 199 (1995).
3. D. A. Barr, J. Matsui, S. F. Wanat, M. E. Gonzalez, Chemistry Courses as the Turning Point for Premedical Students. *Adv. Health Sci. Educ.* **15**, 45 (2010).

Our response

Develop a framework for the ongoing longitudinal assessment of student outcomes in chemistry, asking:

What is it about chemistry or the way it is taught in college, in particular, that drives this sort of change in career plans?

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Further hypothesis: the effects of (a) and (b) will disproportionately affect outcomes among female students and students from under-represented minority groups.

Study methodology: Original curriculum review

Dori to explain student deficit approaches, versus inst. readiness models (SAGE??)

Dori to describe curriculum redesign

Insert slides and/or tables from previous work?

Study methodology: Follow-up

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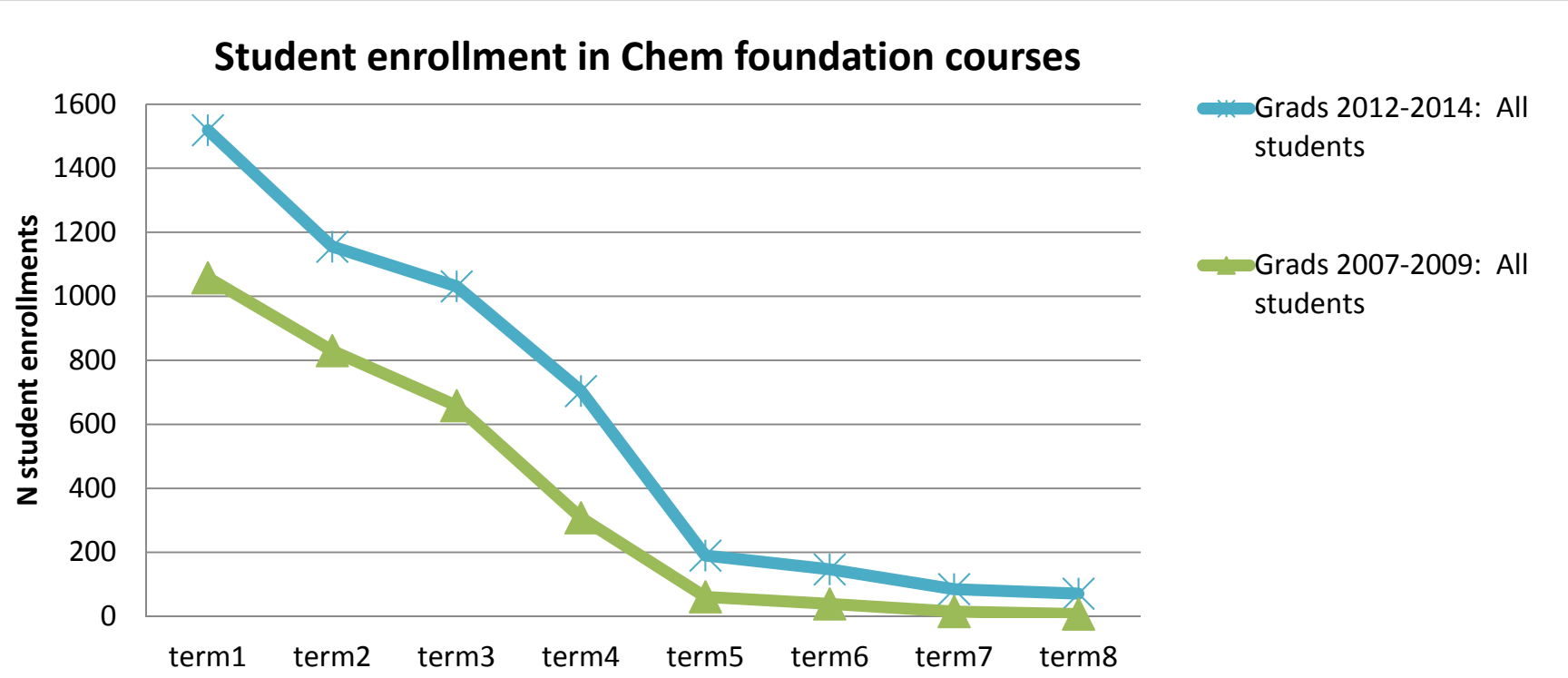

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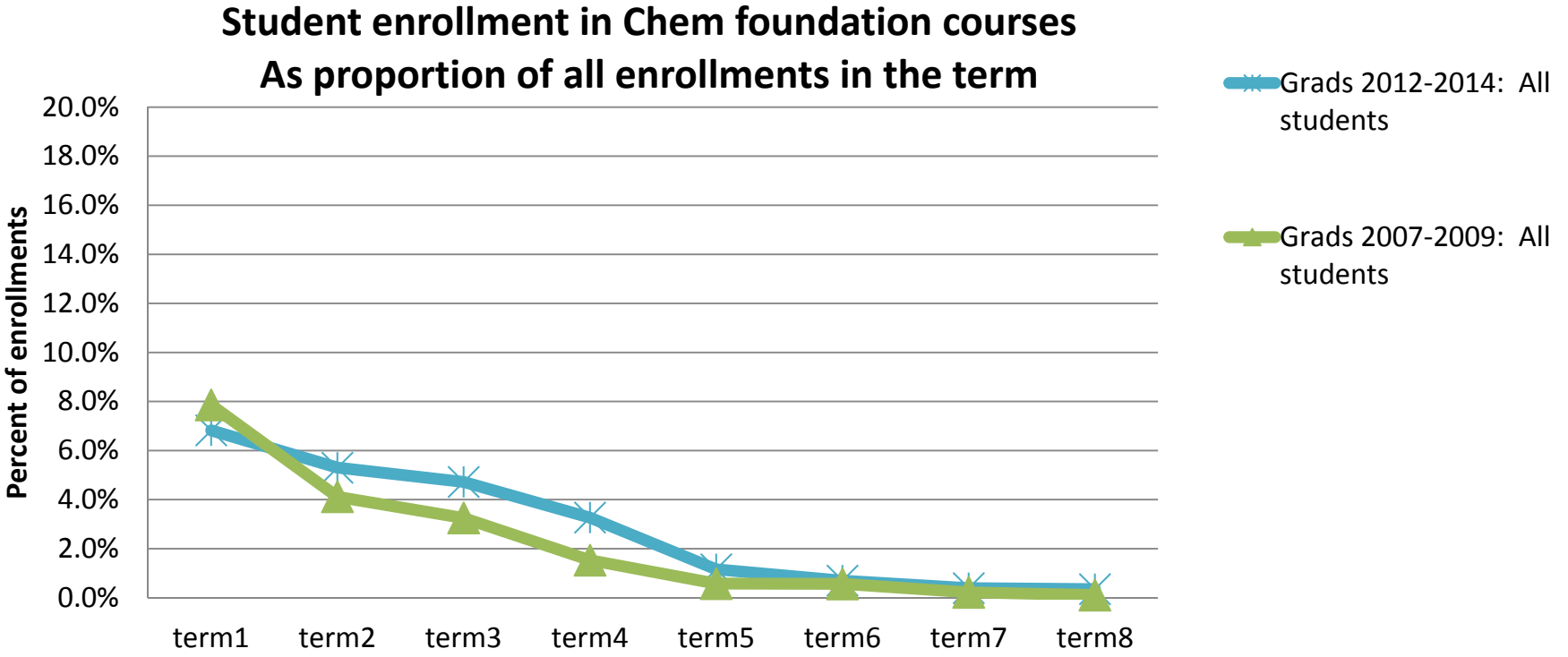

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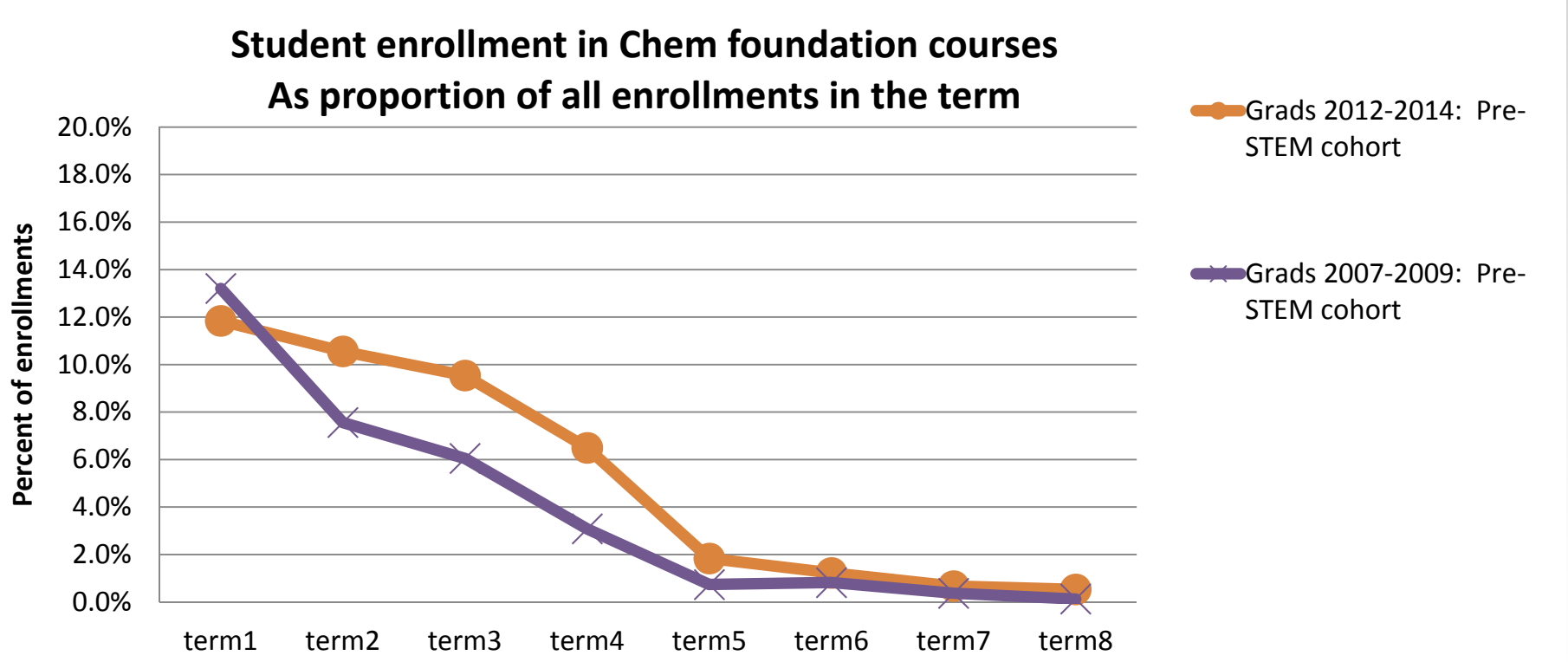

