

Why do students' mindsets change and how do we measure them?

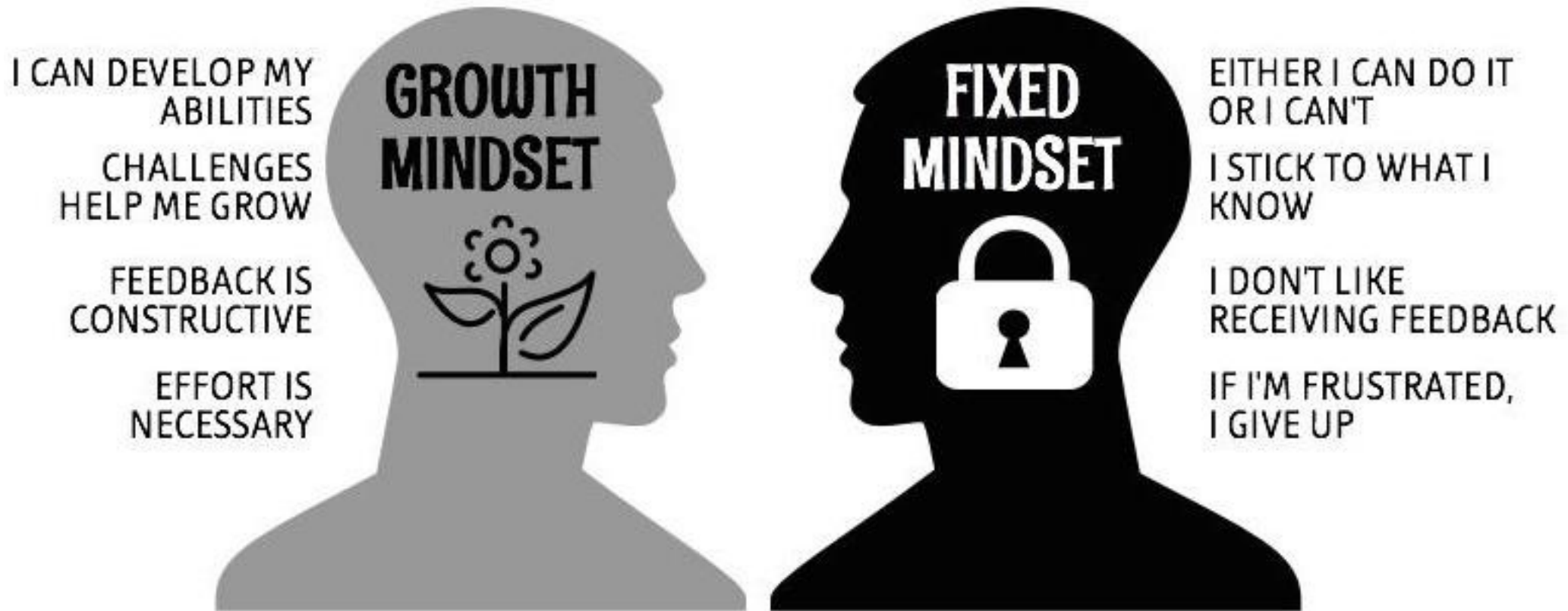
Lisa Limeri

llimeri@ttu.edu

University of Georgia -> Texas Tech University



Decades of research on mindset beliefs shows that they influence students' motivation, behaviors, and academic success.



Dweck, C. S. (1999). *Self-theories*; Smiley, Buttitta, Chung, Dubon, & Chang (2016) *Motivation and Emotion*, 40(6), 878–894.; Robins & Pals (2002) *Self and Identity*, 1(4), 313–336.

Where do your mindset beliefs come from?

Why do you believe intelligence is fixed or flexible?

- Write on the jamboard:

<https://jamboard.google.com/d/1xQncySULd3eHW3XKa382Z21KQ-oIUd3ExCjI5aH5aSw/edit?usp=sharing>

Children's mindsets are influenced by what their parents and teachers say to them.

It's okay, not everyone can be good at math.

You're just not a science person

You're a natural genius!

How and why do undergraduates' mindsets change?

How and why do undergraduates' mindsets change?

