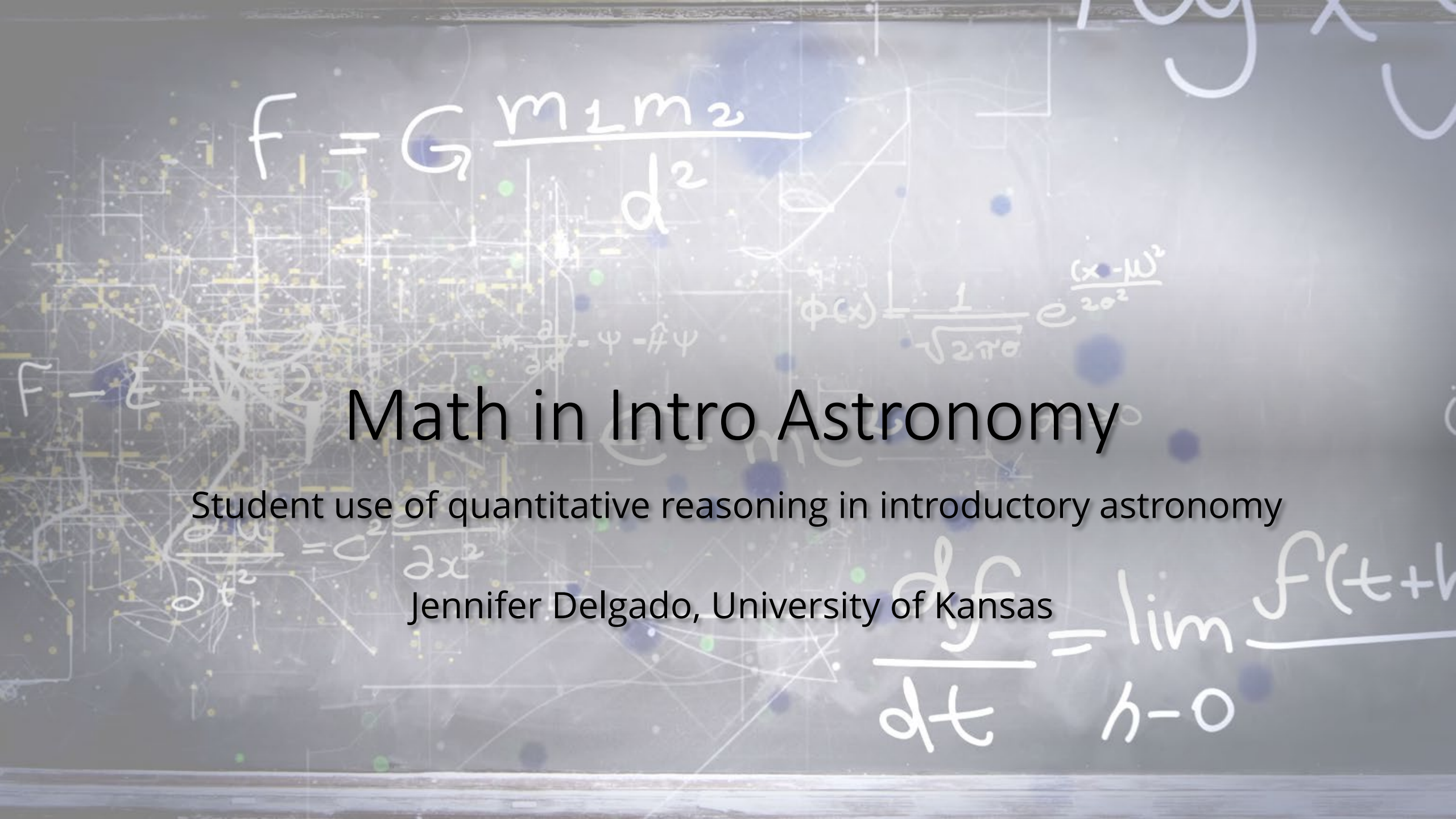
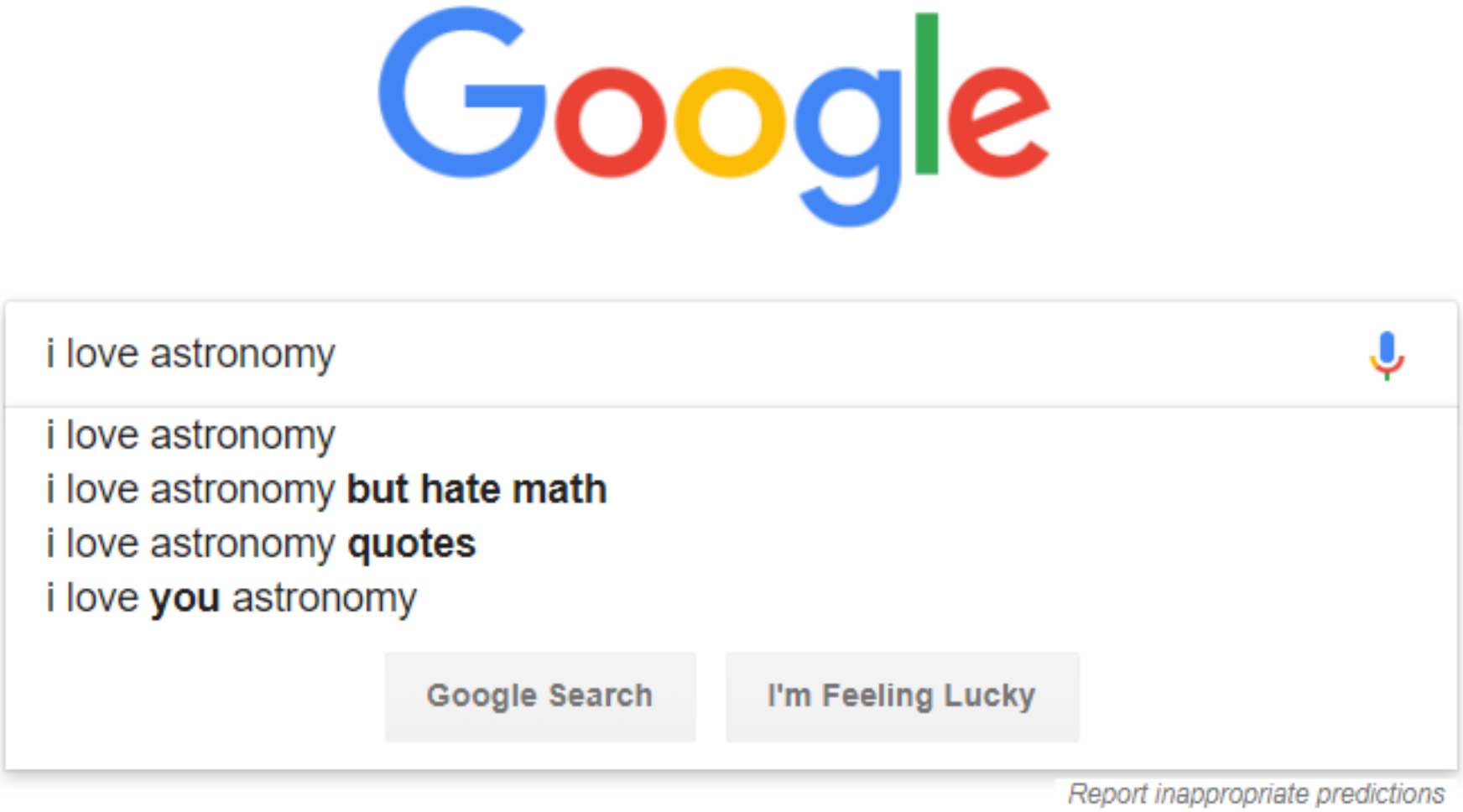


