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Which learning outcomes and teaching methods are instructors really emphasizing in STEM courses?

STEM Teaching Methods That Work

An *Inside Higher Ed* Webinar

March 13, 2013

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Insight
Improvement
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- **I**ndividual **D**evelopment and **E**ducational **A**ssessment
- Kellogg Grant in 1975
- Non-profit Organization in 2001
- Mission

To serve colleges and universities committed to improving learning, teaching, and leadership performance.

Session Overview

- The IDEA Student Learning Model
- Objectives emphasized in STEM classes
- Student learning in STEM classes
- Teaching methods emphasized in STEM classes
- Student and course characteristics in STEM classes

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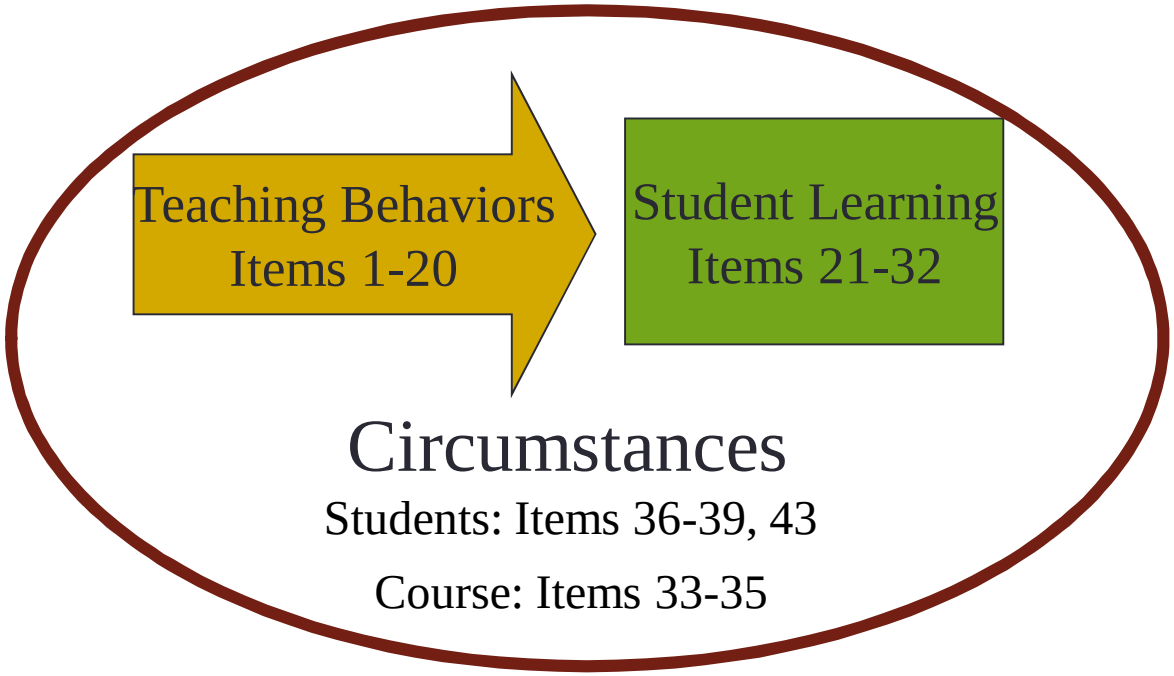
Student Learning Model

- Specific teaching methods influence certain types of student progress (learning) under certain circumstances.



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Learning Objective Category	Faculty Information Form Item Number
Basic Cognitive Background	1, 2
Applications of Learning	3, 4
Expressiveness	6, 8
Intellectual Development	7, 10, 11
Lifelong Learning	9, 12
Team Skills	5

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Teaching Method Category	Diagnostic Form Item Number
Stimulating Student Interest	4, 8, 13, 15
Fostering Student Collaboration	5, 16, 18
Establishing Rapport	1, 2, 7, 20
Encouraging Student Involvement	9, 11, 14,19
Structuring Classroom Experiences	3, 6, 10, 12, 17

Procedure

- Classes using IDEA in academic years 2007-2011
- STEM Classes - 283,176
  - Science – 126,898
  - Computer science – 40, 790
  - Engineering – 37, 534
  - Math – 77, 954
- Non-Stem Classes – 1,800,013
- National (All) Classes - 2,083,189

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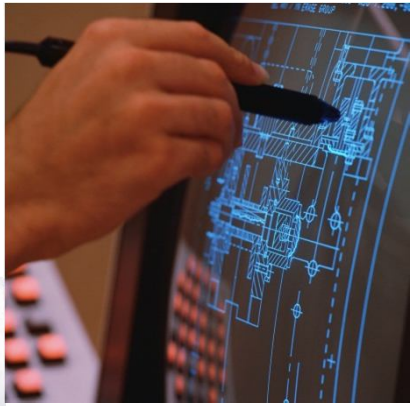
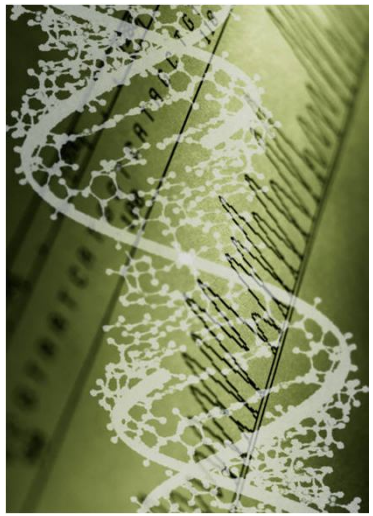
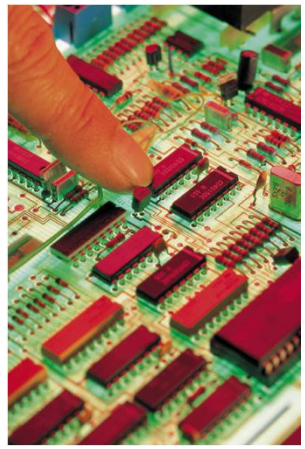
Discussion Question

- Of the 12 IDEA Learning Objectives, which are the 5 most frequently selected by faculty as being Important or Essential in STEM courses?







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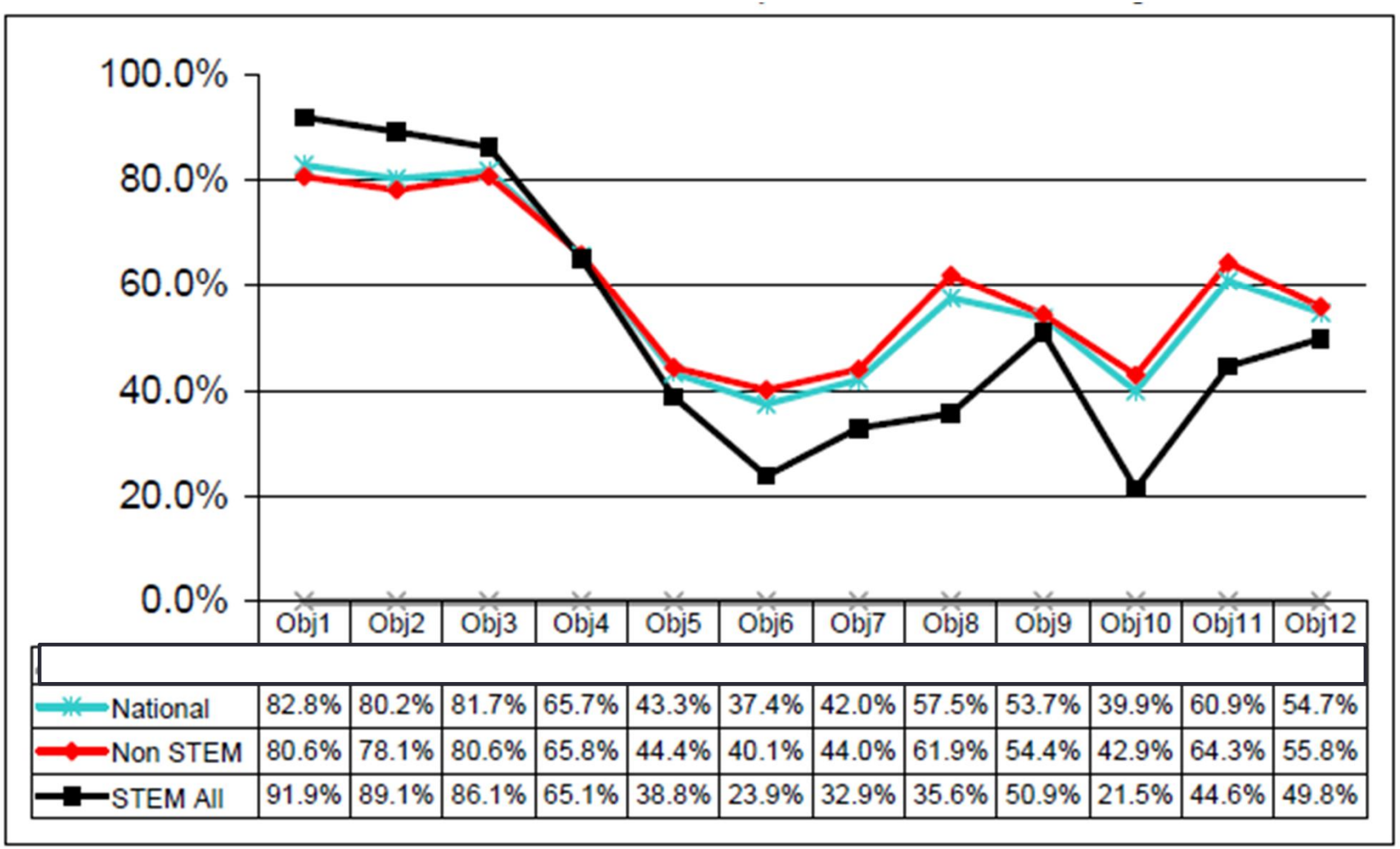
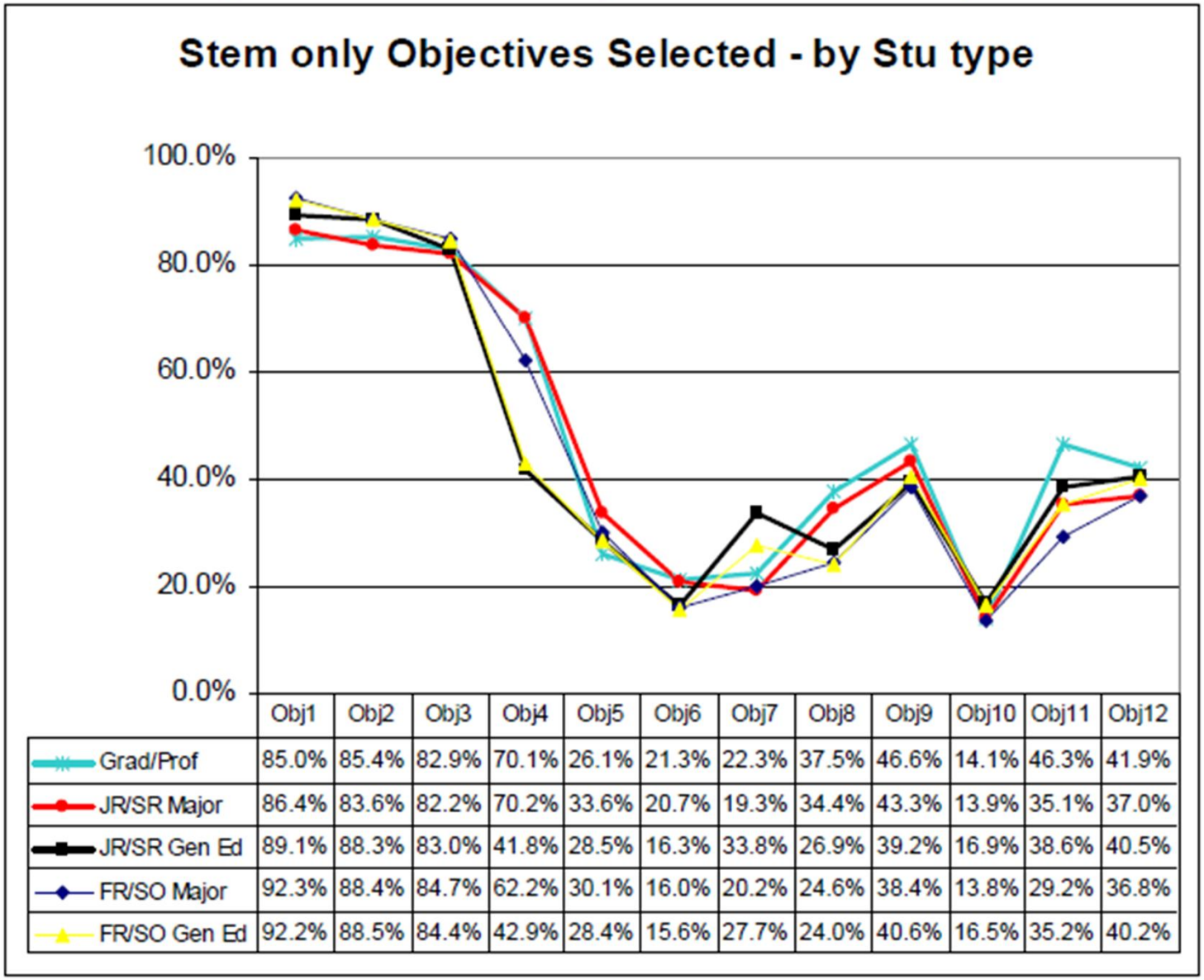
Which learning objectives are emphasized in STEM classes?