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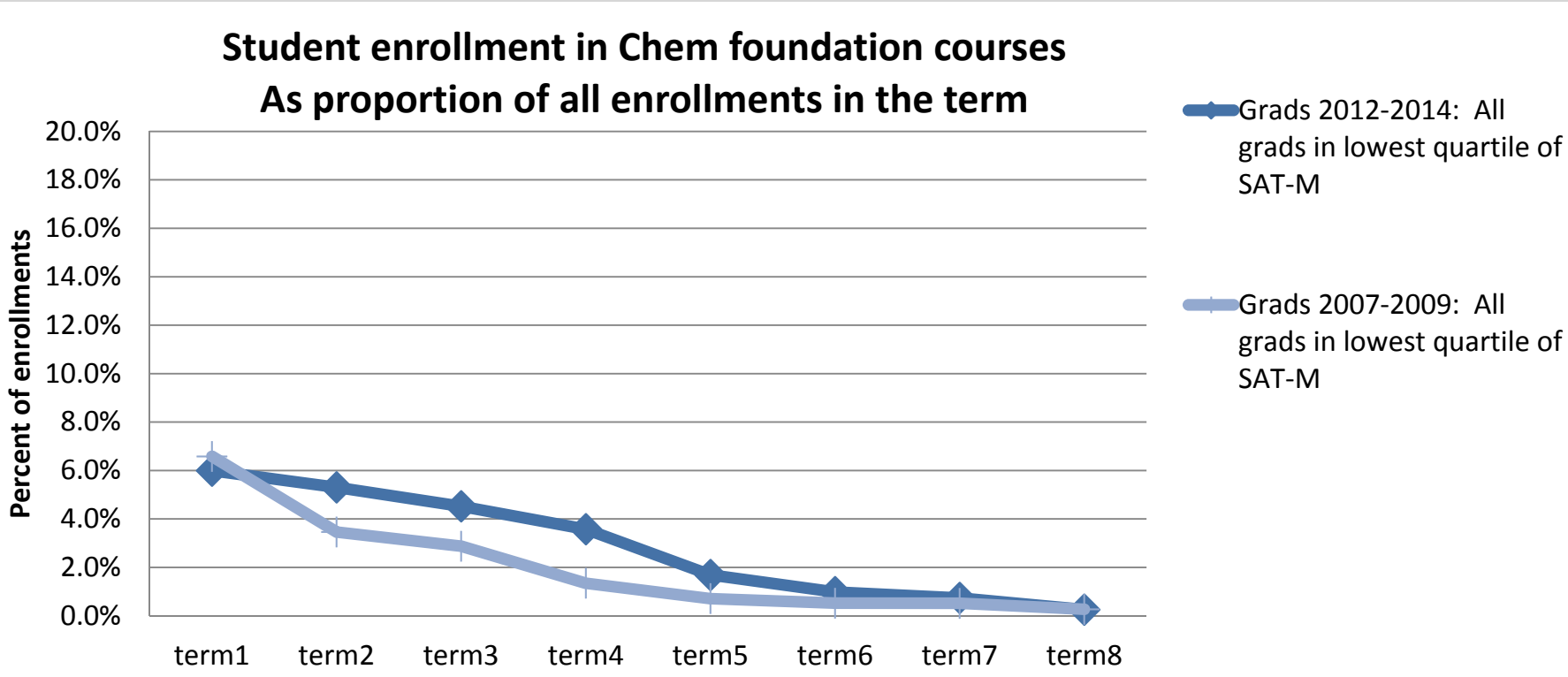

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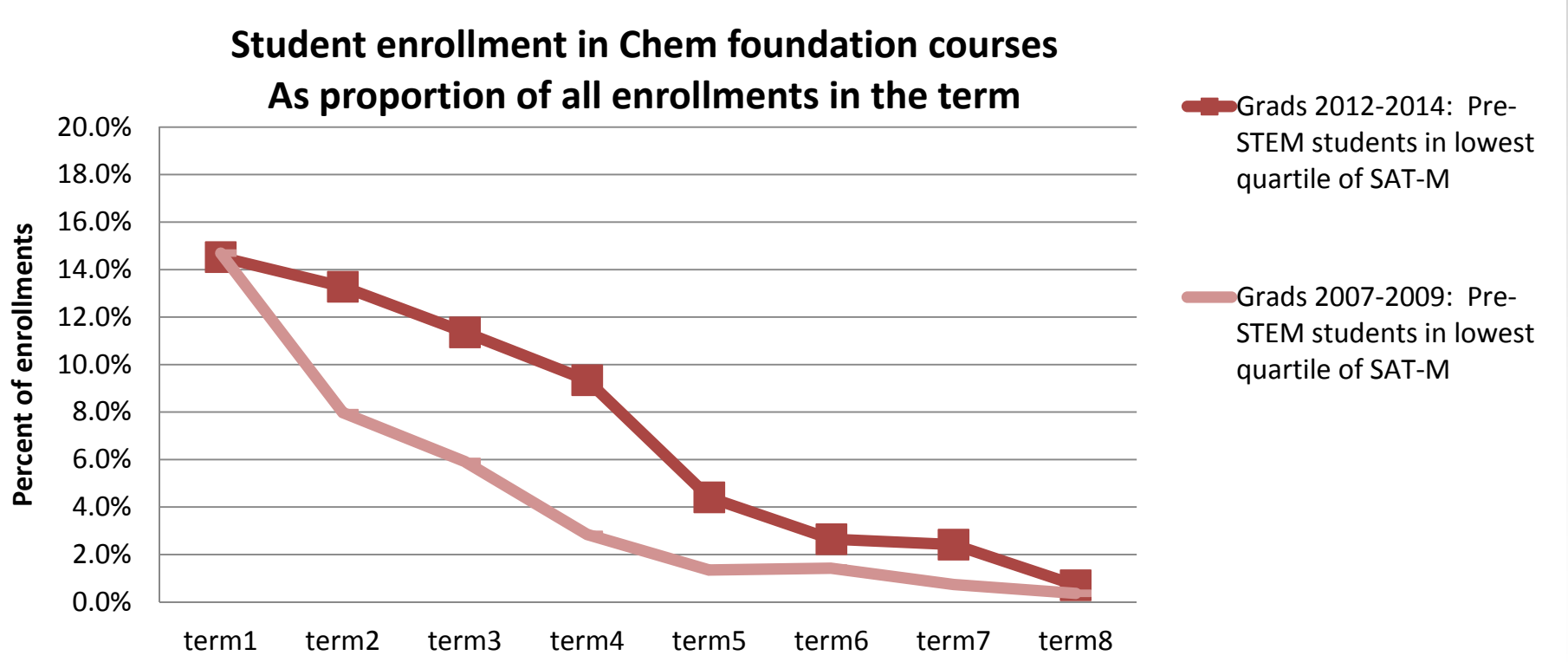

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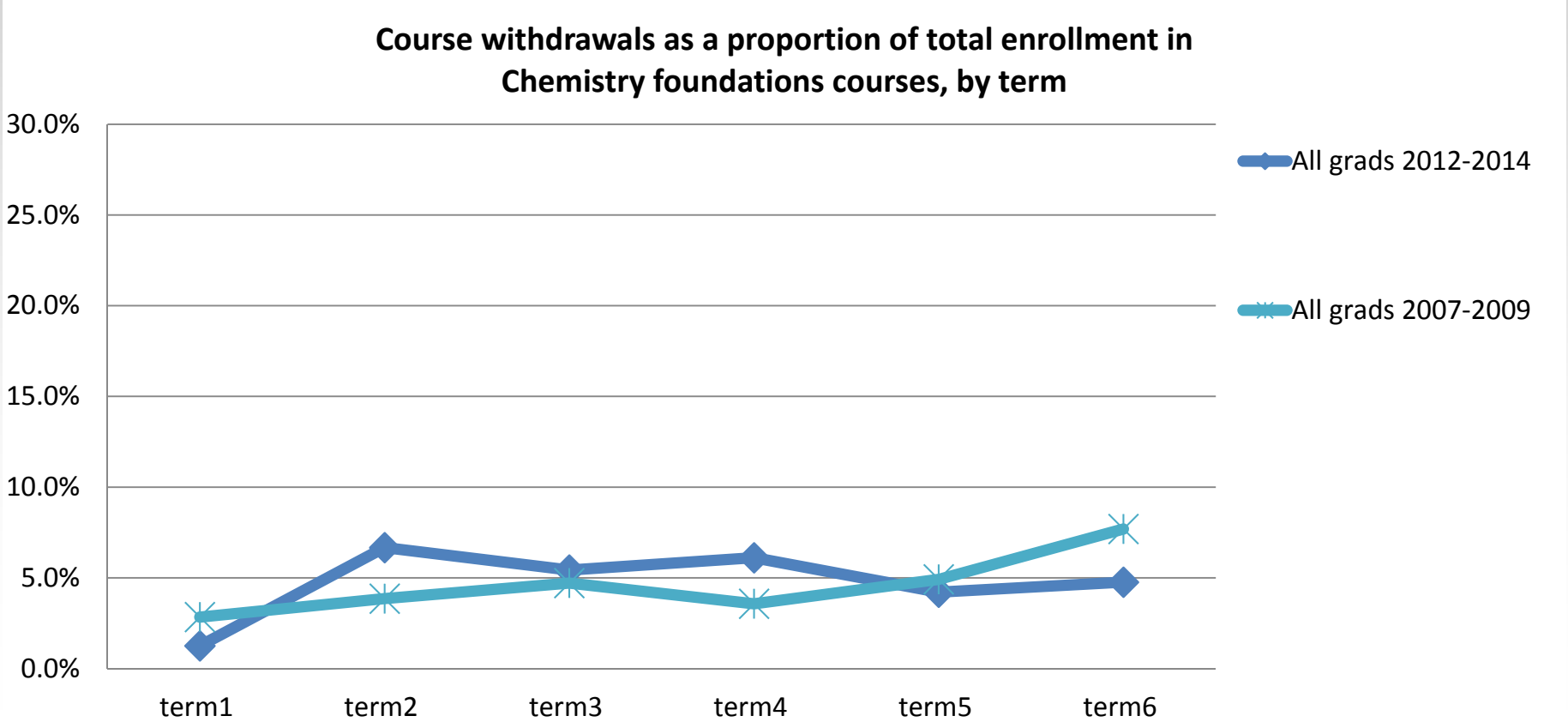

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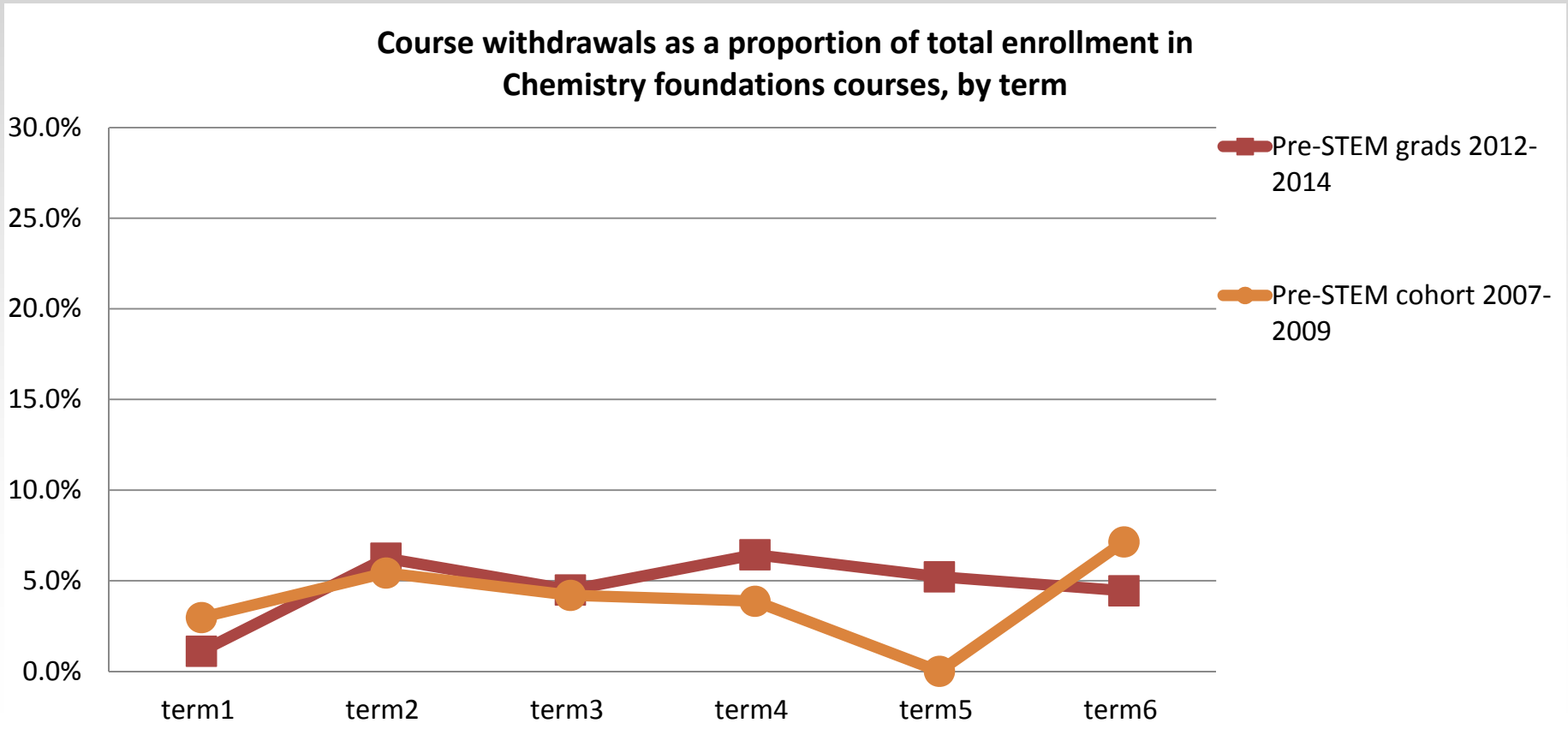