Math in Intro Astronomy

Student use of quantitative reasoning in introductory astronomy

Jennifer Delgado, University of Kansas

Math: A known problem



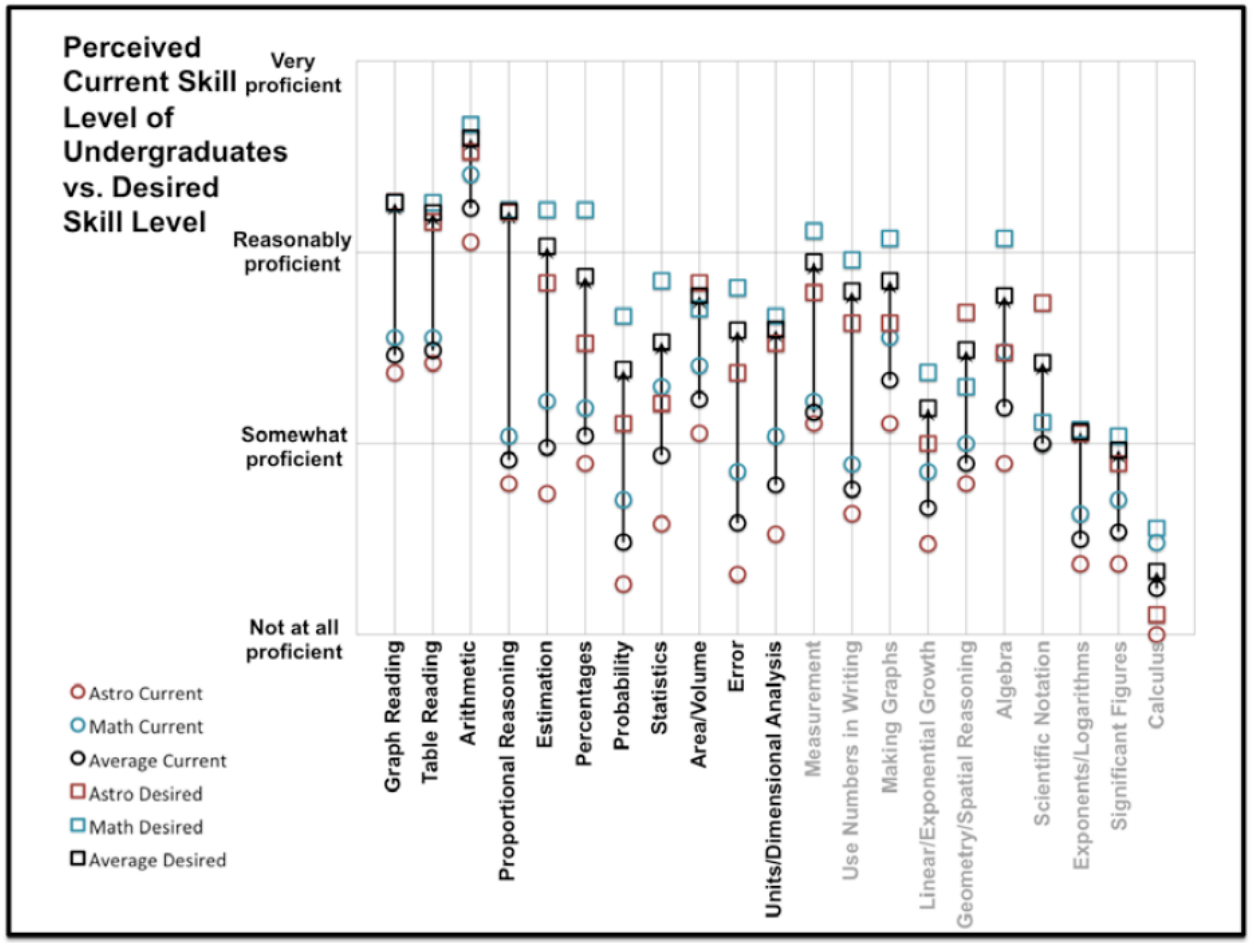