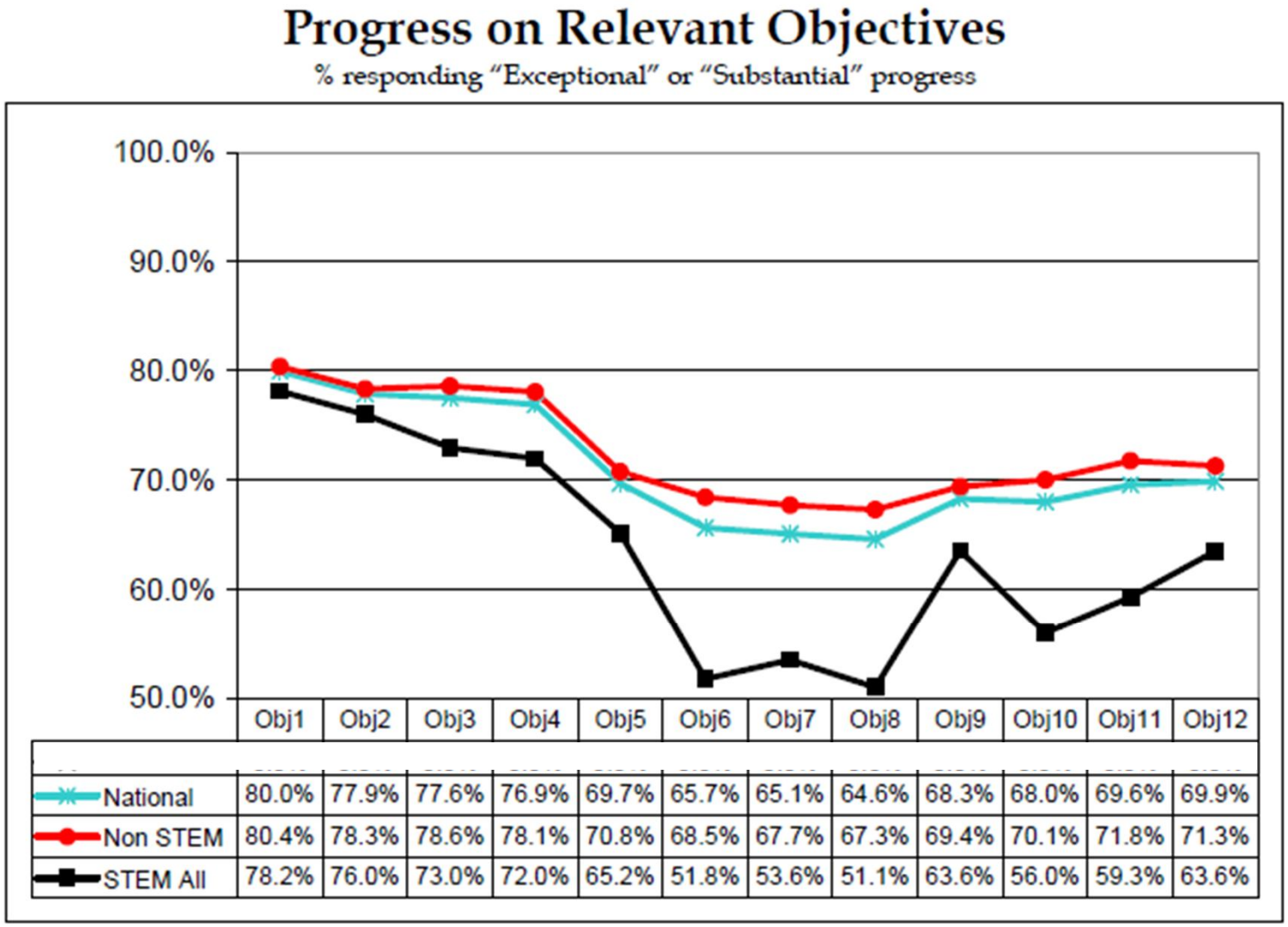
	Obj1	Obj2	Obj3	Obj4	Obj5	Obj6	Obj7	Obj8	Obj9	Obj10	Obj11	Obj12
National	82.8%	80.2%	81.7%	65.7%	43.3%	37.4%	42.0%	57.5%	53.7%	39.9%	60.9%	54.7%
Non STEM	80.6%	78.1%	80.6%	65.8%	44.4%	40.1%	44.0%	61.9%	54.4%	42.9%	64.3%	55.8%
STEM All	91.9%	89.1%	86.1%	65.1%	38.8%	23.9%	32.9%	35.6%	50.9%	21.5%	44.6%	49.8%

Are different objectives emphasized by course level?



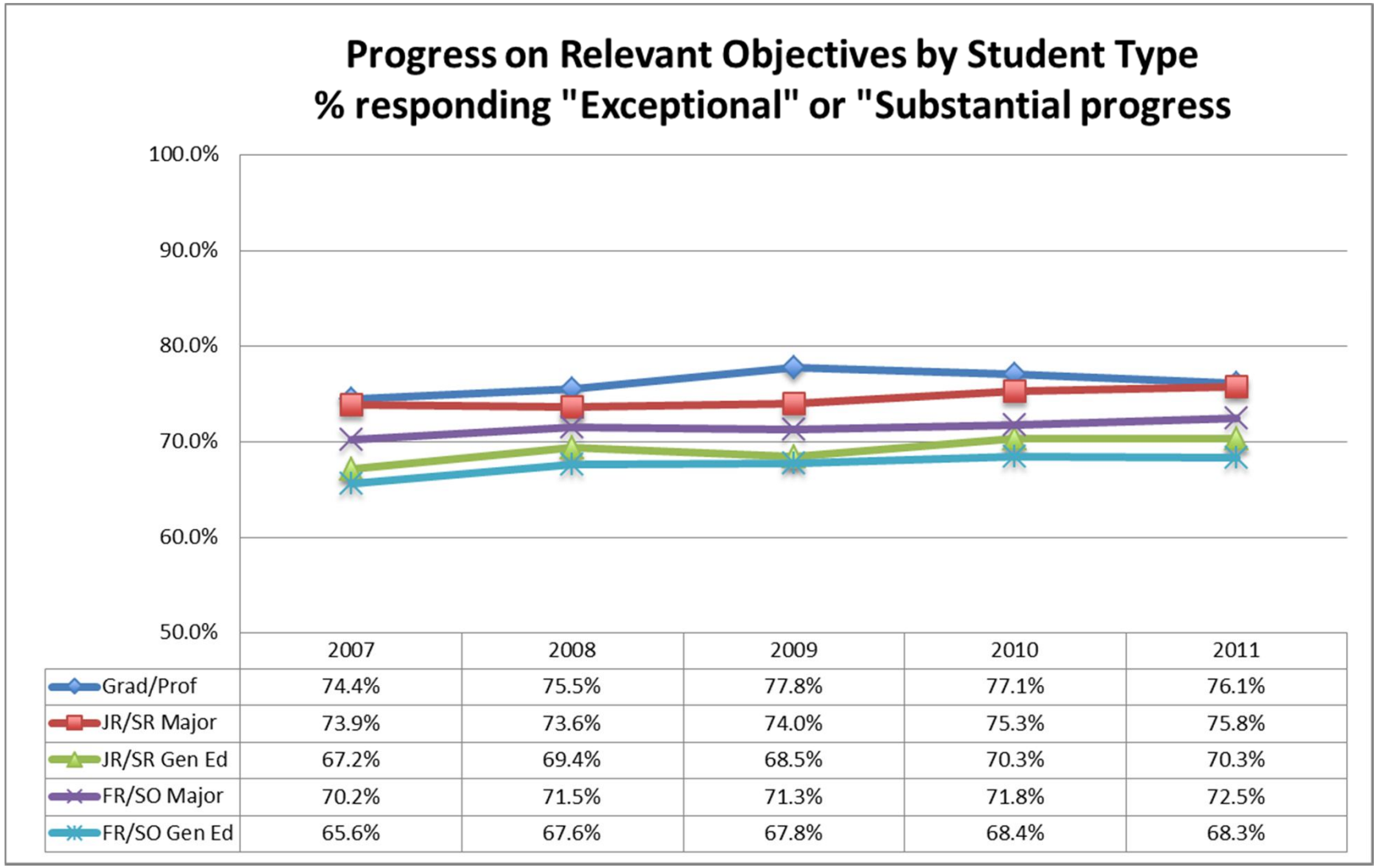
	Obj1	Obj2	Obj3	Obj4	Obj5	Obj6	Obj7	Obj8	Obj9	Obj10	Obj11	Obj12
Grad/Prof	85.0%	85.4%	82.9%	70.1%	26.1%	21.3%	22.3%	37.5%	46.6%	14.1%	46.3%	41.9%
JR/SR Major	86.4%	83.6%	82.2%	70.2%	33.6%	20.7%	19.3%	34.4%	43.3%	13.9%	35.1%	37.0%
JR/SR Gen Ed	89.1%	88.3%	83.0%	41.8%	28.5%	16.3%	33.8%	26.9%	39.2%	16.9%	38.6%	40.5%
FR/SO Major	92.3%	88.4%	84.7%	62.2%	30.1%	16.0%	20.2%	24.6%	38.4%	13.8%	29.2%	36.8%
FR/SO Gen Ed	92.2%	88.5%	84.4%	42.9%	28.4%	15.6%	27.7%	24.0%	40.6%	16.5%	35.2%	40.2%

How much learning are students reporting on relevant learning objectives?