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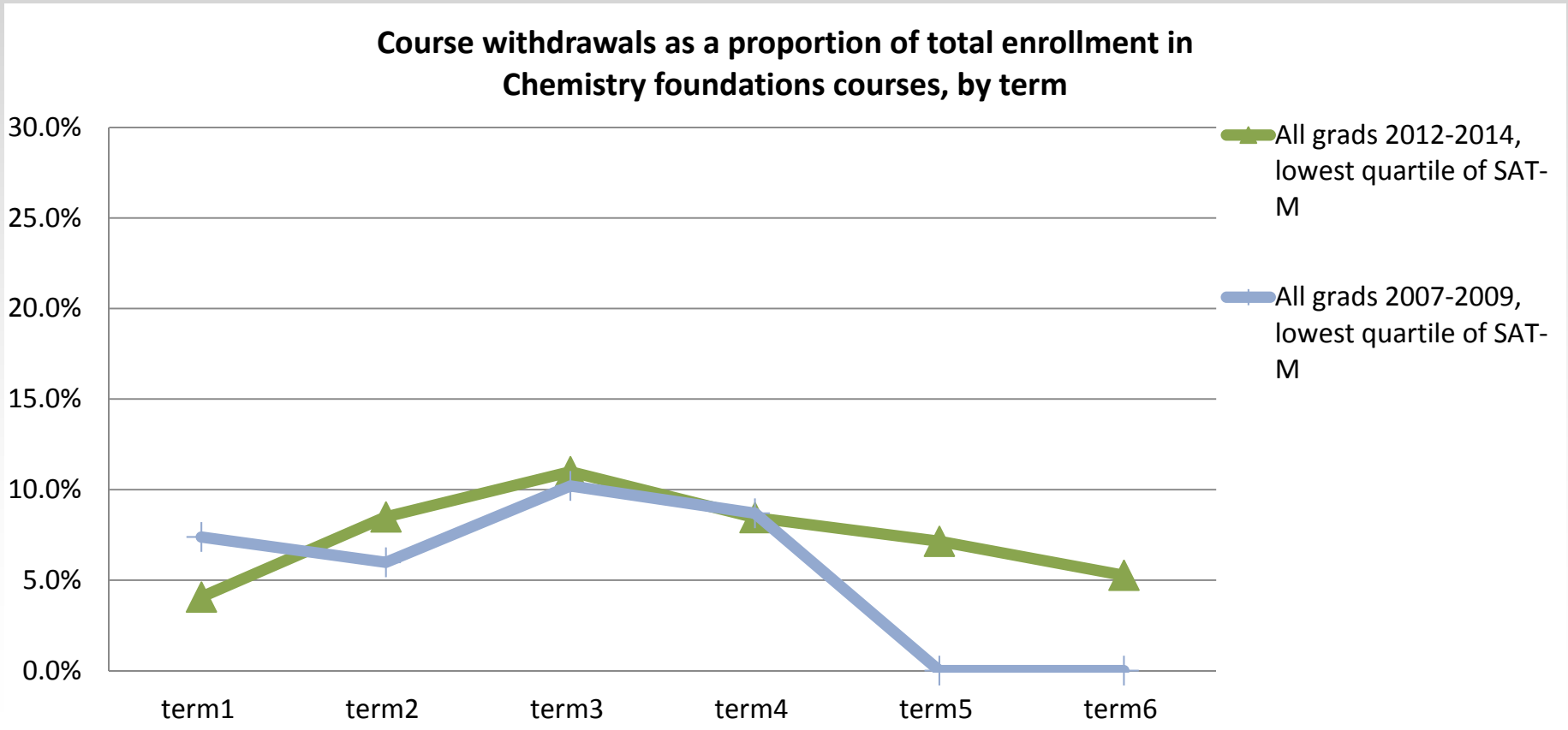

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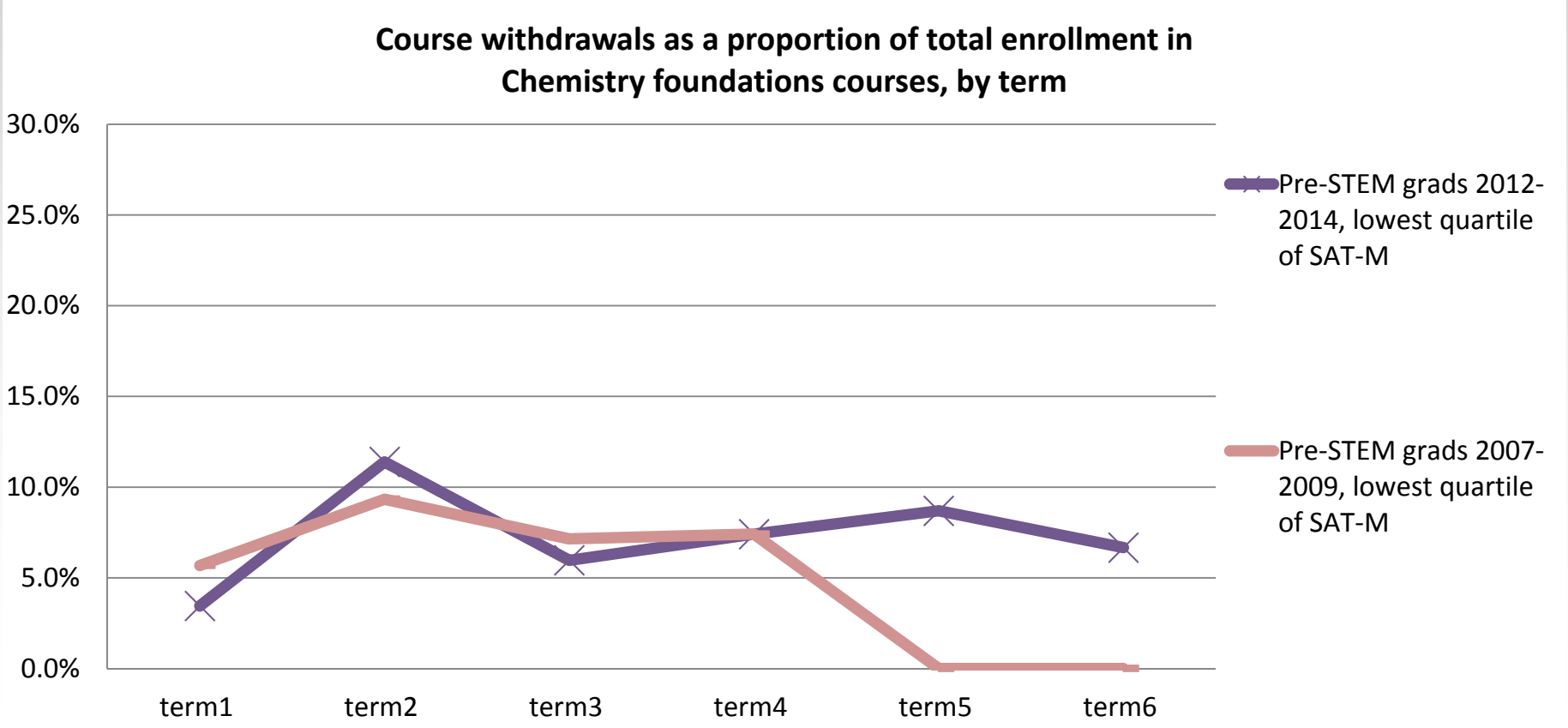

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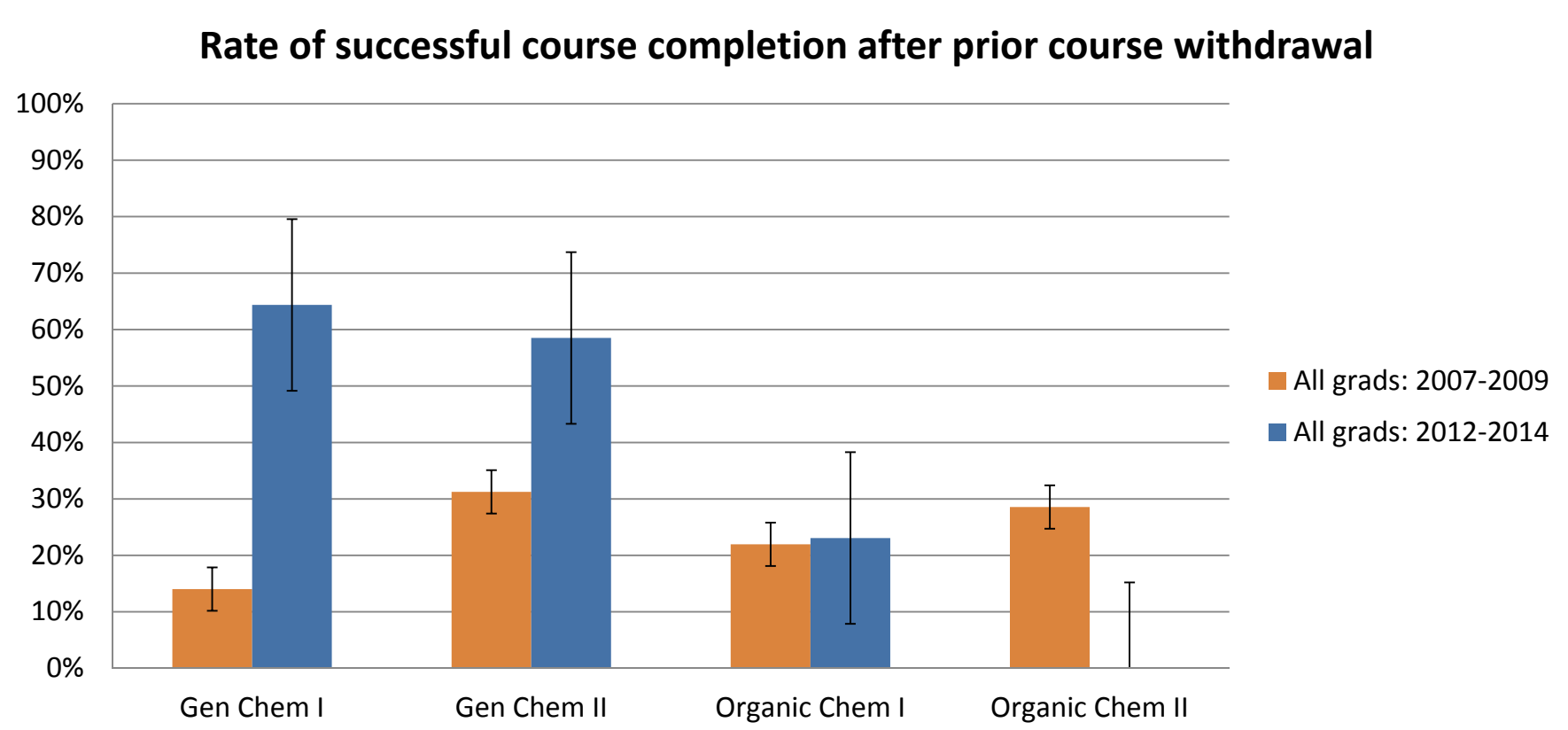