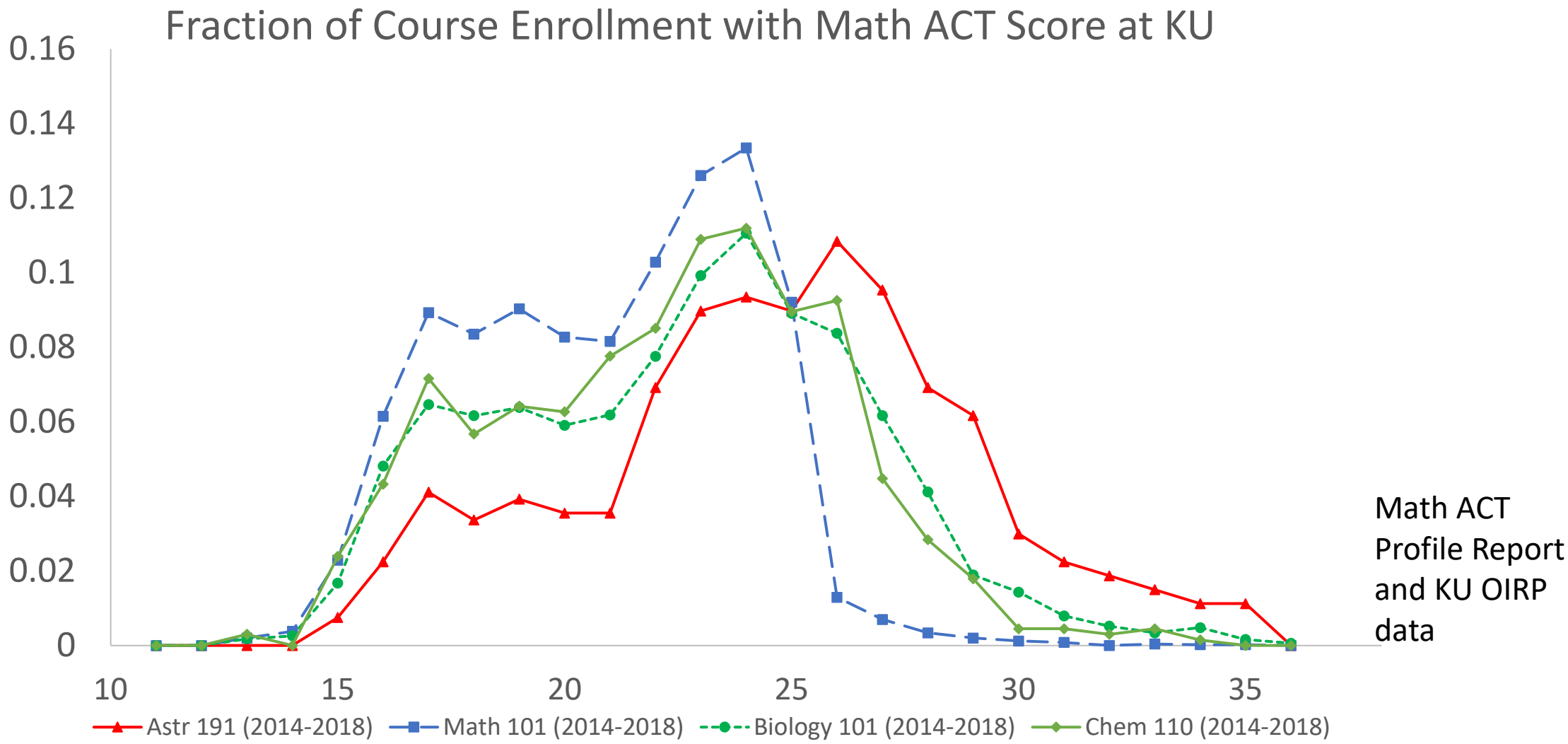


Figure 3. Desired (squares) and perceived current (circles) student proficiency levels for various quantitative skills among math (blue) and Astronomy (red) educators.