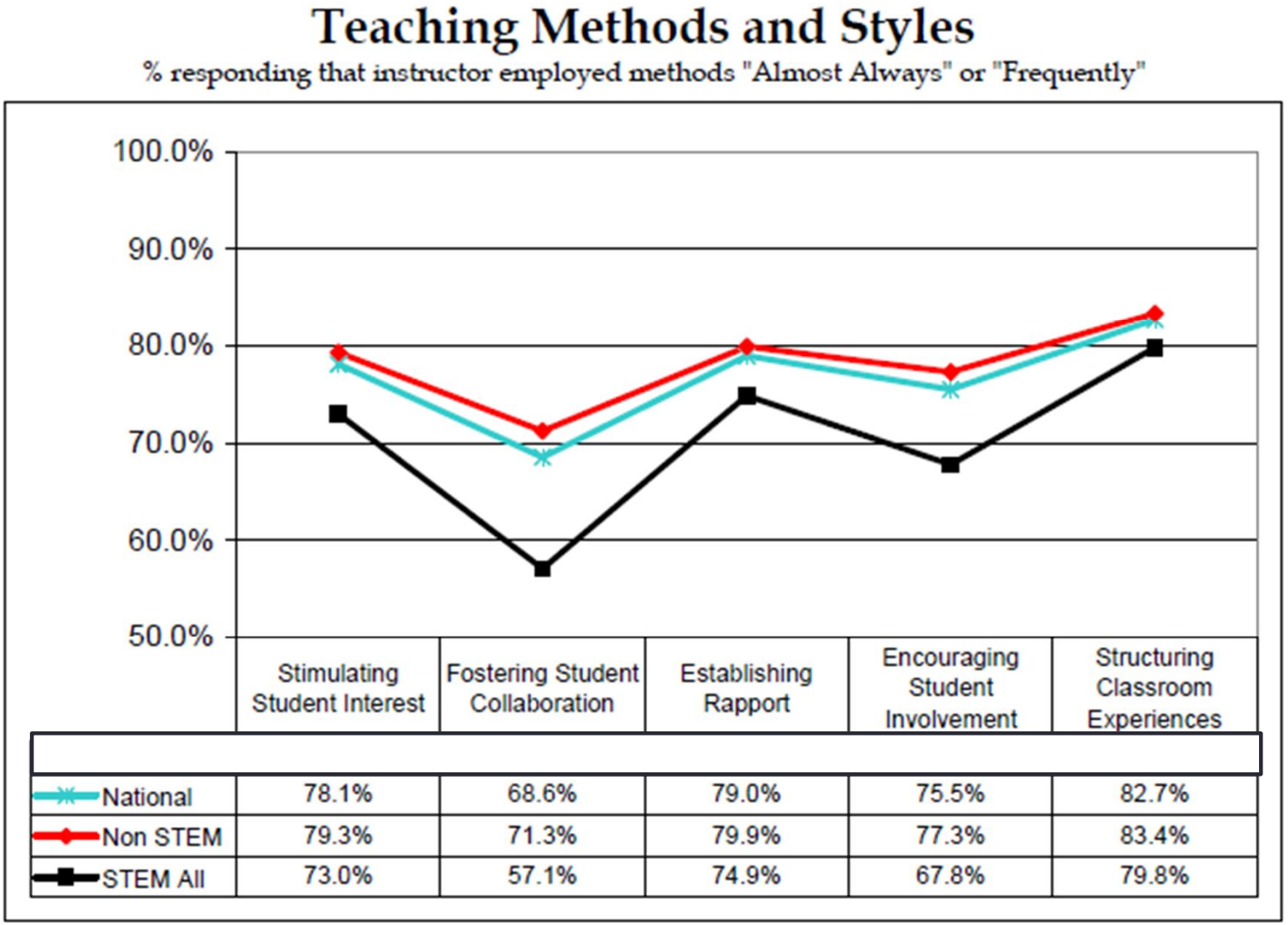
	Obj1	Obj2	Obj3	Obj4	Obj5	Obj6	Obj7	Obj8	Obj9	Obj10	Obj11	Obj12
National	80.0%	77.9%	77.6%	76.9%	69.7%	65.7%	65.1%	64.6%	68.3%	68.0%	69.6%	69.9%
Non STEM	80.4%	78.3%	78.6%	78.1%	70.8%	68.5%	67.7%	67.3%	69.4%	70.1%	71.8%	71.3%
STEM All	78.2%	76.0%	73.0%	72.0%	65.2%	51.8%	53.6%	51.1%	63.6%	56.0%	59.3%	63.6%

Are there differences for courses enrolling primarily majors or non-majors?



	2007	2008	2009	2010	2011
Grad/Prof	74.4%	75.5%	77.8%	77.1%	76.1%
JR/SR Major	73.9%	73.6%	74.0%	75.3%	75.8%
JR/SR Gen Ed	67.2%	69.4%	68.5%	70.3%	70.3%
FR/SO Major	70.2%	71.5%	71.3%	71.8%	72.5%
FR/SO Gen Ed	65.6%	67.6%	67.8%	68.4%	68.3%

Which teaching methods might be employed to support greater student learning?



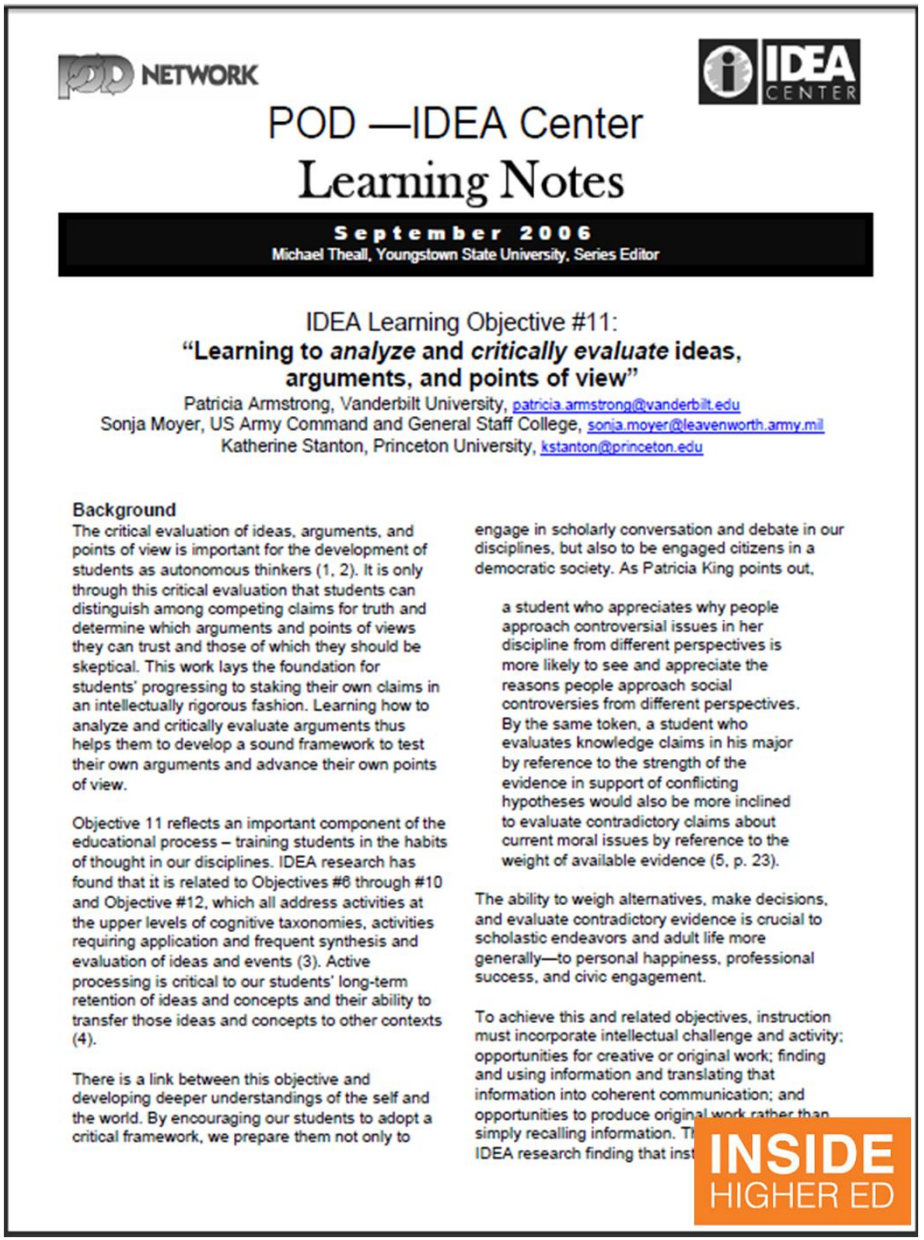
	Stimulating Student Interest	Fostering Student Collaboration	Establishing Rapport	Encouraging Student Involvement	Structuring Classroom Experiences
National	78.1%	68.6%	79.0%	75.5%	82.7%
Non STEM	79.3%	71.3%	79.9%	77.3%	83.4%
STEM All	73.0%	57.1%	74.9%	67.8%	79.8%

Teaching Styles and Methods Associated with Progress on Cognitive Objectives

- Stimulating Student Interest
  - Demonstrate importance of subject matter
  - Stimulate intellectual effort
- Structuring the Classroom Experience
  - Make it clear how each topic fits into course
  - Explain course material clearly and concisely

POD-IDEA Notes

- Background
- Helpful Hints
- Assessment Issues
- References and Resources



POD NETWORK

IDEA CENTER

POD —IDEA Center

Learning Notes

September 2006

Michael Theall, Youngstown State University, Series Editor

IDEA Learning Objective #11:

"Learning to *analyze* and *critically evaluate* ideas, arguments, and points of view"

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Sonja Moyer, US Army Command and General Staff College, sonja.moyer@leavenworth.army.mil
Katherine Stanton, Princeton University, kstanton@princeton.edu

Background

The critical evaluation of ideas, arguments, and points of view is important for the development of students as autonomous thinkers (1, 2). It is only through this critical evaluation that students can distinguish among competing claims for truth and determine which arguments and points of views they can trust and those of which they should be skeptical. This work lays the foundation for students' progressing to staking their own claims in an intellectually rigorous fashion. Learning how to analyze and critically evaluate arguments thus helps them to develop a sound framework to test their own arguments and advance their own points of view.

Objective 11 reflects an important component of the educational process – training students in the habits of thought in our disciplines. IDEA research has found that it is related to Objectives #6 through #10 and Objective #12, which all address activities at the upper levels of cognitive taxonomies, activities requiring application and frequent synthesis and evaluation of ideas and events (3). Active processing is critical to our students' long-term retention of ideas and concepts and their ability to transfer those ideas and concepts to other contexts (4).