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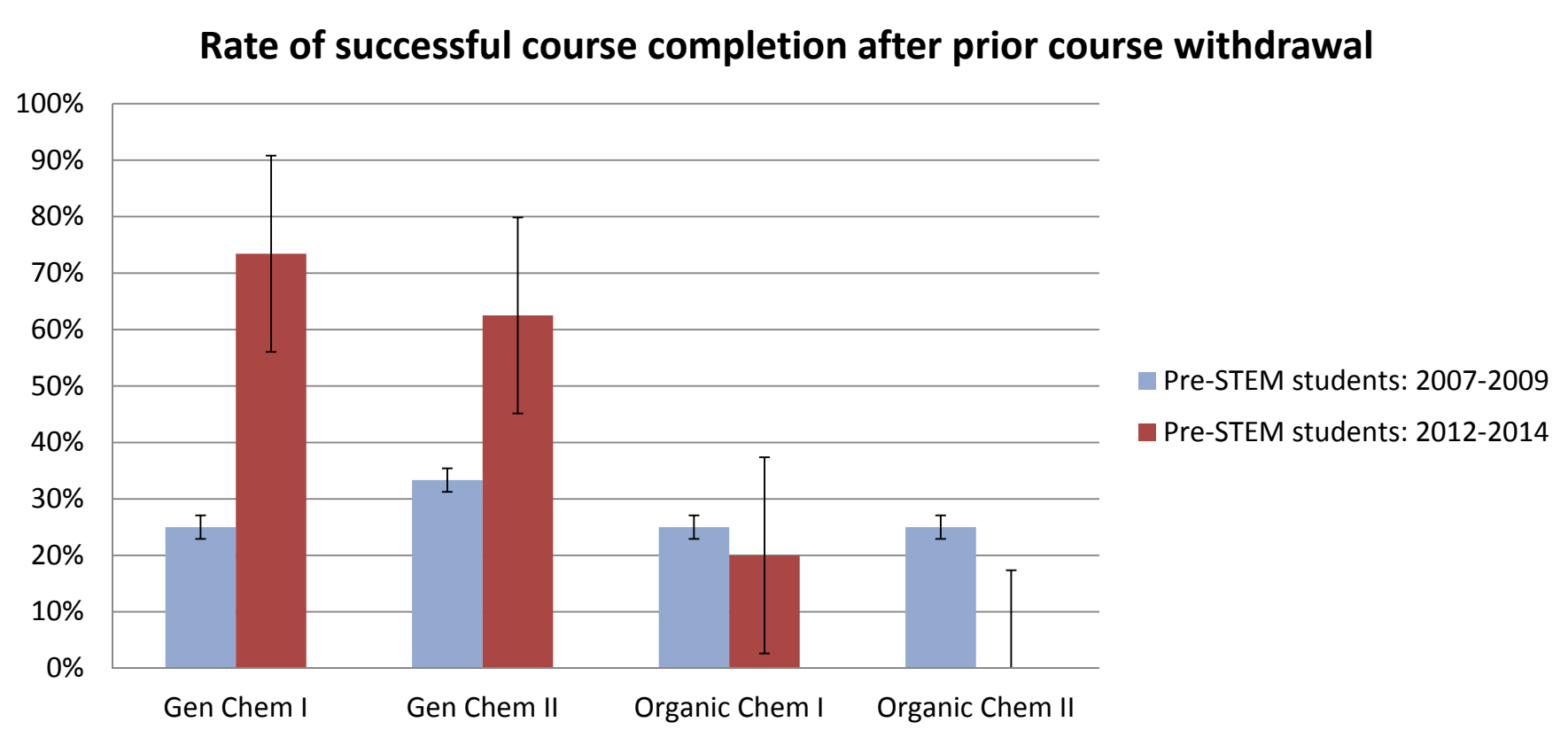

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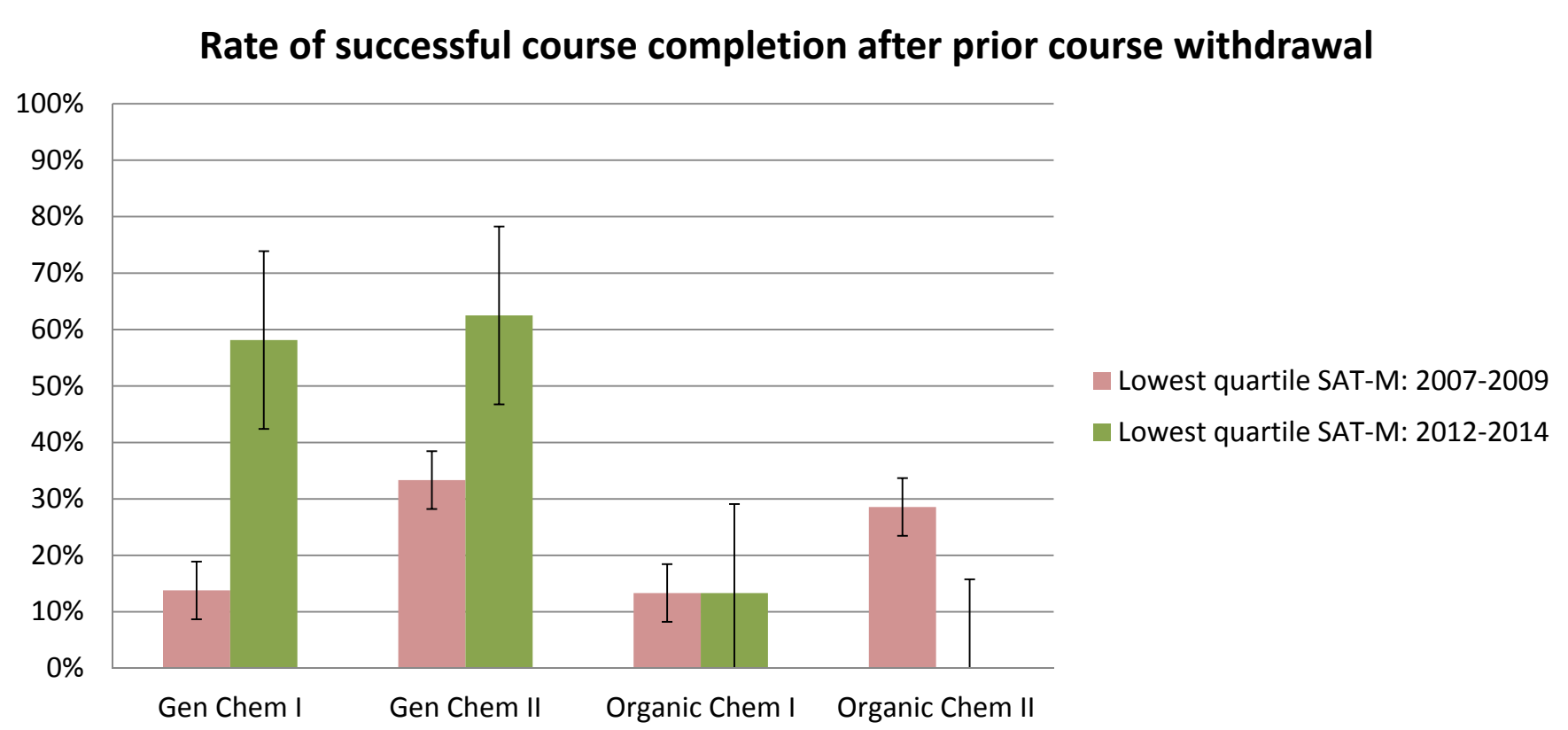

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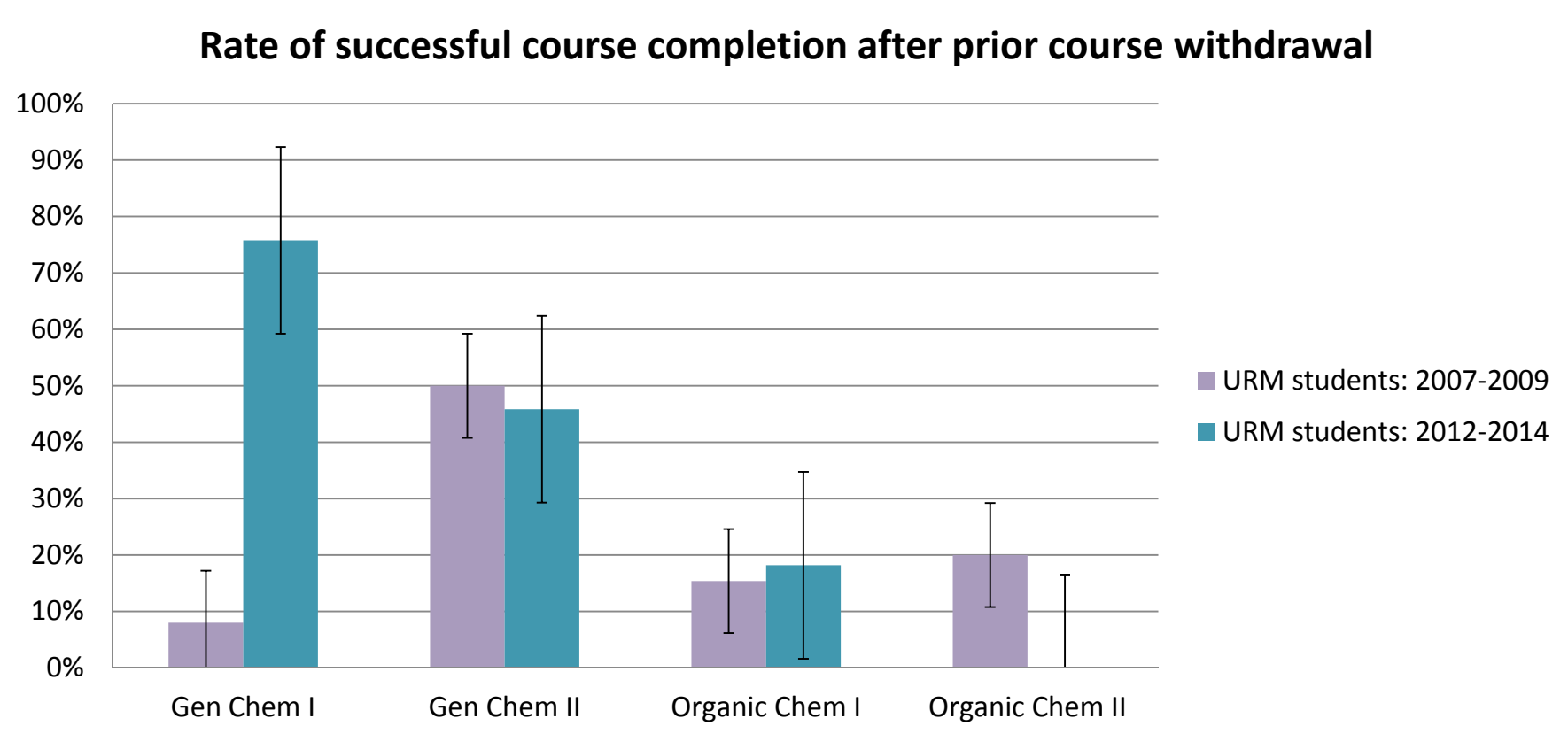

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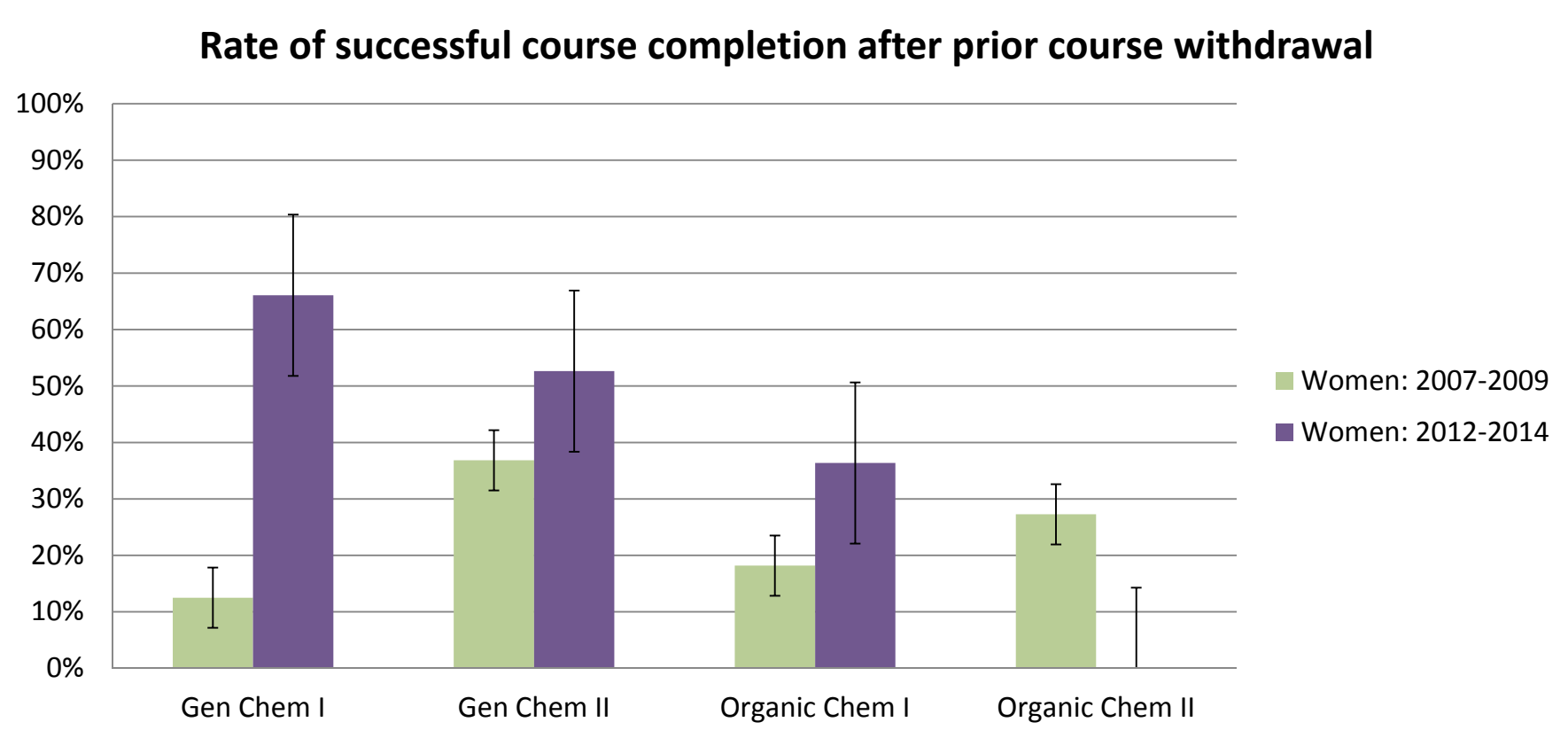

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Dori, do you want to include your very persuasive tables from previous years?