"Students don't know the math they need."
-Us (Astronomy educators)

Follette et al. 2015

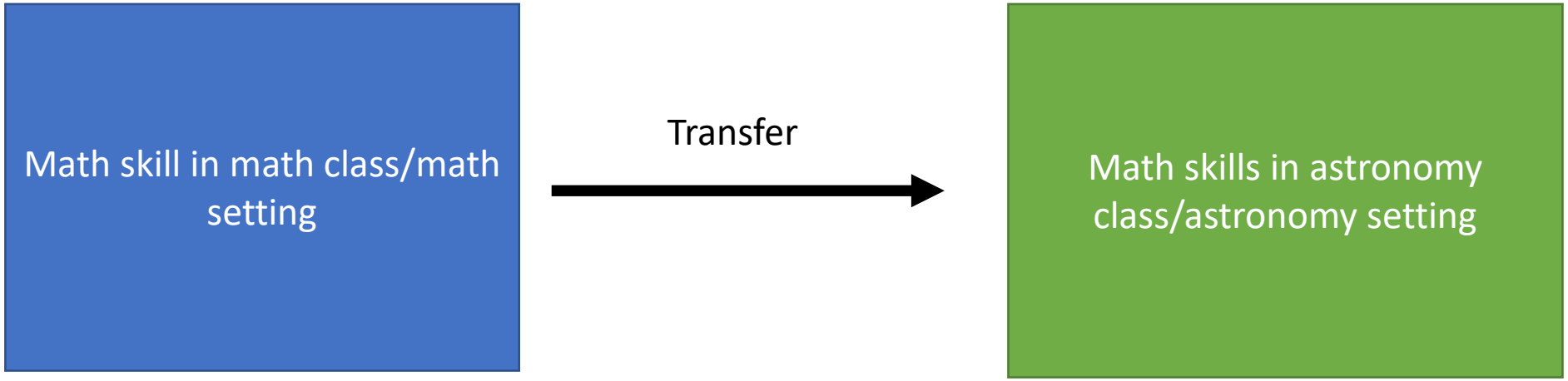
Intro Astro students are not uniquely bad at math



Math ACT Profile Report and KU OIRP data

Math Transfer

Being “good at math” doesn’t necessarily mean being “good at math in astronomy”!



LSCI (Bardar et al. 2005,2006, 2008) and Math

The LSCI is the "**L**ight and **S**pectroscopy **C**oncept **I**nventory"

It is designed to test the degree to which introductory astronomy courses address **misconceptions** in astronomy.

Misconceptions are the major focus, but some of the assessment questions are dependent on a student's ability to use mathematical reasoning in astronomy.

Consider the 3 stars described below.
• Star X gives off the same amount of energy as the Sun and gives off most of its energy at a wavelength of 400 nm.
• Star Y gives off more energy than the Sun and gives off most of its energy at a wavelength of 800 nm.
• Star Z gives off less energy than the Sun and gives off most of its energy at a wavelength of 600 nm.
Which star is the coolest?

a. Star X.
b. Star Y.
c. Star Z.
d. The relative temperatures of these stars cannot be determined from this information.

The larger a boorps unik at which it gives off most of its fler, the reni-er it is.
Consider the 3 boorps described below.

- Boorp X gives off the same amount of fler as Bheq and gives off most of its fler at a unik of 10 vess.
- Boorp Y gives off more fler than Bheq and gives off most of its fler at a unik of 20 vess
- Boorp Z gives off less fler than Bheq and gives off most of its fler at a unik of 15 vess.

Which boorp is the **reni-est**?

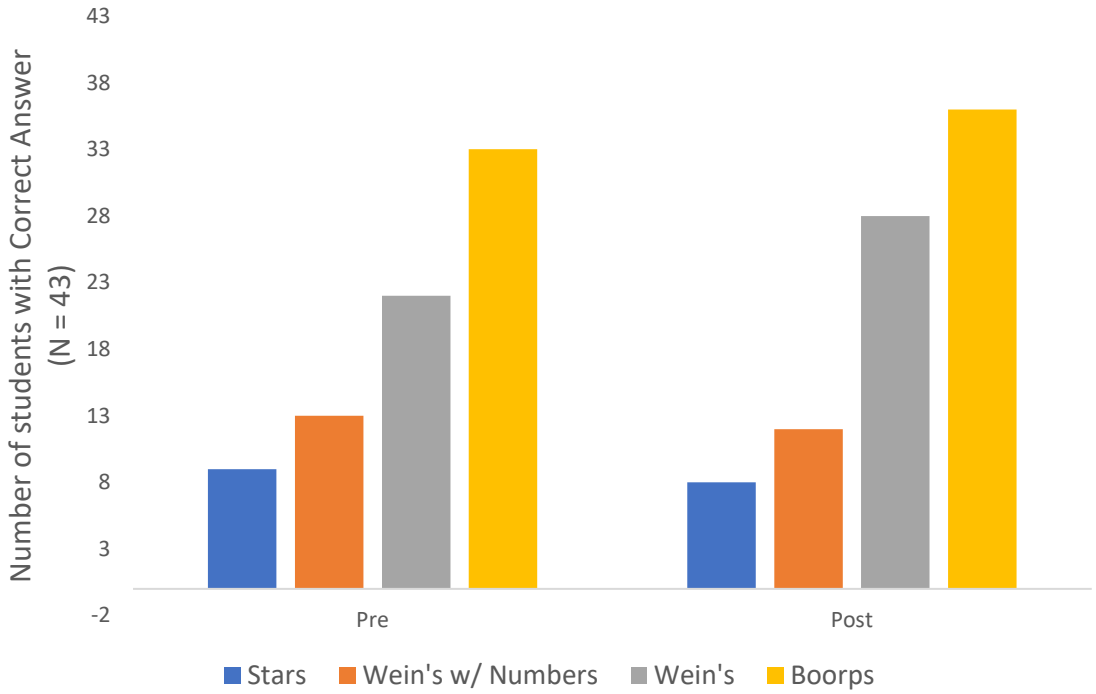
A. Boorp X
B. Boorp Y
C. Boorp Z
D. The relative reni levels of these boorps cannot be determined from this information.