There is a link between this objective and developing deeper understandings of the self and the world. By encouraging our students to adopt a critical framework, we prepare them not only to engage in scholarly conversation and debate in our disciplines, but also to be engaged citizens in a democratic society. As Patricia King points out,

> a student who appreciates why people approach controversial issues in her discipline from different perspectives is more likely to see and appreciate the reasons people approach social controversies from different perspectives. By the same token, a student who evaluates knowledge claims in his major by reference to the strength of the evidence in support of conflicting hypotheses would also be more inclined to evaluate contradictory claims about current moral issues by reference to the weight of available evidence (5, p. 23).

The ability to weigh alternatives, make decisions, and evaluate contradictory evidence is crucial to scholastic endeavors and adult life more generally—to personal happiness, professional success, and civic engagement.

To achieve this and related objectives, instruction must incorporate intellectual challenge and activity; opportunities for creative or original work; finding and using information and translating that information into coherent communication; and opportunities to produce original work rather than simply recalling information. Th
IDEA research finding that inst

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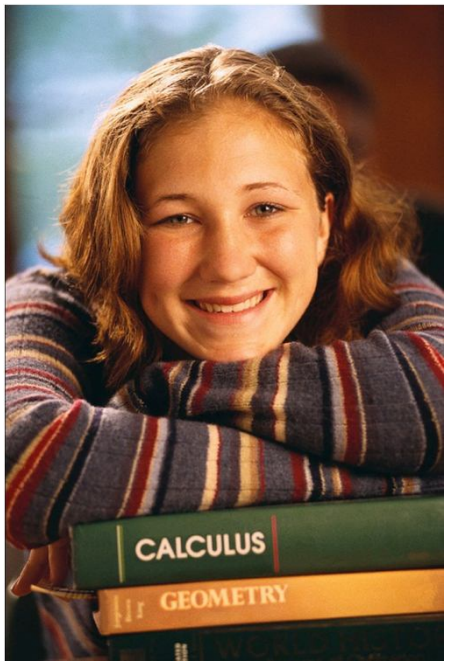
What are student characteristics in STEM courses?

Student Motivation

Student Work Habits

Student Motivation



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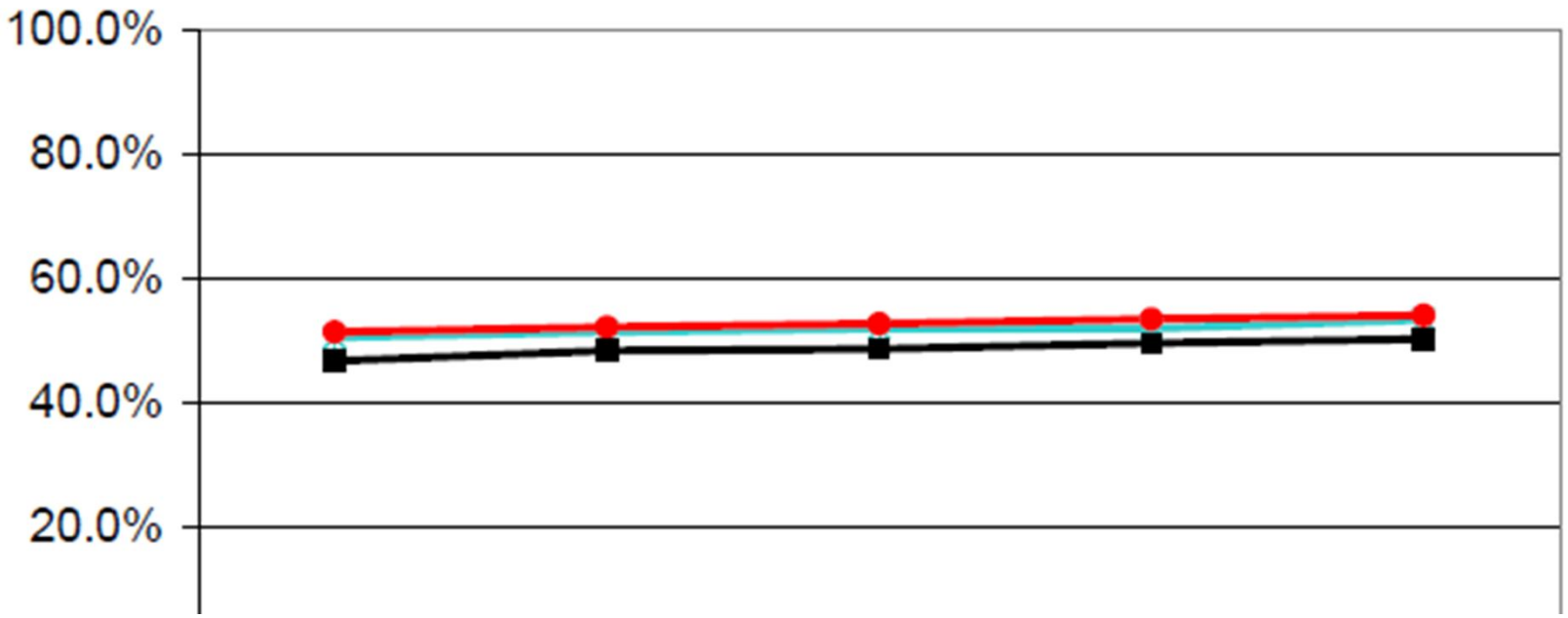
I really wanted to take this course regardless of who taught it

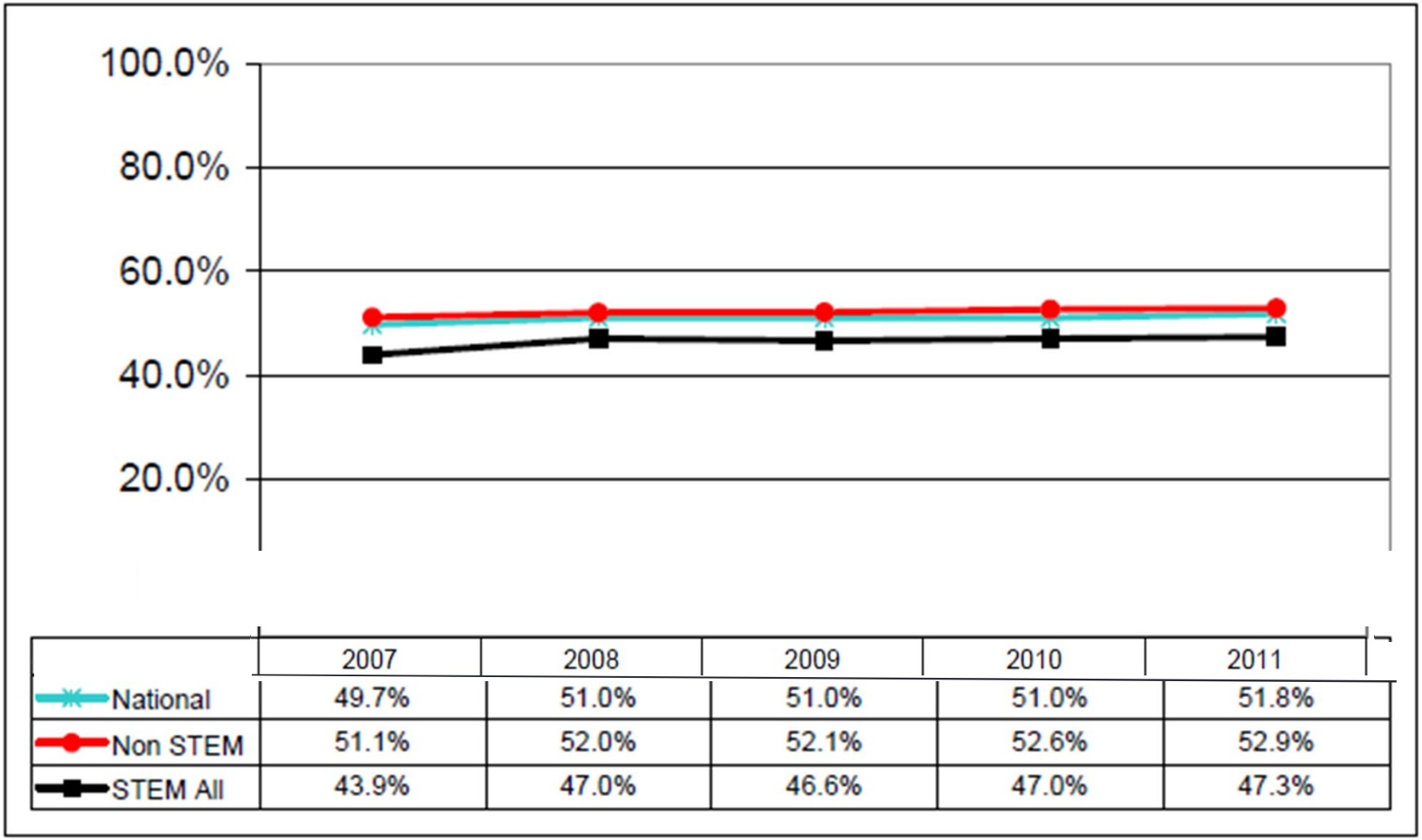
% responding "Definitely True" or "More True than False"



	2007	2008	2009	2010	2011
National	50.5%	51.4%	51.9%	51.9%	53.3%
Non STEM	51.4%	52.1%	52.7%	53.5%	54.1%
STEM All	46.7%	48.3%	48.6%	49.5%	50.2%

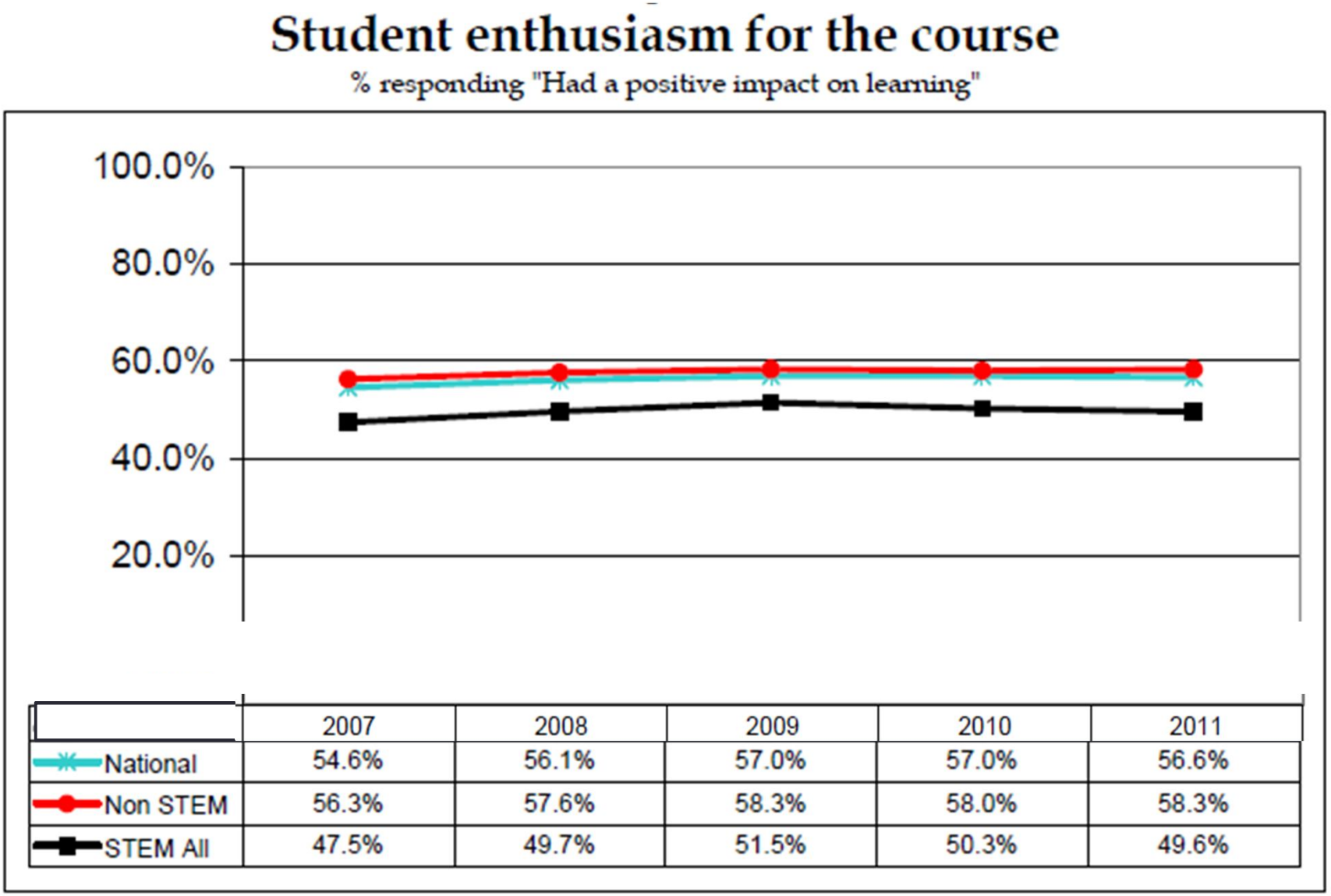
I really wanted to take a course from this instructor