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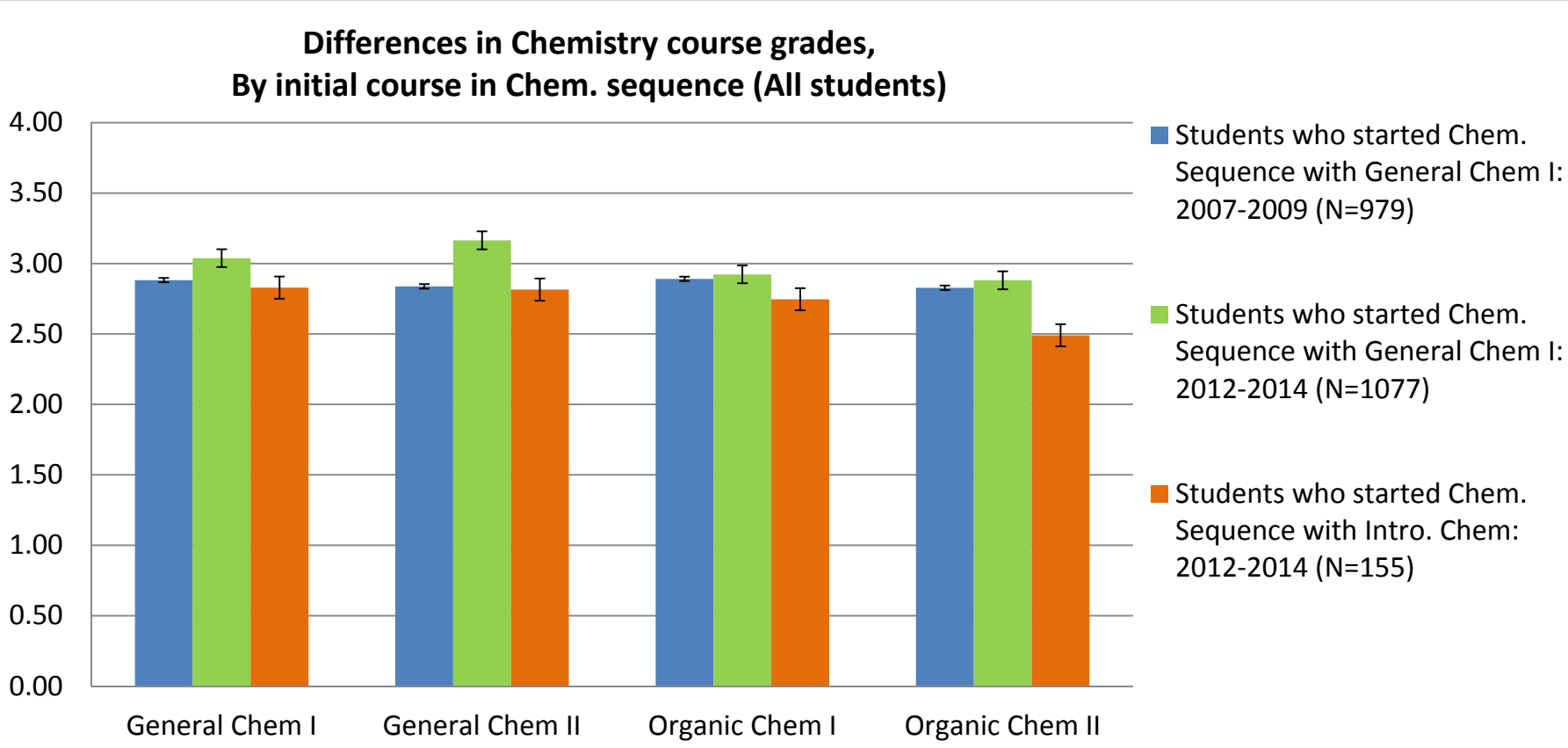

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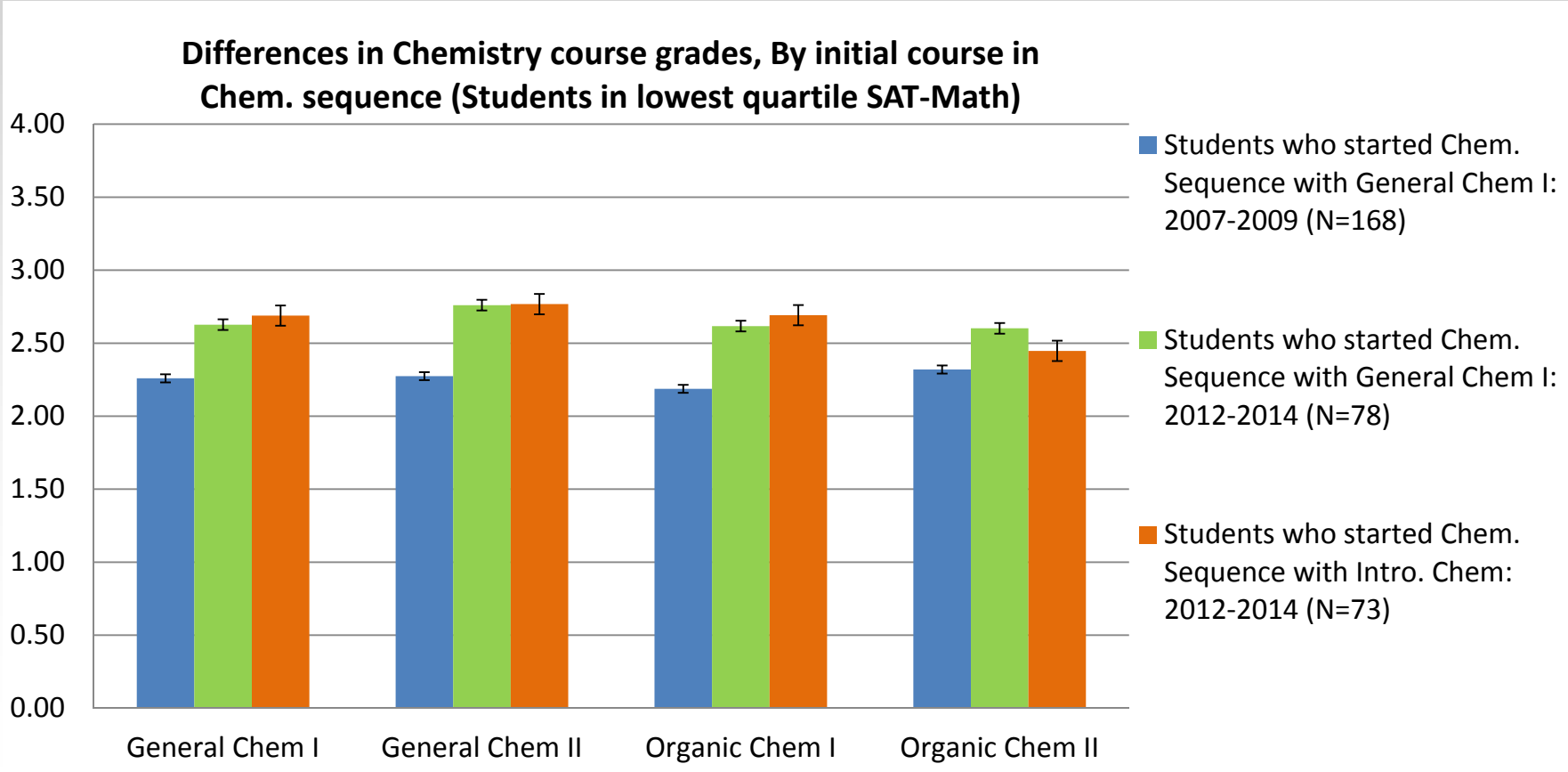

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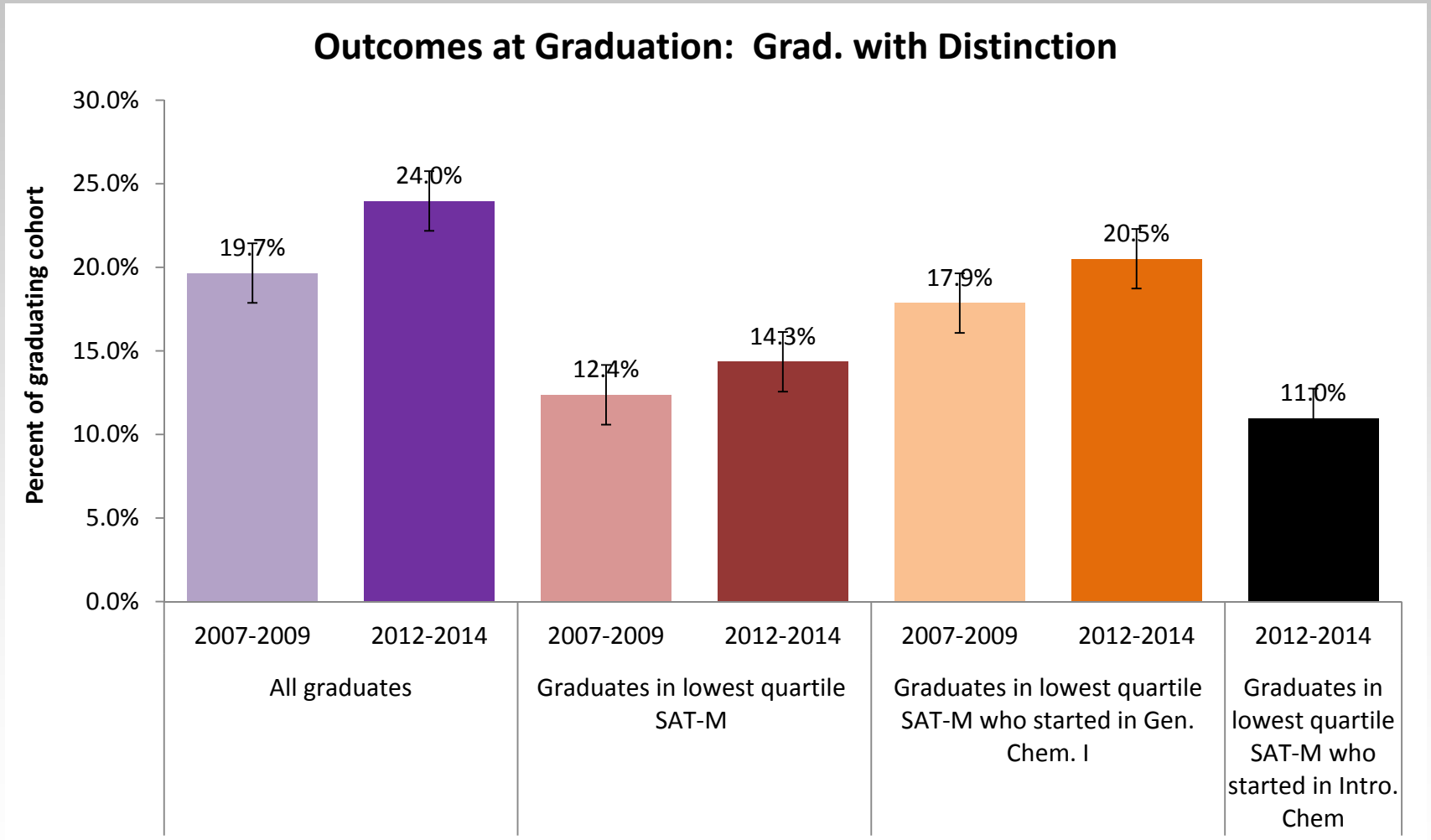