The cooler a star, the _____ the wavelength it gives off most of its energy at

A. Shorter
B. Longer
C. Cooler
D. Hotter
E. This question is unanswerable because there is not a relation between temperature and peak wavelength for stars

A blackbody that gives off most of its energy at 600 nm will be _____ than a blackbody that gives off most of its energy at 800 nm

A. Cooler
B. Hotter
C. The same temperature
D. The temperatures can't be known from this information



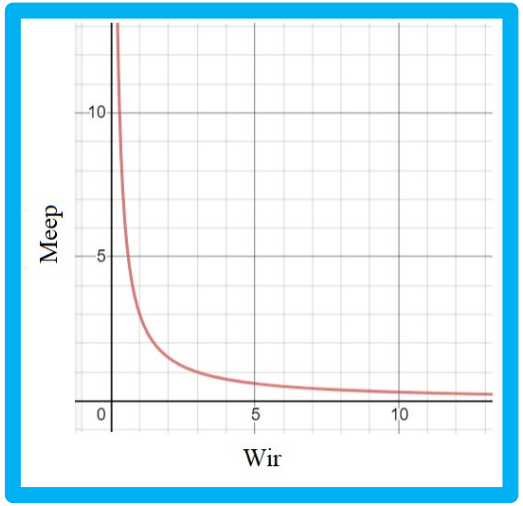
Students are quite capable of logical reasoning with numbers, but have trouble transferring this to Astronomy!

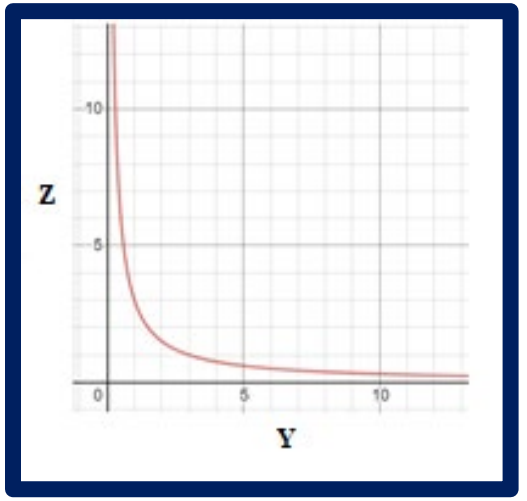
Logic or Math
Inverse relationships

The older a turtle is the smaller it is and the reverse is also true. Turtle Bryell is larger than Turtle Alice. Which turtle is older?

The hotter a star is the bluer it is and the reverse is also true (colder stars are redder). Star Garth is redder than Star Mohan. Which star is hotter?

An object's meep is related to its wir as seen in this plot. If object A has a meep of 5, how does its wir compare to object B that has a meep of 2?