% responding "Definitely True" or "More True than False"



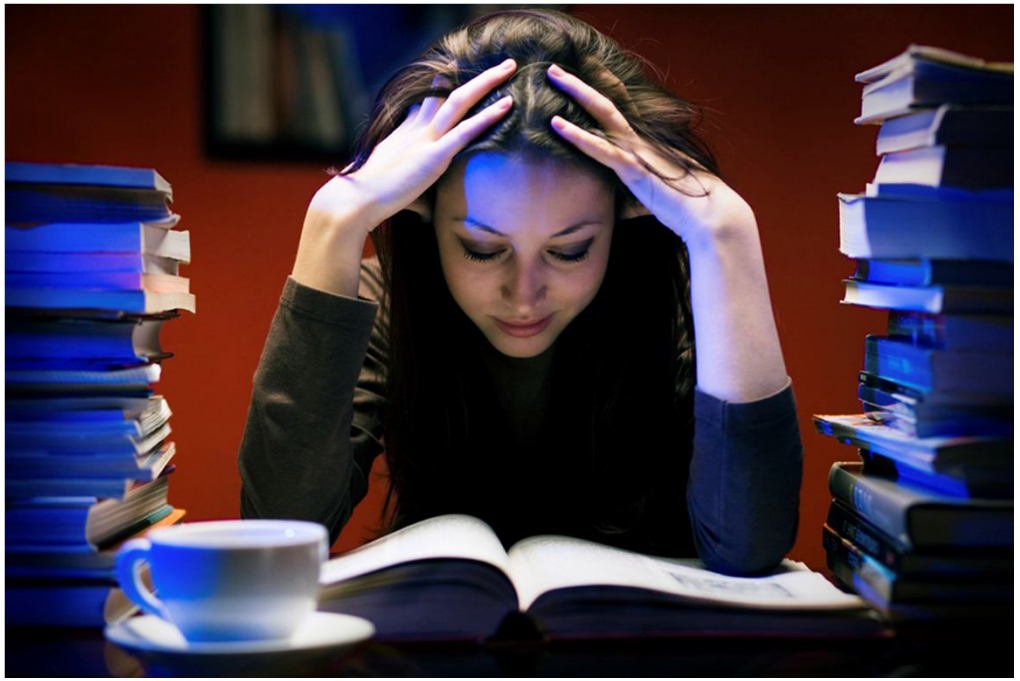
	2007	2008	2009	2010	2011
National	49.7%	51.0%	51.0%	51.0%	51.8%
Non STEM	51.1%	52.0%	52.1%	52.6%	52.9%
STEM All	43.9%	47.0%	46.6%	47.0%	47.3%

Faculty Response:



	2007	2008	2009	2010	2011
National	54.6%	56.1%	57.0%	57.0%	56.6%
Non STEM	56.3%	57.6%	58.3%	58.0%	58.3%
STEM All	47.5%	49.7%	51.5%	50.3%	49.6%

Student Work Habits & Effort



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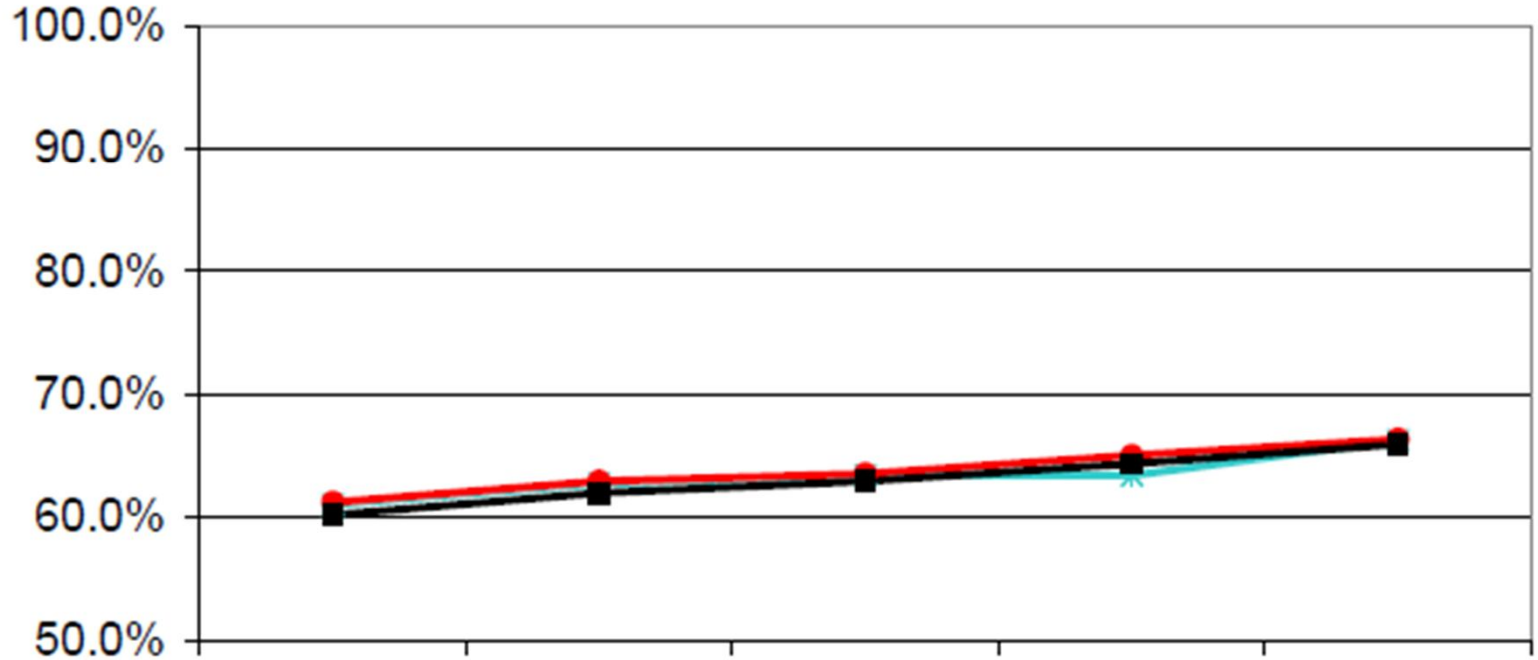
As a rule, I put forth more effort than other students on academic work

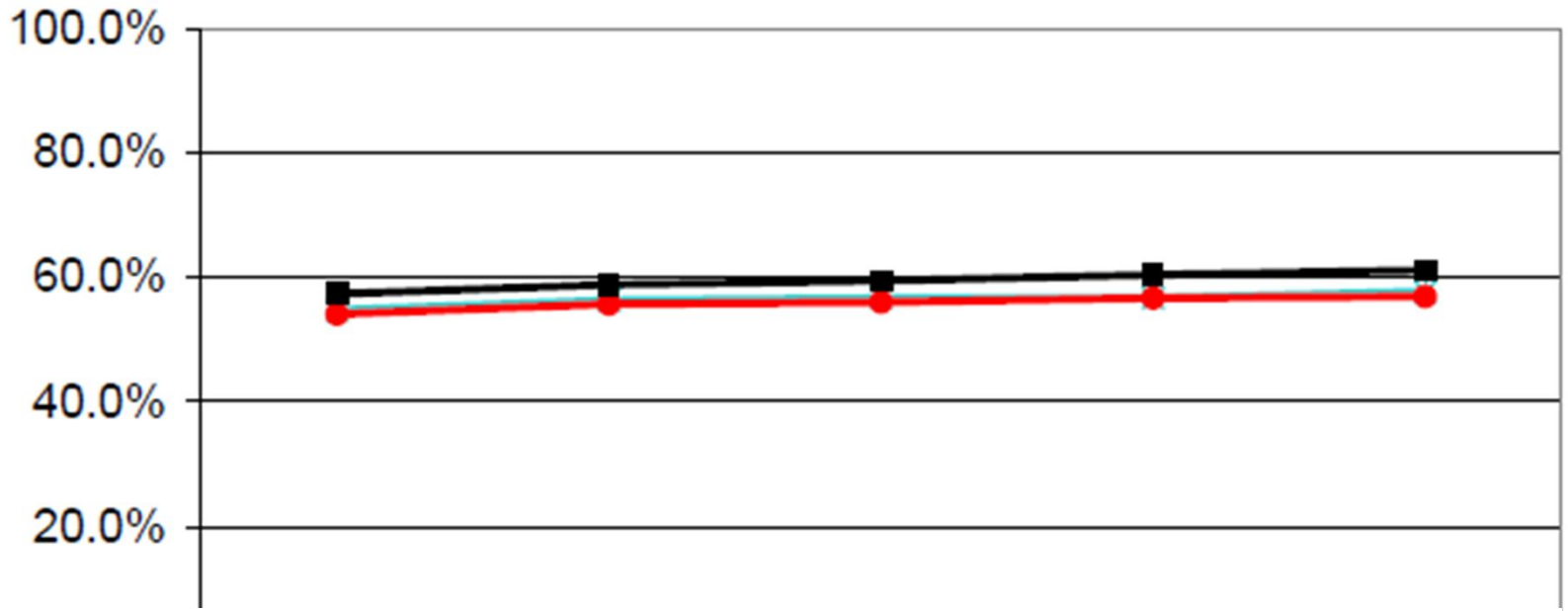
% responding "Definitely True" or "More True than False"