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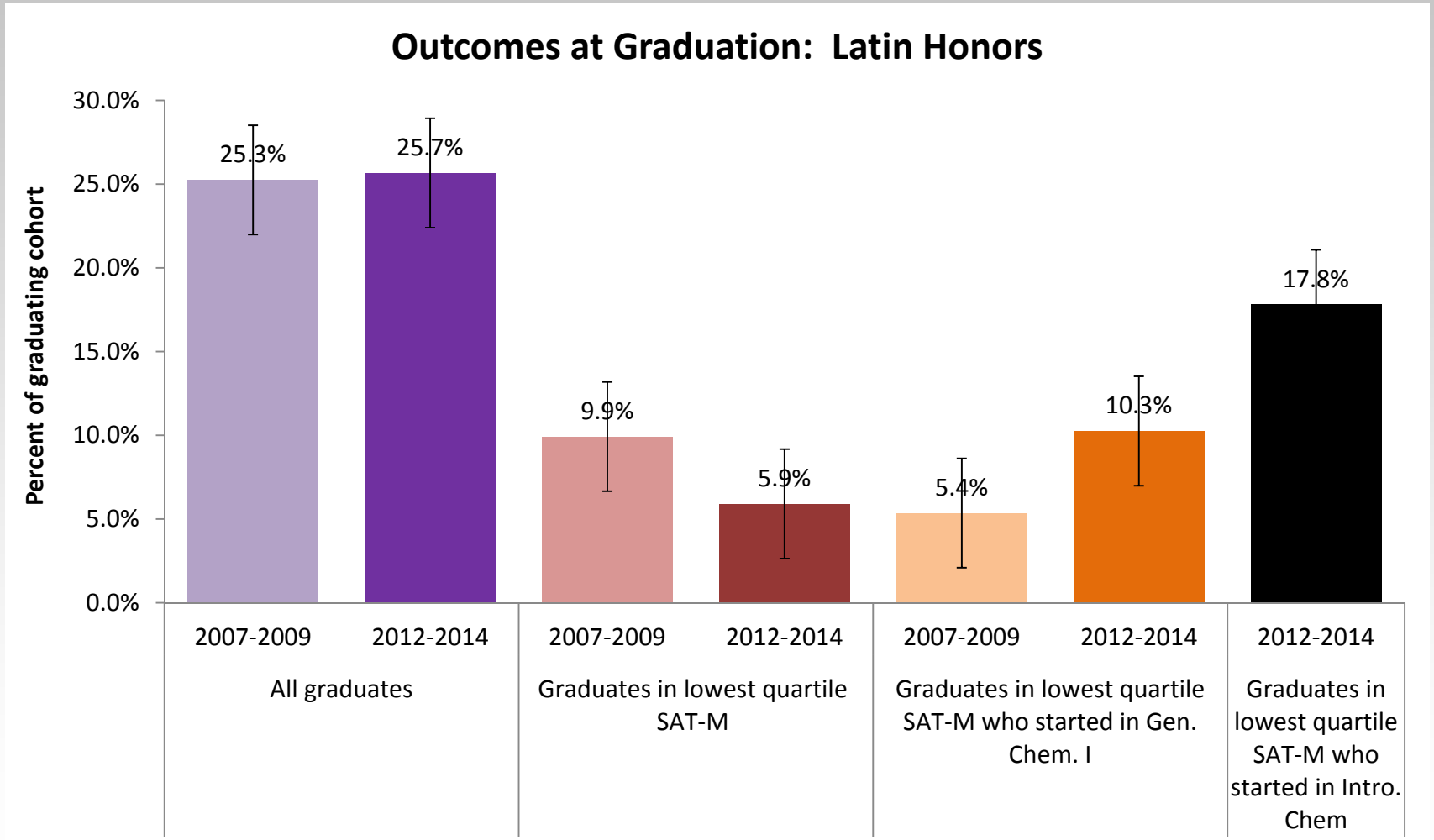

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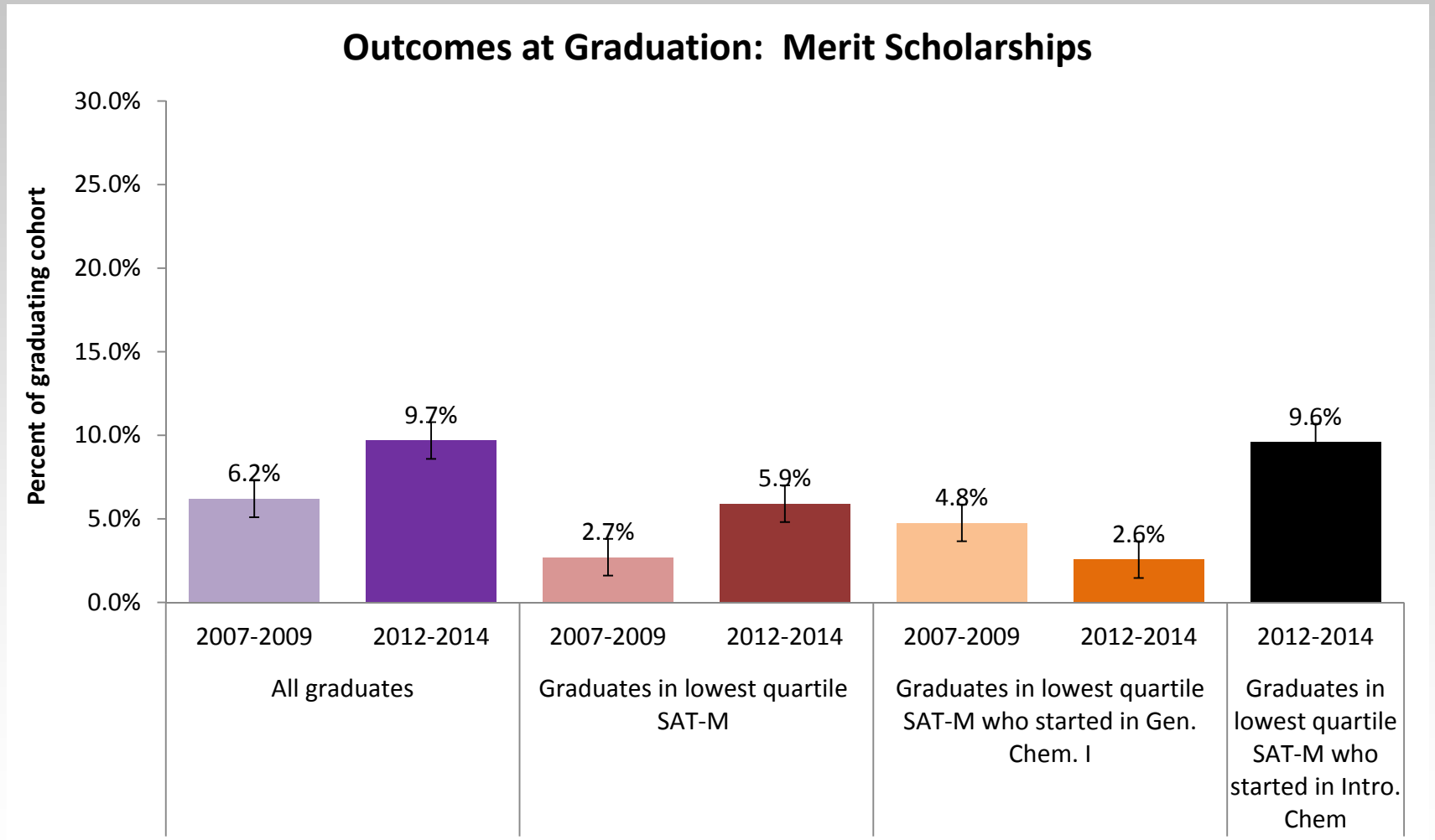

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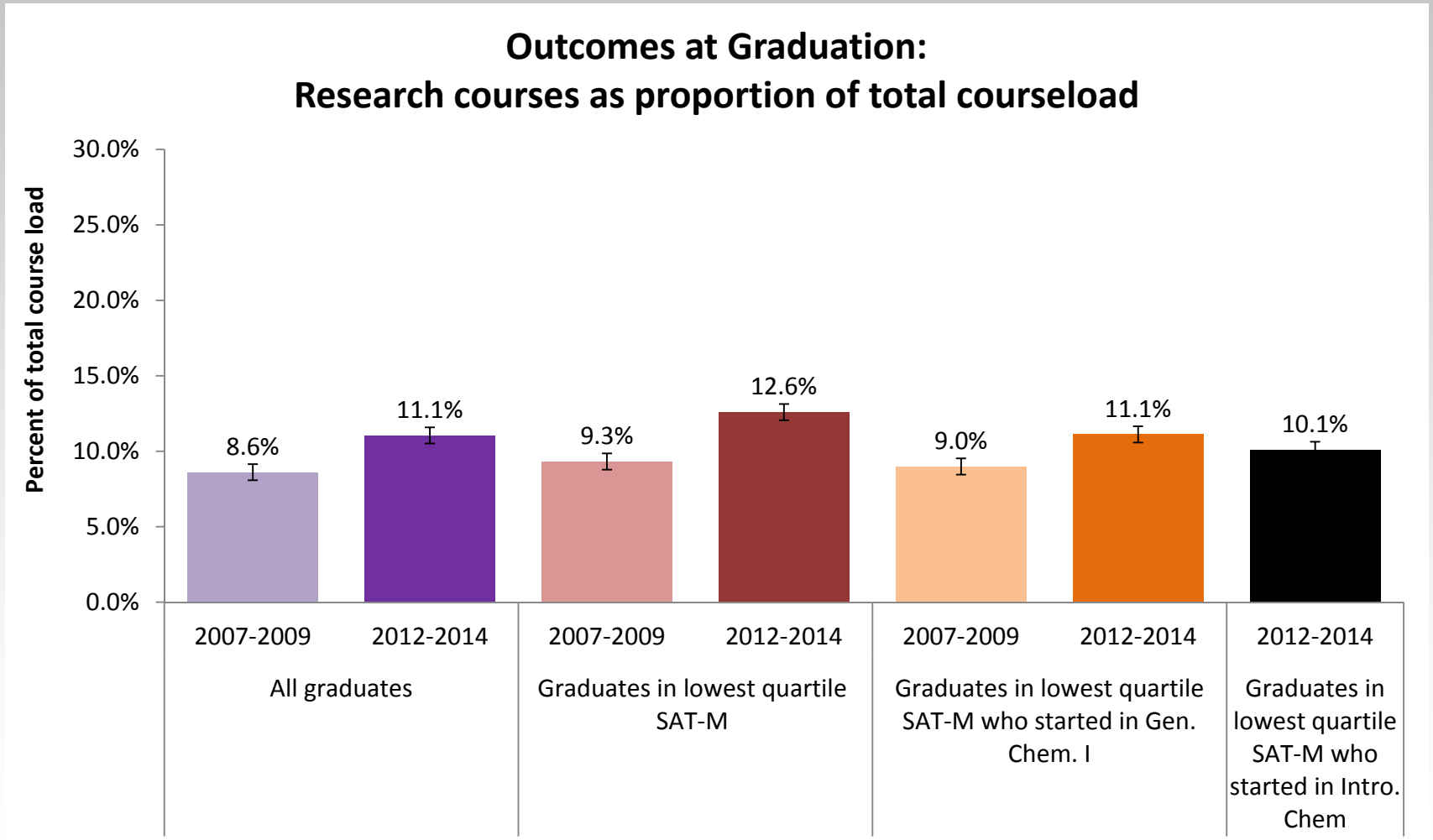