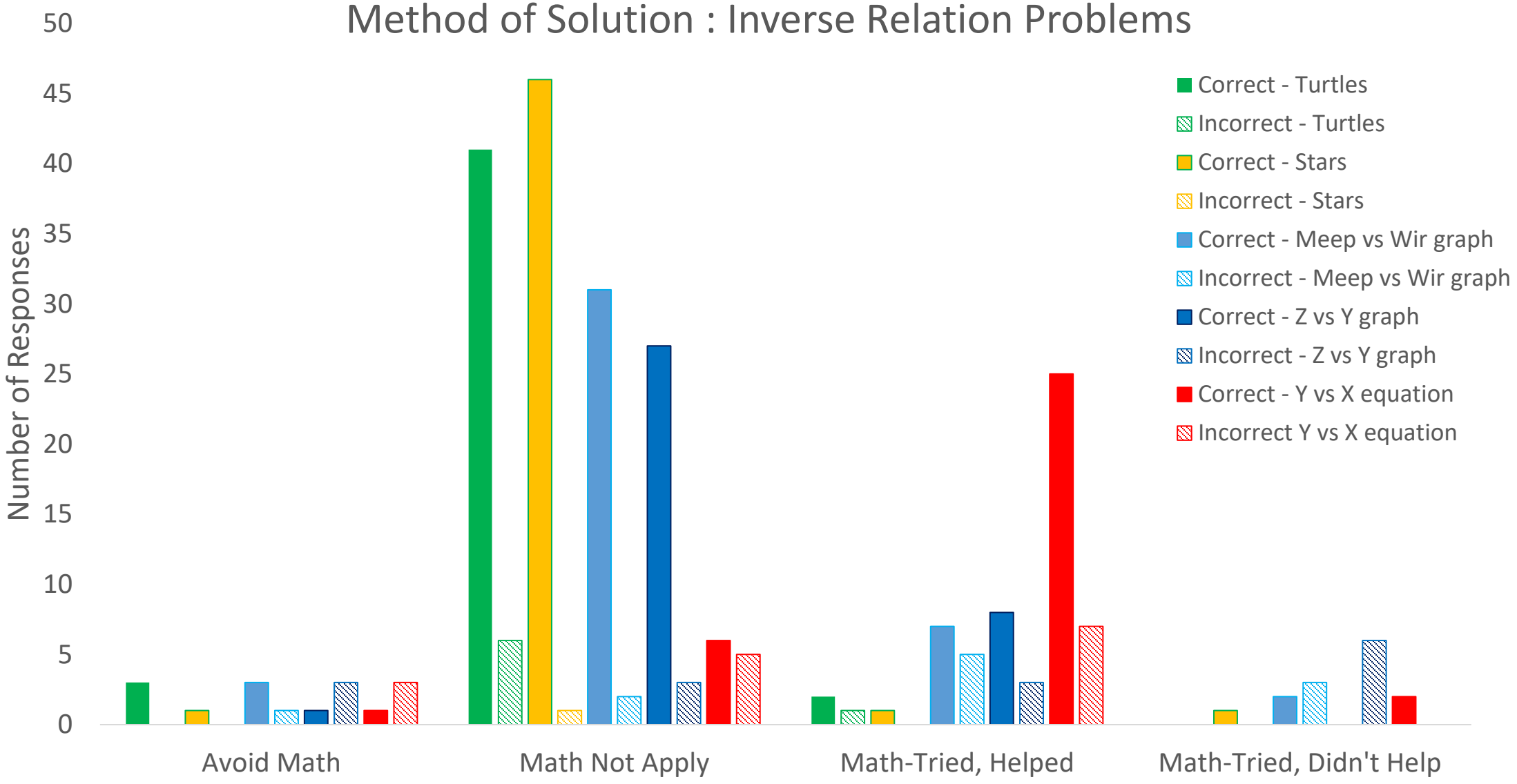




An object's z value is related to its y value as seen in this plot. If object A has a z value of 8, how does its y value compare to object B that has a z value of 3?

The value of an object's y-value is given by the equation y=1/x. If object E has an x-value that is double that of object T, which object has the larger y-value?

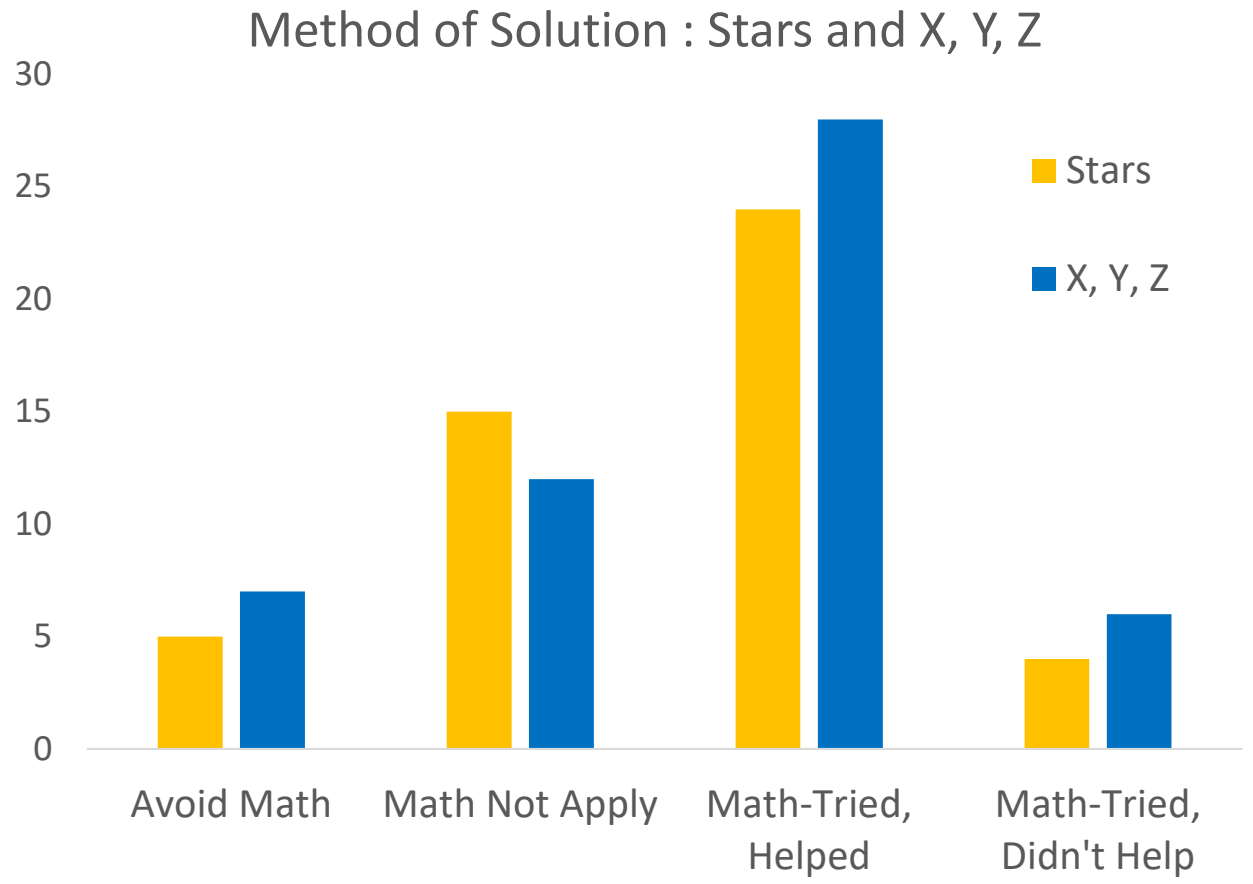
Method of Solution : Inverse Relation Problems