	2007	2008	2009	2010	2011
National	61.0%	62.7%	63.4%	63.4%	66.3%
Non STEM	61.2%	62.9%	63.5%	65.0%	66.4%
STEM All	60.2%	62.0%	62.9%	64.4%	65.9%

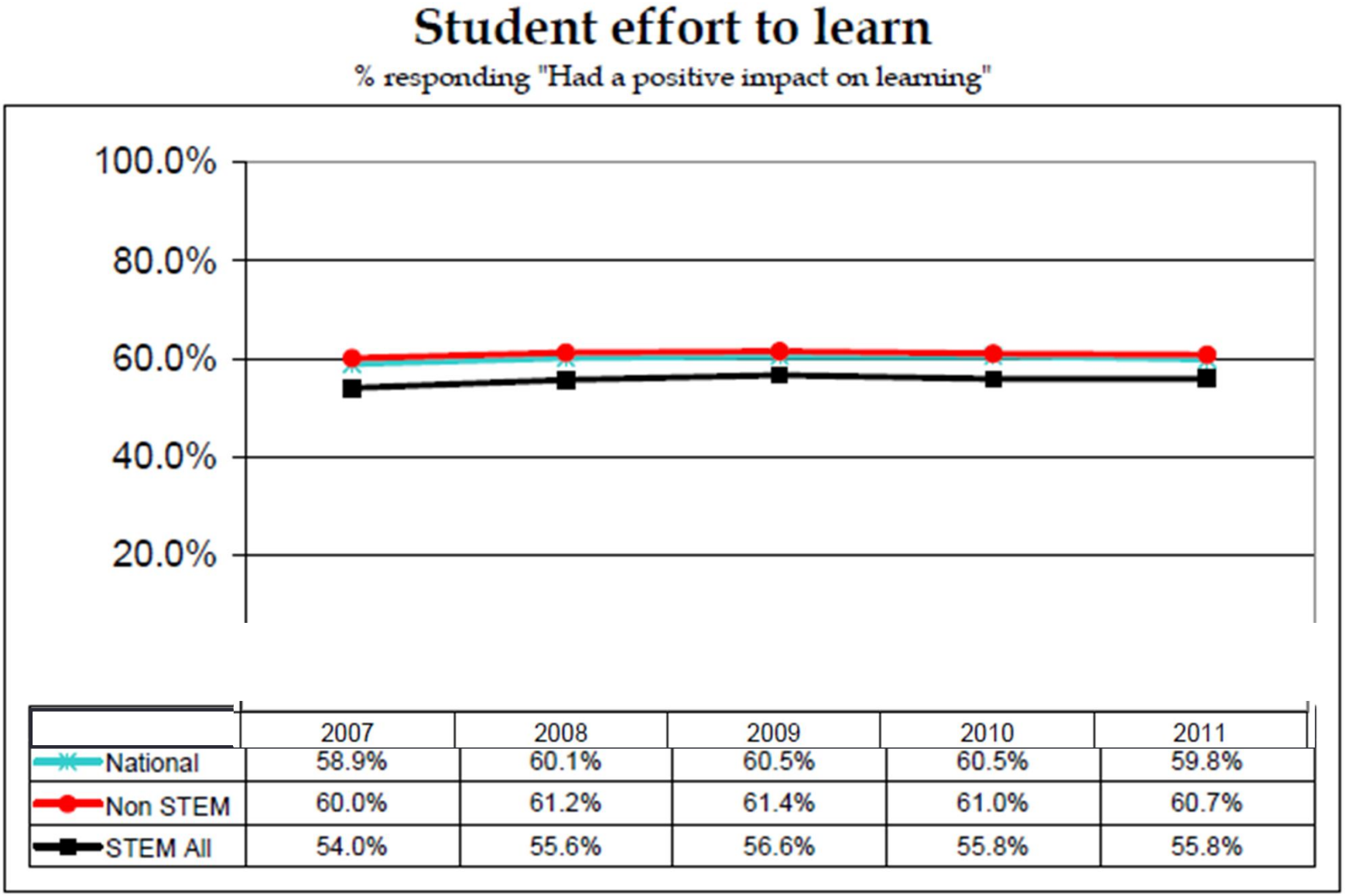
I worked harder on this course than on most courses I have taken

% responding "Definitely True" or "More True than False"



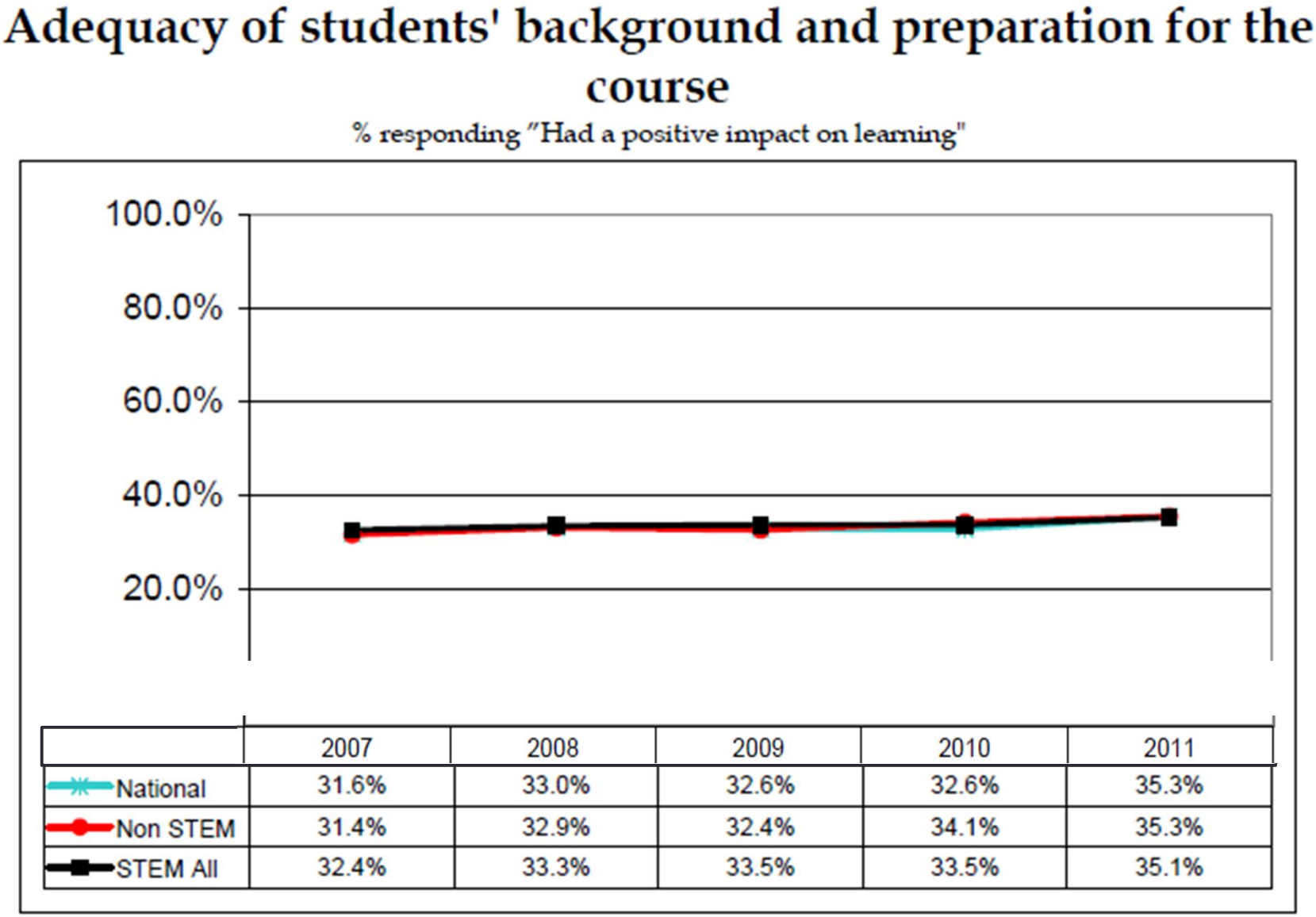
	2007	2008	2009	2010	2011
National	54.8%	56.4%	56.8%	56.8%	57.8%
Non STEM	54.2%	55.8%	56.1%	56.7%	57.0%
STEM All	57.4%	58.9%	59.5%	60.5%	61.2%

Faculty Response



	2007	2008	2009	2010	2011
National	58.9%	60.1%	60.5%	60.5%	59.8%
Non STEM	60.0%	61.2%	61.4%	61.0%	60.7%
STEM All	54.0%	55.6%	56.6%	55.8%	55.8%

Faculty Response:



	2007	2008	2009	2010	2011
National	31.6%	33.0%	32.6%	32.6%	35.3%
Non STEM	31.4%	32.9%	32.4%	34.1%	35.3%
STEM All	32.4%	33.3%	33.5%	33.5%	35.1%

Course Characteristics

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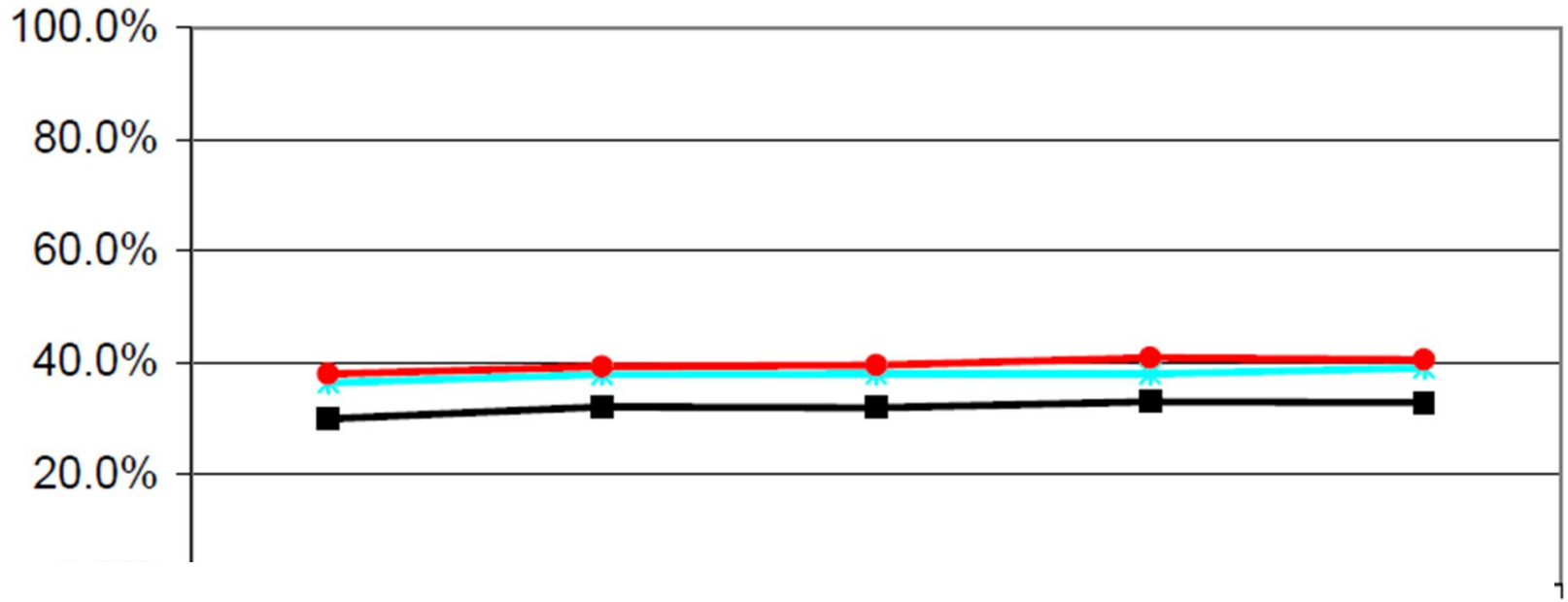
Response to: Amount of Reading