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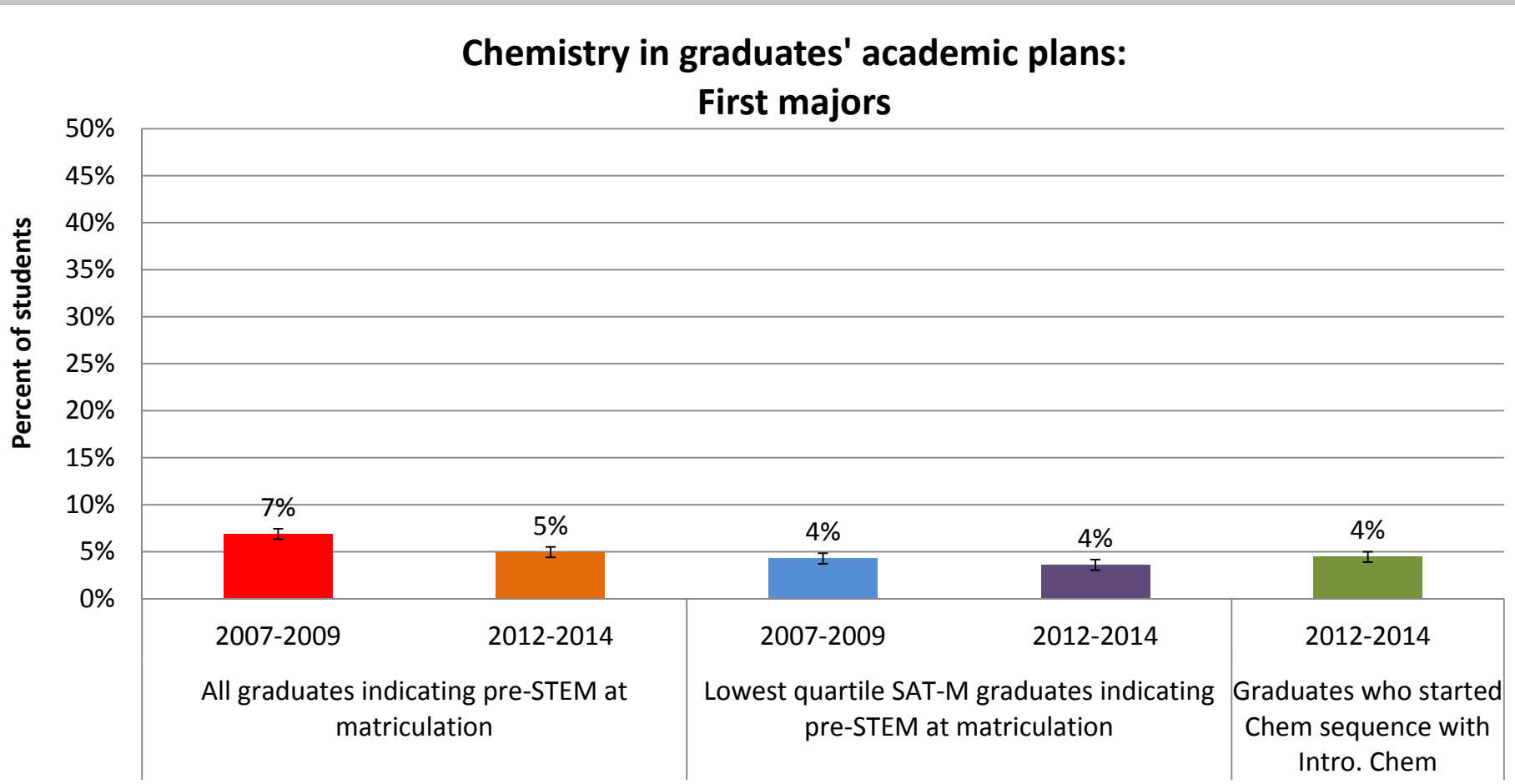

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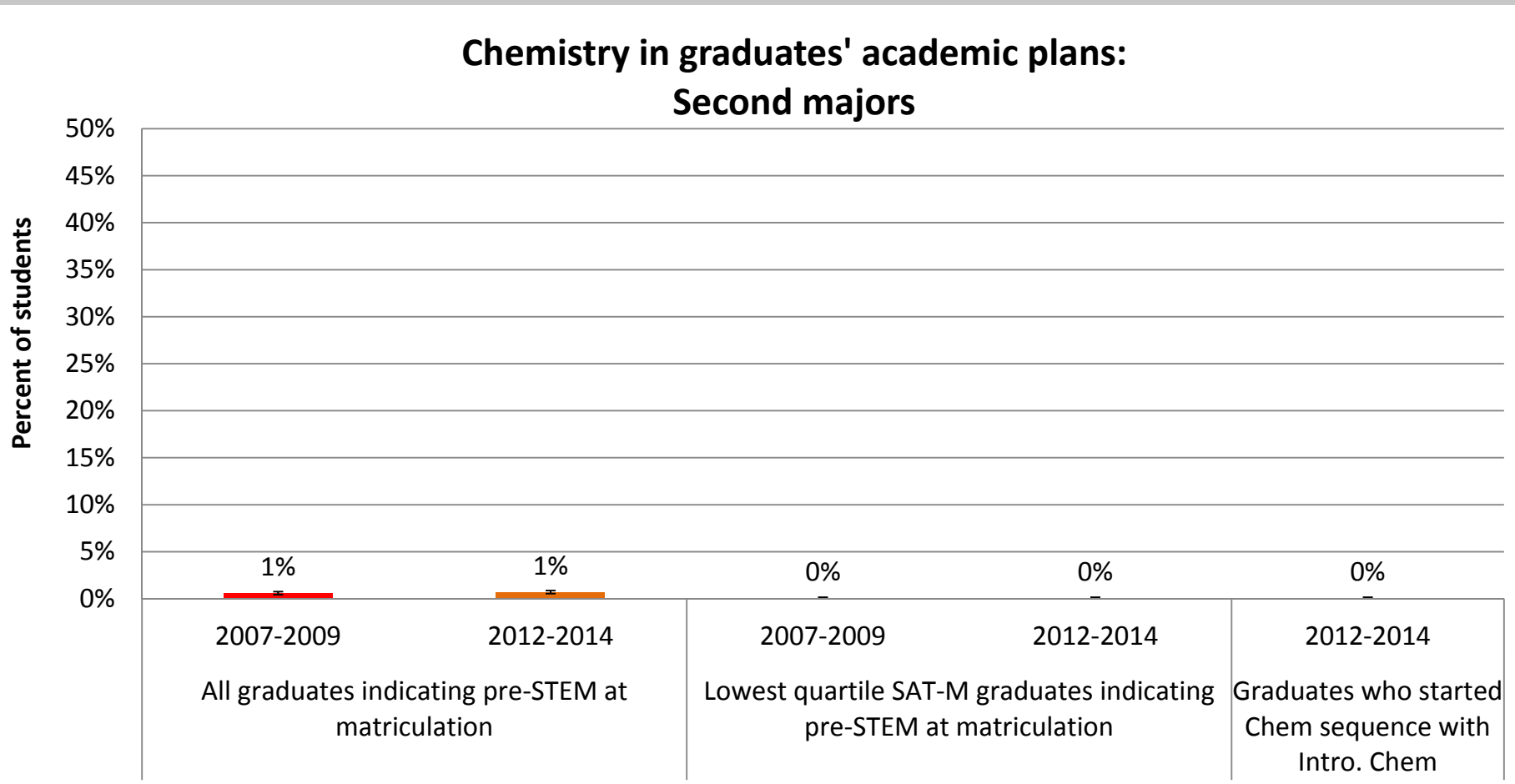

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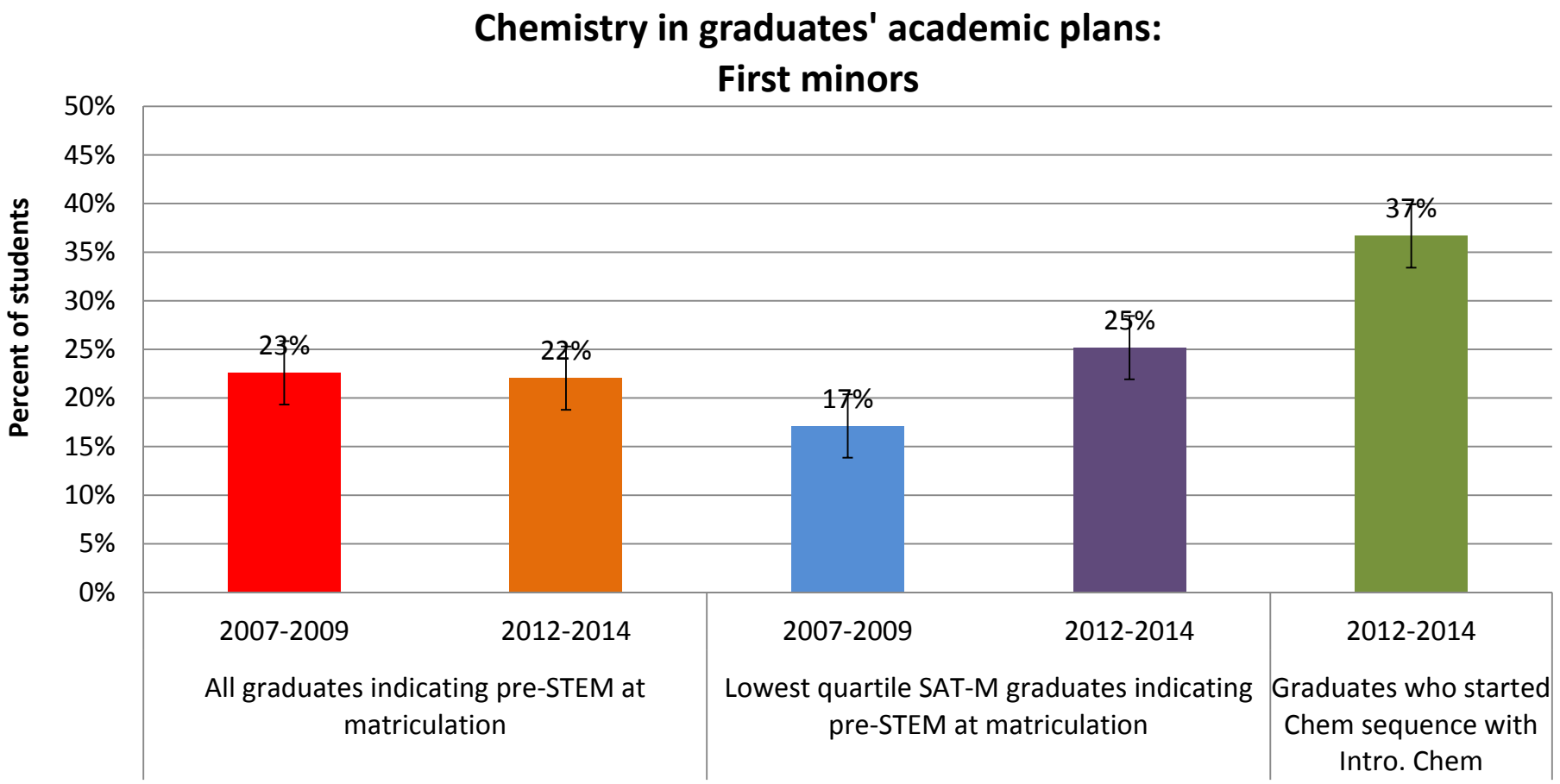