Power Laws – Too complex to be logic

The quantity Z is equal to the quantity X squared multiplied by the fourth power of the quantity Y. How would X change if Y was halved, but Z stayed the same?

The Luminosity is equal to the radius squared multiplied by the fourth power of the temperature. How would radius change if temperature was halved, but luminosity stayed the same?

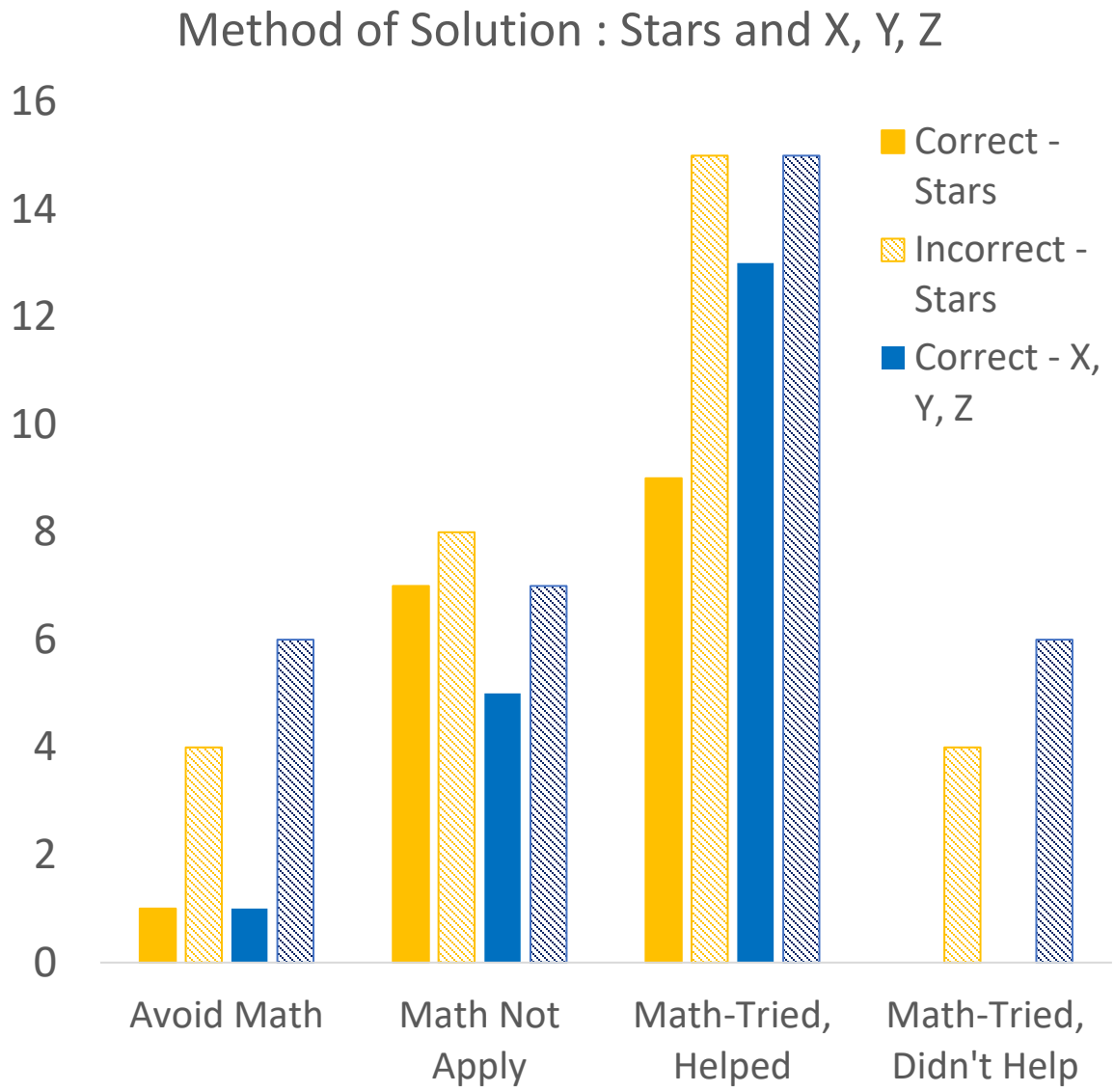


Problems with Power Laws are more likely to be approached as "Math" than "not Math" but the ~*Stars*~ context possibly hinders transfer.