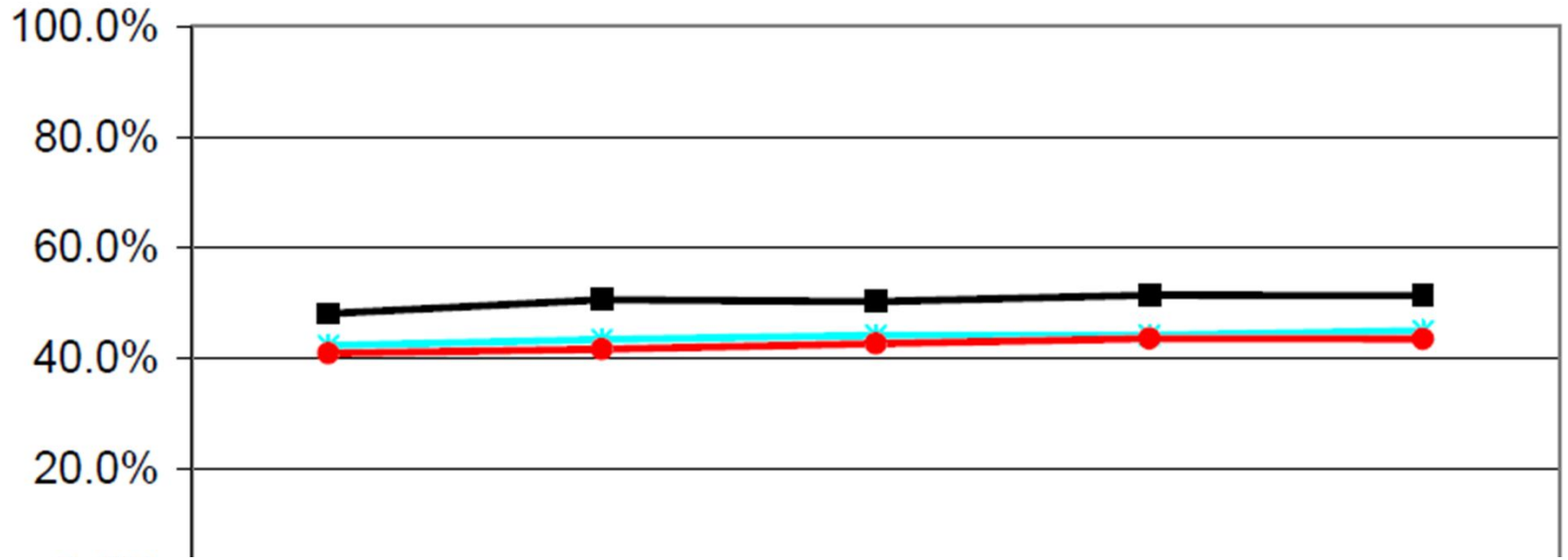
% of students responding with "Much More than Most Courses" or "More than Most Courses"



	2007	2008	2009	2010	2011
National	36.3%	37.8%	37.9%	37.9%	39.0%
Non STEM	37.9%	39.3%	39.4%	40.8%	40.5%
STEM All	29.8%	32.0%	31.8%	32.9%	32.7%

Response to: Amount of work in other (non-reading) assignments

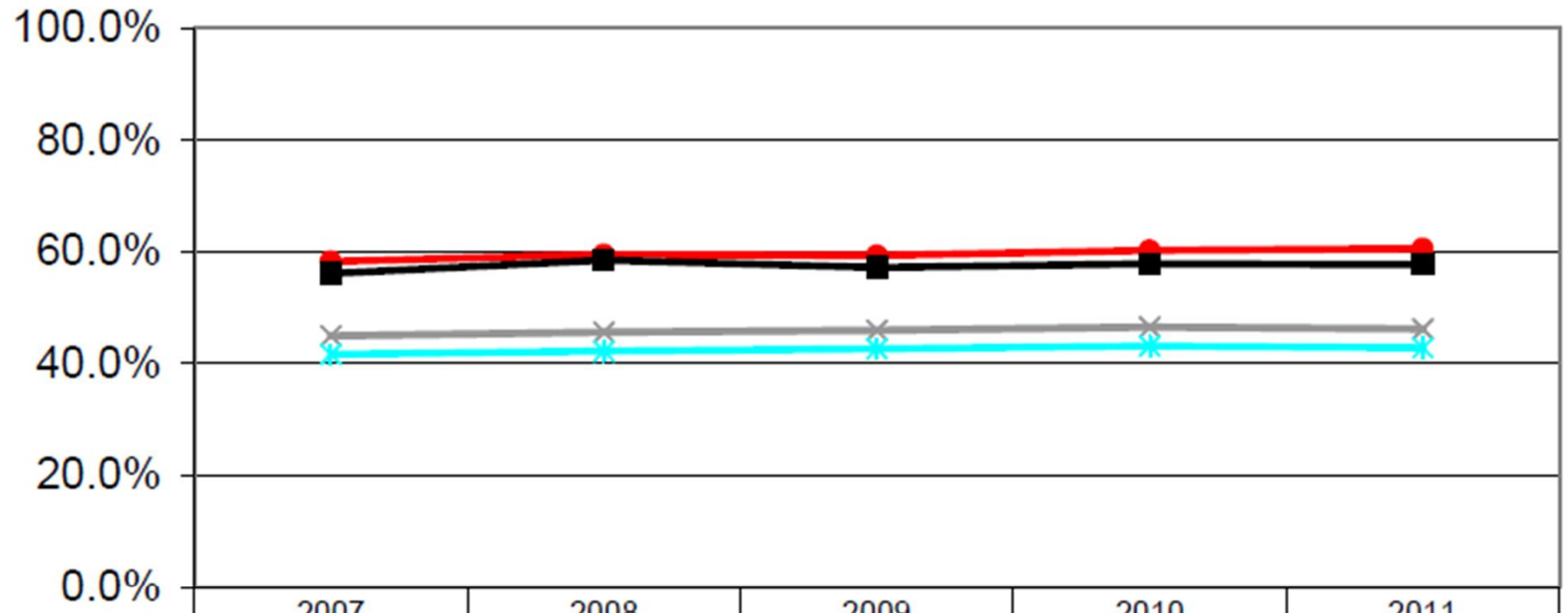
% of students responding with "Much More than Most Courses" or "More than Most Courses"



	2007	2008	2009	2010	2011
National	42.4%	43.5%	44.2%	44.2%	45.1%
Non STEM	41.0%	41.7%	42.7%	43.6%	43.6%
STEM All	48.1%	50.6%	50.3%	51.5%	51.4%

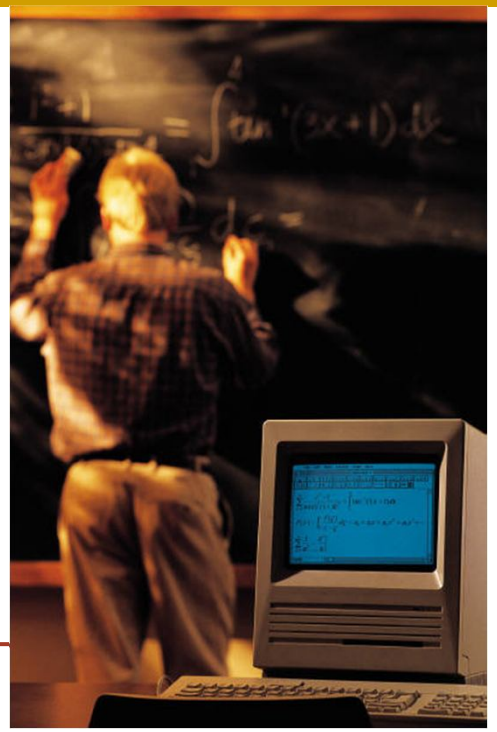
Response to: Difficulty of subject matter

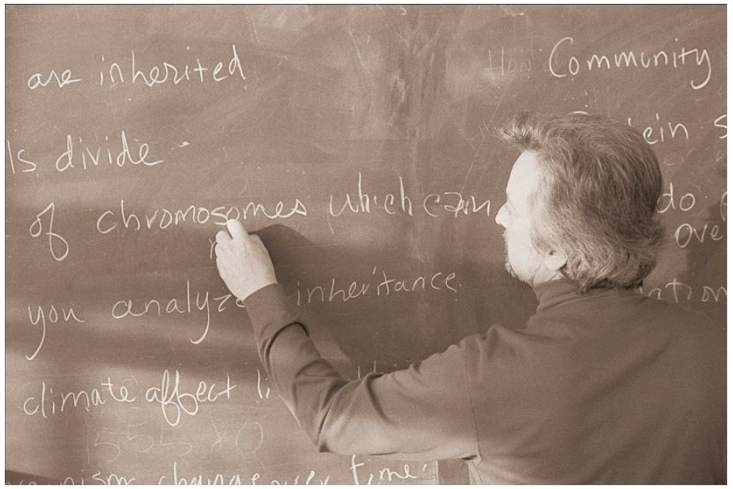
% of students responding with "Much More than Most Courses" or "More than Most Courses"



	2007	2008	2009	2010	2011
National	44.9%	45.6%	46.0%	46.5%	46.2%
Non STEM	41.6%	42.2%	42.7%	43.1%	42.8%
STEM All	58.2%	59.4%	59.3%	60.2%	60.5%
MATH	56.0%	58.4%	57.2%	57.8%	57.6%