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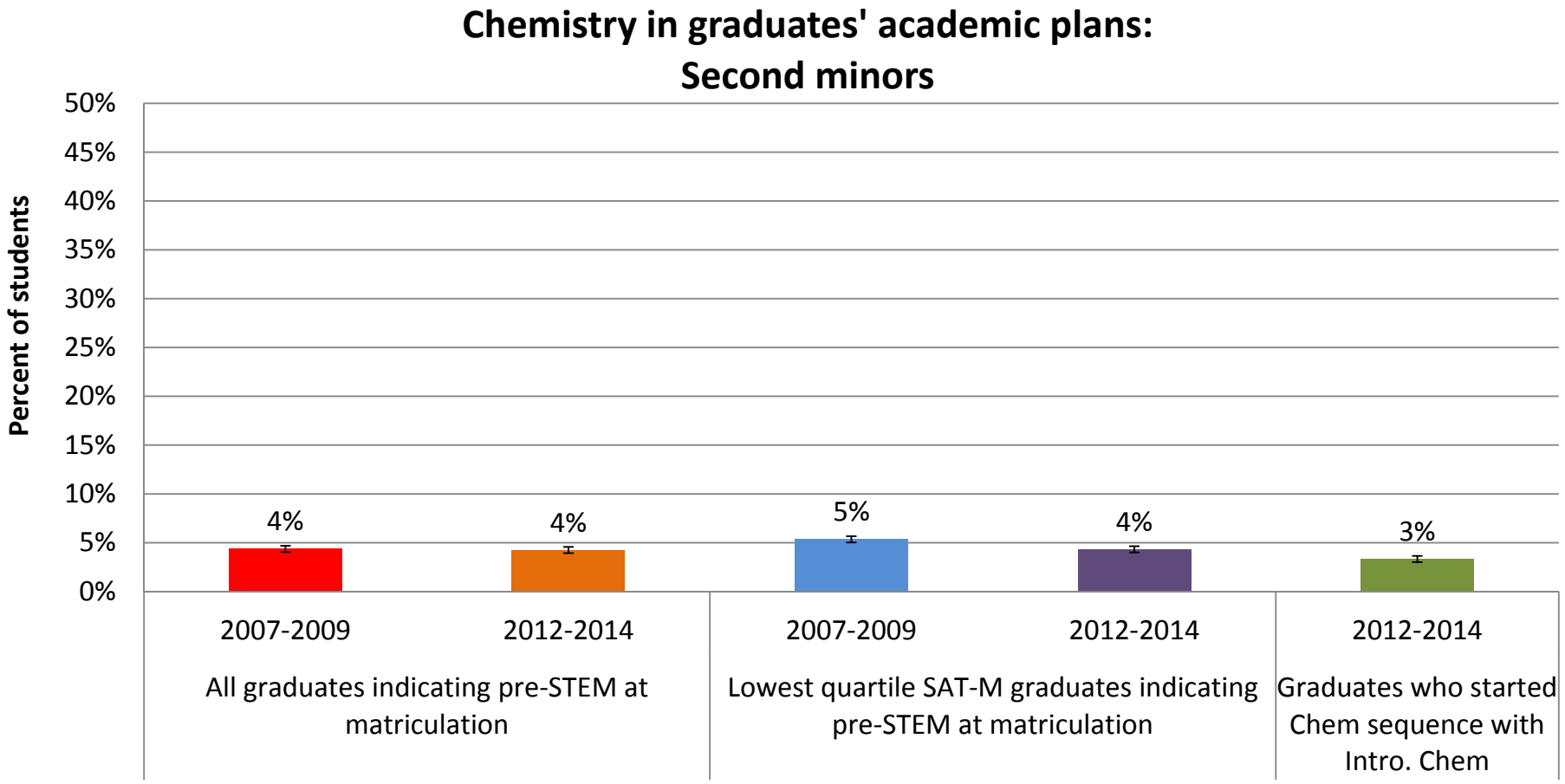

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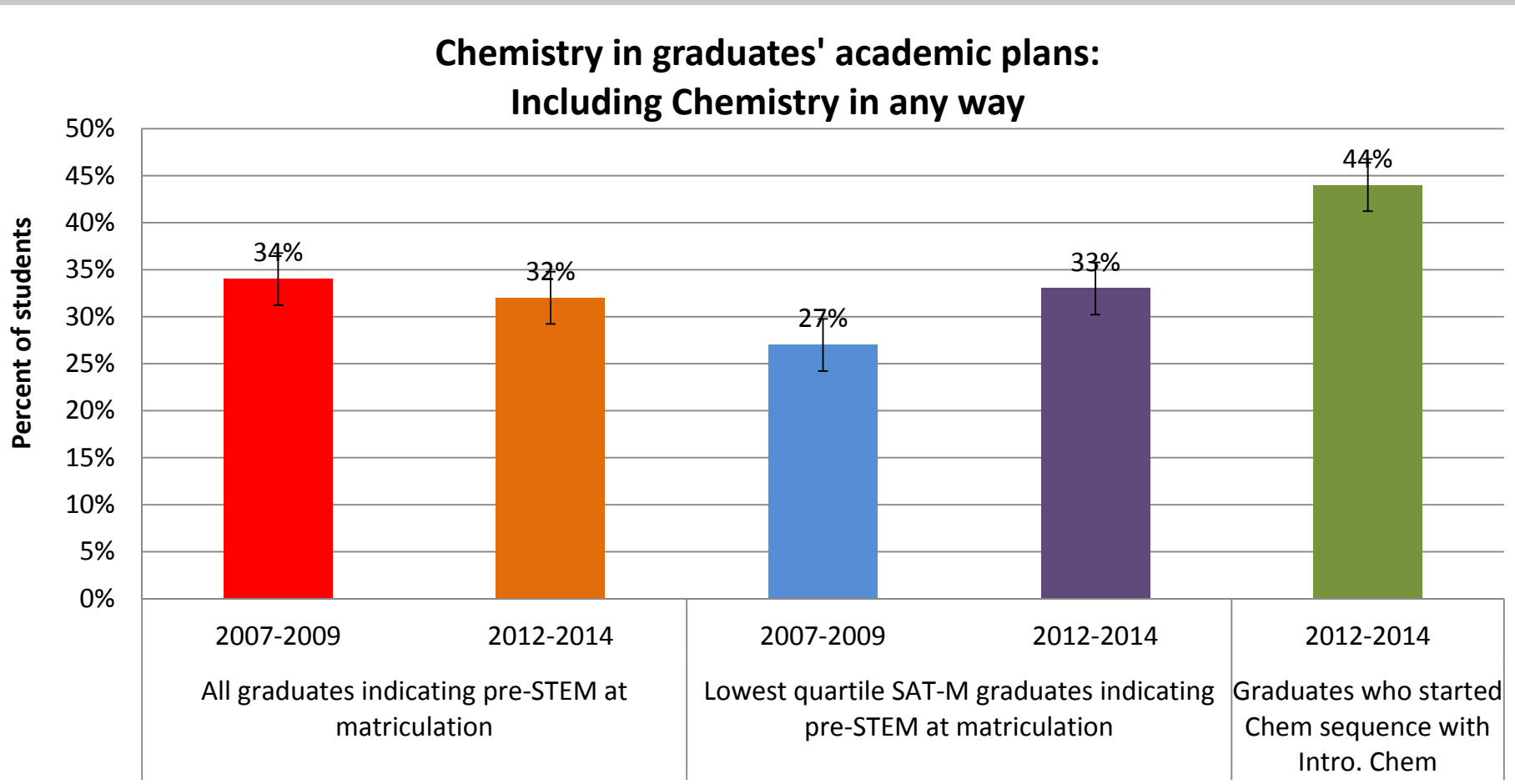

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- Logistic regression model
- Sample:
  Control (2007-2009 grad classes) and treatment cohorts (2012-2014 grad classes), specifically students who indicated being pre-STEM at matriculation
- D.V.: Persistence operationalized as the binary variable:
  Did student successfully complete the final recommended course in the sequence of Chemistry foundations courses?
- Independent variables include
  - *Pre-matriculation markers from Office of Admissions*
  - *Biodemographic information from Office of Admissions, College Board, etc.*
  - *Academic data collected during tenure at Duke*

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- Sample:
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- D.V.: Retention operationalized as the binary variable:
  Did student successfully complete the final recommended course in the sequence of Chemistry foundations courses?
- Independent variables include
  - *Pre-matriculation markers from Office of Admissions*
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Study findings & interpretation

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OLS regression model

- Dependent variables
  - Grade in first semester Organic Chemistry
  - Cumulative GPA in Chemistry foundations coursework
- Independent variables
  - Pre-matriculation markers from Office of Admissions
  - Biodemographic information

Study methodology: Part 2

- Track students enrolled in Chemistry foundations courses by point of entry, monitoring attrition and grade outcomes by course
- Follow-up with quantitative modeling using stepwise OLS regression

Learning in Organic Chemistry

- Strategy: Hybrid Lecture/Activity Format
- Mirror successful pedagogy used in Chem99
- Many students enjoy lectures
- Importance of inquiry in learning:
  - Paletz Innovative Teaching Grant

    Add in POGIL or SCALE UP activities to build basics, Problem Manipulation exercises to challenge even the strongest students

Learning in Organic Chemistry

- Are we sacrificing content if we don't lecture about every topic?
- Problems, class activities, and applications:
  - students can construct independent knowledge
  - students learn from peer discussions
  - Students become motivated: leads to "early frequency of study" (Szu et al *J. Chem. Ed. 2011*)
  - instructors become more enlightened about the learning challenges for a particular topic/student population in real time
  - strongest students retain information better

    (S. M. Hein, *J. Chem. Ed.* **89**, 860 (2012))

Learning in Organic Chemistry

- Collaboration with Linnenbrink-Garcia: Link to and enhance LEAP study data
- better understand if, how, and why student-centered interventions are effective in undergraduate chemistry courses.
  - The baseline and follow up surveys from the LEAP protocol provide a rich longitudinal database foundation upon which we can build with this research (thousands of students over past 3 years)
  - assessment of key psychological variables (e.g., interest and value, perceived competence, beliefs about knowing and knowledge, identity development, feelings of belonging)
  - Compare hybrid section & traditional lecture sections

Learning in Organic Chemistry

- Student Assessment of Learning Gains (SALG) instrument

  –surveys will also include assessments of students' perception of how well the course addresses course learning objectives and broad science literacy and skill development

  For example, develop and deploy:

  American Chemical Society (ACS) Student Skills Survey

EXAMPLE SURVEY:

These questions ask you to rate the degree to which this course has improved your ability to achieve specific American Chemical Society (ACS) student skills. For each skill, you'll need to select a number to show how well THIS COURSE increased your ability to achieve each skill. If you select a 1, that means that you strongly disagree – the course did not improve your ability to use this skill. If you select a 3, that means the course moderately increased your ability to use this skill. If you select a 5, that means that you strongly agree that the course improved your ability to use this skill.

	1 Strongly Disagree	2	3 Moderately Agree	4	5 Strongly Agree
Define problems clearly.	○	○	○	○	○
Use appropriate laboratory skills and instrumentation to solve problems.	○	○	○	○	○
Use the peer-reviewed scientific literature effectively and evaluate technical articles critically.	○	○	○	○	○
Retrieve specific information from the chemical literature with online, interactive searching tools.	○	○	○	○	○
Understand the concepts of safe laboratory practices and how to apply them.	○	○	○	○	○
Present information in a clear and organized manner.	○	○	○	○	○
Work effectively in a group to solve problems.	○	○	○	○	○
Be aware of the role of chemistry in contemporary societal and global ethical issues.	○	○	○	○	○
Develop testable hypotheses.	○	○	○	○	○
Design and execute experiments.	○	○	○	○	○
Analyze data and models and draw appropriate conclusions.	○	○	○	○	○
Write well-organized and concise reports in a scientifically appropriate style.	○	○	○	○	○

Develop Activities, Materials, & Technology for Inquiry-Based Learning

- Grant from CIT: 11 iPads (one per group) to develop new computer-based classroom activities for organic learning
- Inspiration came from:

  Abraham et al. J. Chem. Ed. 2010, *87(12)*, 1425-9.
- Stereochemistry as an example

- Collaborations with NCSU and VCU in the works: gathering preliminary data for grant proposals targeting the end of the year.

Investigation of Interactive Online Learning Systems

- *How can chemistry courses change in response to rapid increases in the vast and nearly instantaneous availability of public factual information in all disciplines?*
- Can we more effectively channel students to the appropriate level resources? ALEKS?
- Challenge: Internet materials can be moving targets!
- Challenge: Many of the online problem sets gear for a certain "course" are not sufficiently challenging for our students
- Student contribution idea being tested this term

"New" Course Development

- Keep gateway courses current
- Opportunities for upper level courses?
  - Example) Educ390T
  - Synthesis of Polymers and/or Polymer Physics
- Continue developing entry level courses (lower than 100 level)