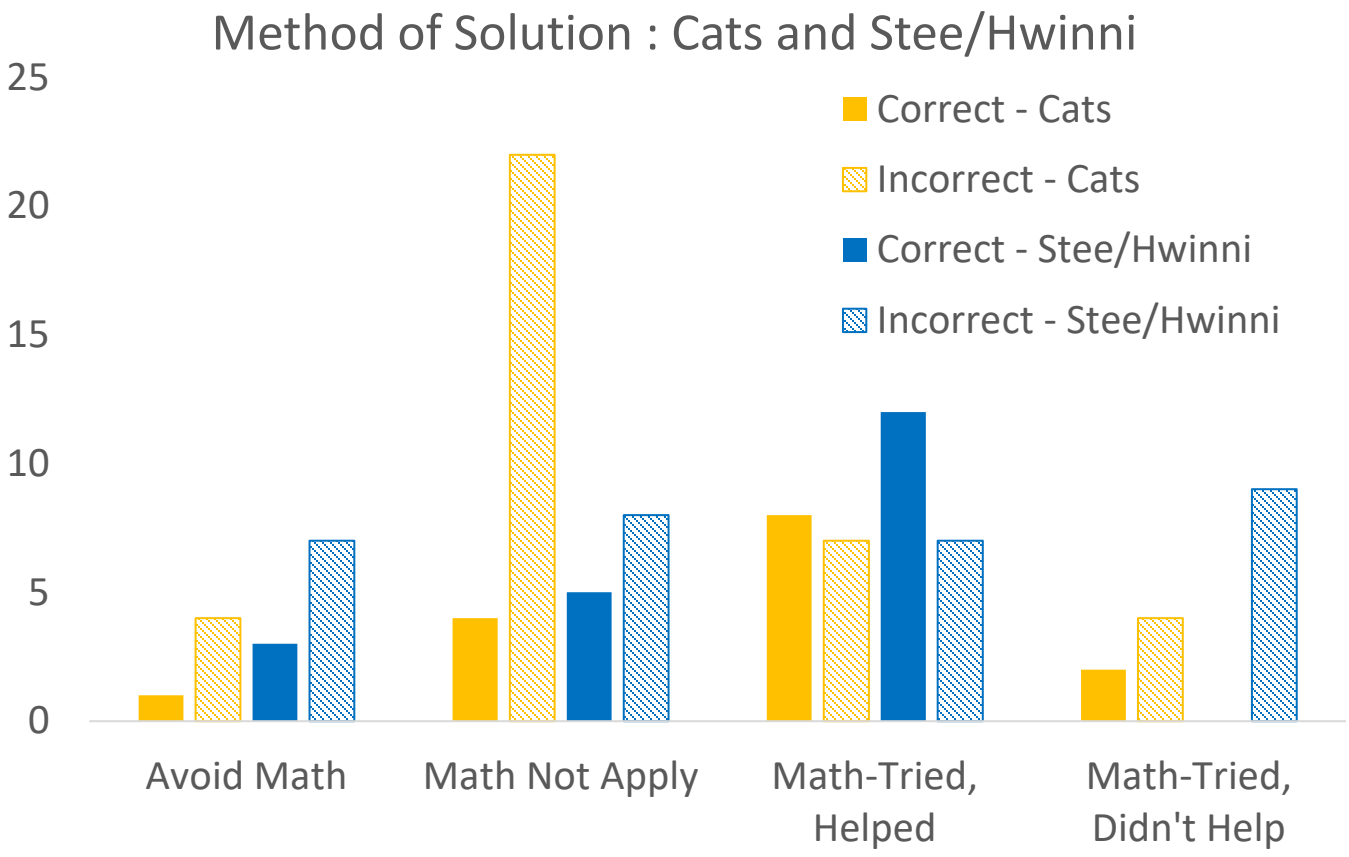
Math – Thinking it helped does not mean it did

- For both the Stars and Math versions of this question students tended to see math as relevant to the question.

- If they got it wrong, they were more likely to think math had helped even though it had not.



Math, Cats and too many new words



Cat Arturo and Cat Bianca give off the same amount of sassiness, but Arturo is cuter than Bianca. The sassiness given off by a cat is proportional to the desirability of a cat as a pet squared times their cuteness to the fourth power. Which cat is more desirable as a pet?

Object E and object T give off the same amount of hwinni, but object E has more stee than object T. The amount of hwinni given off by these kinds of objects is proportional to the ooblek of the object squared times the stee to the fourth power. How does the ooblek of E compare to the ooblek of T?

“These made up terms and associations really mess up my head and confuse me”

“The units confused me”

“I tried pretty hard on the more logic based problems. But the heavier math ones and the ones with the weird names I made educated guesses on”

New words can make math more difficult – Mental Load

Quotes from Students

Conclusions and Future Work

- Transfer of math skills doesn't happen automatically
- Mental load with new/unfamiliar terms makes problems more difficult than they are with more familiar terms
- Willingness to use math increases with problem complexity but students still struggle with answering correctly
- May have issues with wanting to short-cut answers to complex problems.

- Want to have your students take this survey? Email me (jadecat@ku.edu) or fill out the google form at the other end of this QR code.