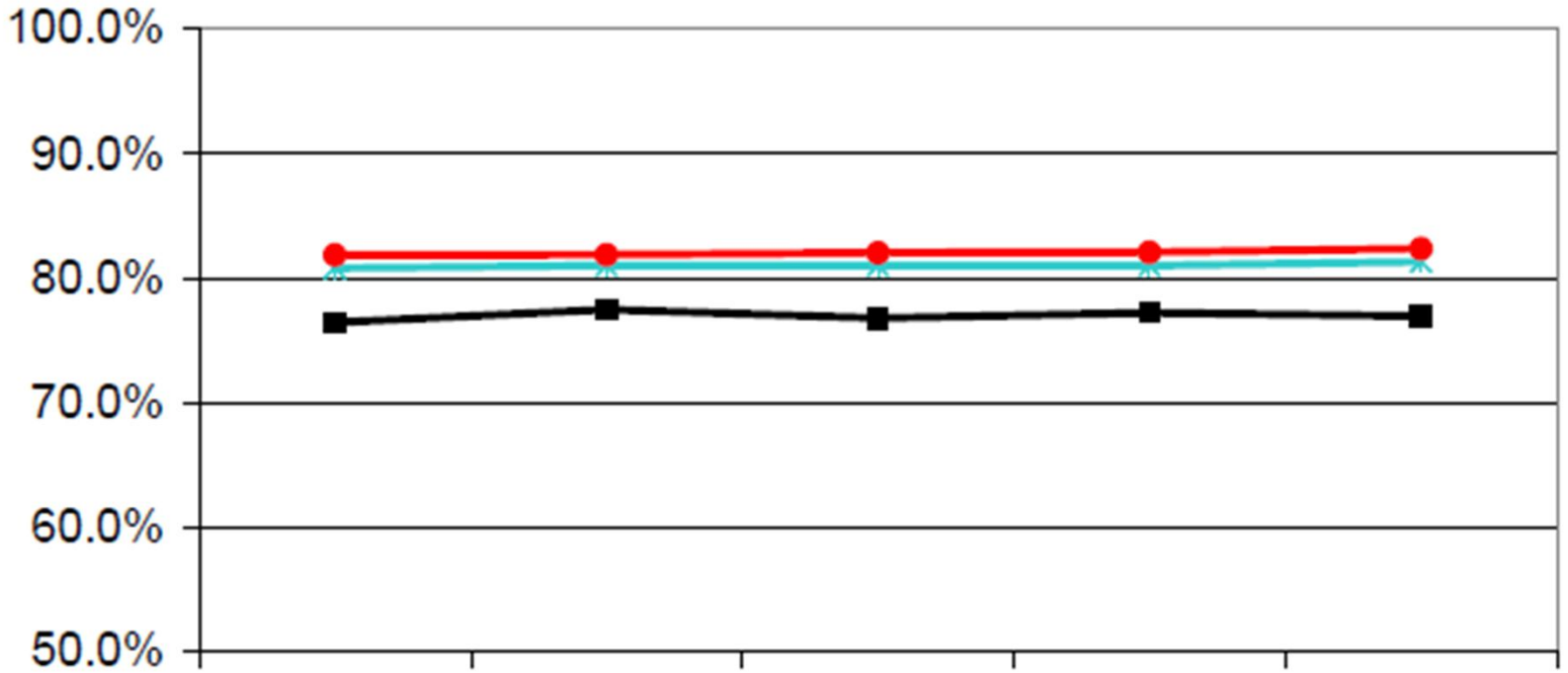
Summary Ratings





Overall, I rate this instructor an excellent teacher

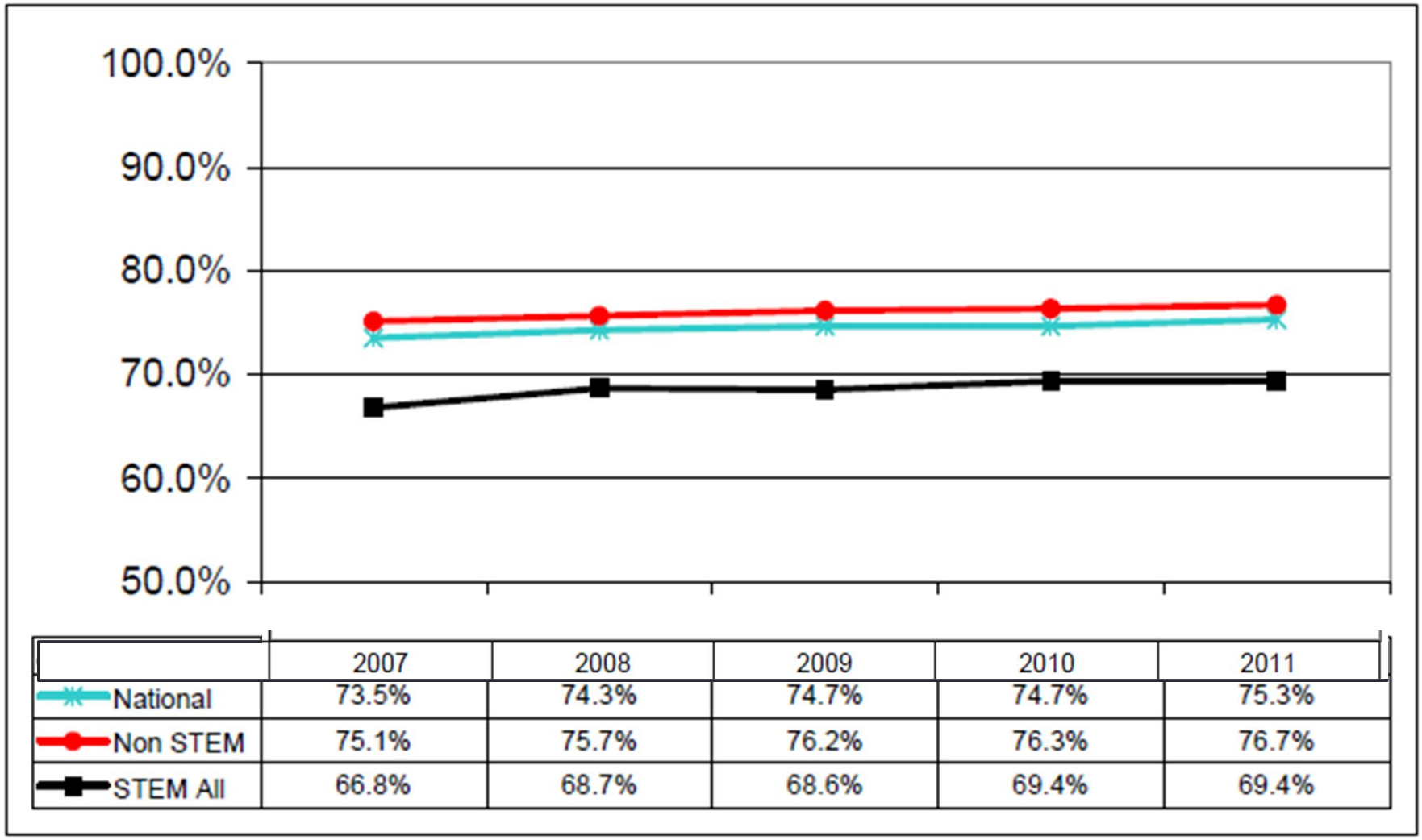
% responding "Definitely True" or "More True than False"



	2007	2008	2009	2010	2011
National	80.8%	81.0%	81.0%	81.0%	81.3%
Non STEM	81.8%	81.8%	82.0%	82.0%	82.3%
STEM All	76.4%	77.5%	76.8%	77.2%	76.9%

Overall, I rate this course as excellent

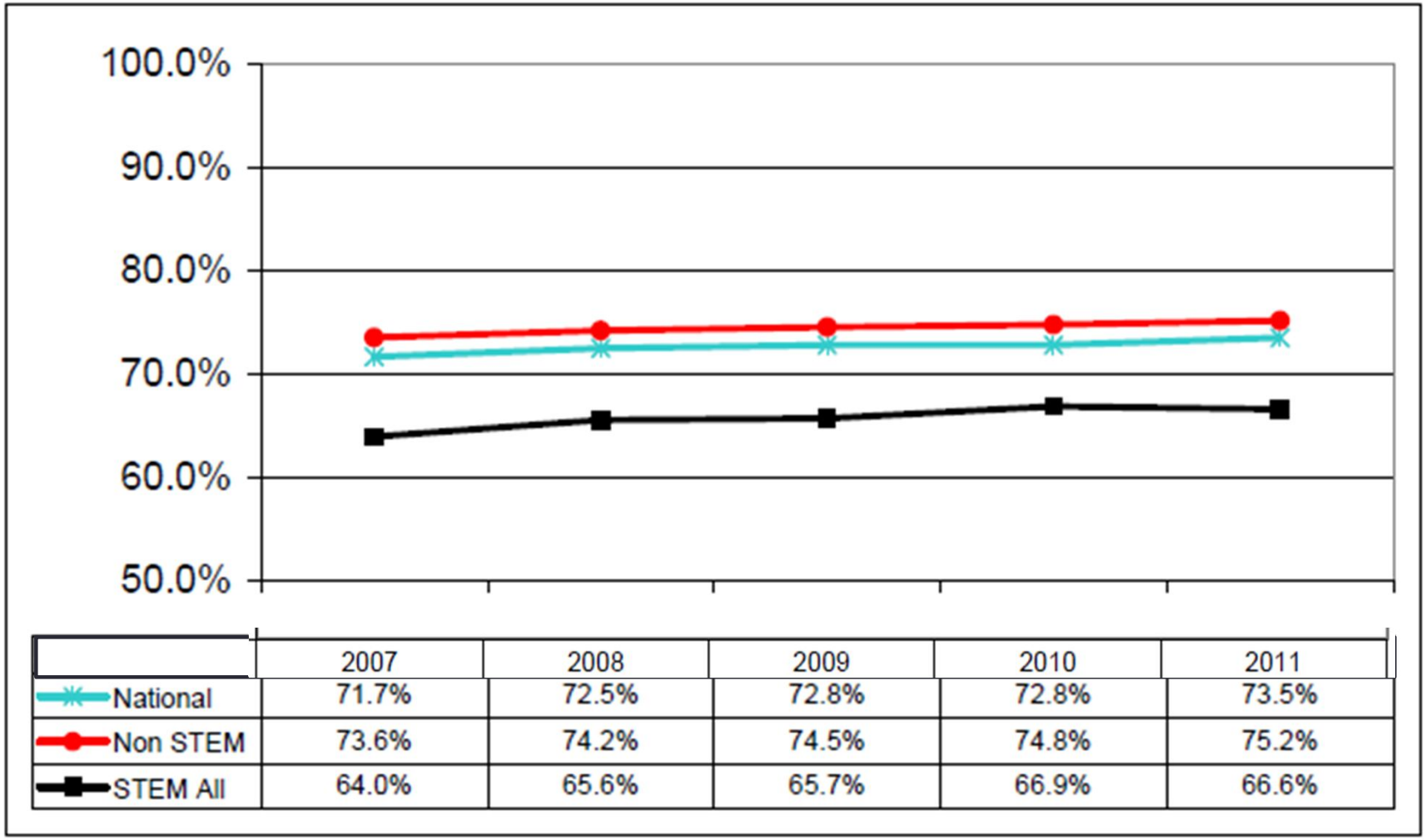
% responding "Definitely True" or "More True than False"



	2007	2008	2009	2010	2011
National	73.5%	74.3%	74.7%	74.7%	75.3%
Non STEM	75.1%	75.7%	76.2%	76.3%	76.7%
STEM All	66.8%	68.7%	68.6%	69.4%	69.4%

As a result of taking this course, I have more positive feelings toward this field of study

% responding "Definitely True" or "More True than False"



	2007	2008	2009	2010	2011
National	71.7%	72.5%	72.8%	72.8%	73.5%
Non STEM	73.6%	74.2%	74.5%	74.8%	75.2%
STEM All	64.0%	65.6%	65.7%	66.9%	66.6%

Session Summary

- STEM instructors emphasize basic cognitive background and applications
- Students report learning basic cognitive information
- STEM teaching methods emphasize stimulating interest, establishing rapport, and course organization
- STEM student motivation and work habits comparable to non-STEM
- STEM reading assignments somewhat less, non-reading assignments somewhat more than non-STEM
- STEM courses rated more difficult than non-STEM
- Most students rate STEM teaching and courses positively

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Discussion

- Which results confirmed what you might think about STEM courses?
- Which results were surprising?
- What additional insights or questions do you have?

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Contact

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