We surveyed and interviewed students in organic chemistry II

4 surveys throughout the semester (n=875)

- Measured mindsets using well-established survey (Dweck, 2000)

Interviewed 20 of these participants

Students reported five sources of their mindset beliefs

Limeri et al. *International Journal of STEM Education* (2020) 7:35
<https://doi.org/10.1186/s40594-020-00227-2>

International Journal of
STEM Education

RESEARCH

Open Access

Growing a growth mindset: characterizing how and why undergraduate students' mindsets change



Lisa B. Limeri^{1*} , Nathan T. Carter², Jun Choe¹, Hannah G. Harper¹, Hannah R. Martin³, Annaleigh Benton⁴ and Erin L. Dolan¹

Participants reported that their mindset beliefs were influenced by 5 factors

Academic experiences

Observing peers

Deducing logically

Societal cues

Formal learning

Participants reported that their mindset beliefs were influenced by 5 factors

Academic experiences

Observing peers

Deducing logically

Societal cues

Formal learning

Students who struggled throughout saw this as evidence that they had a fixed level of intelligence.

A teal-colored hexagonal graphic with the text "Academic experiences" inside in white.

Academic
experiences

Students who struggled throughout saw this as evidence that they had a fixed level of intelligence.

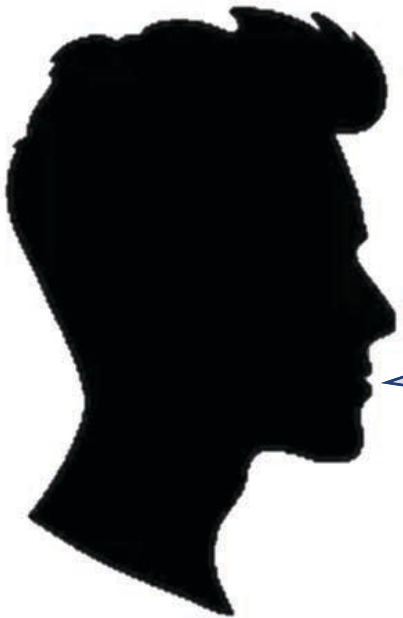
Academic
experiences



I thought if you had the resources and you worked as hard as you could and you had the help that you needed, you could get to the point that you wanted to be ... But then, after organic chemistry, I had those resources and I used them and I didn't do as well. So, I thought there might be a threshold to as far as resources could take you. And then at some point, it's really like whether you're genetically capable of connecting concepts or not.

Students who overcame struggles saw this as evidence that they could improve their intelligence.

Academic
experiences



Coming out of high school, I did not have a strong chemistry base. I struggled a bit when I took first semester general chemistry. However, in my second semester of chemistry I felt like I had a better grasp of learning the content and ended up getting an A in the class. So, I do believe it is possible to change your chemistry intelligence level.

Participants reported that their mindset beliefs were influenced by 5 factors

Academic experiences

Observing peers

Deducing logically

Societal cues

Formal learning

Students learned mindset beliefs by observing their peers fail or overcome challenges.



Observing
peers

Students learned mindset beliefs by observing their peers fail or overcome challenges.

Observing
peers

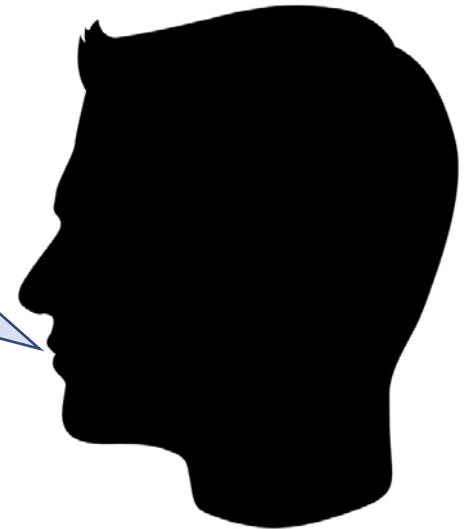
I have several friends who began in a science major and transferred to different majors after failing to be successful in general chemistry. One of these friends specifically barely passed gen chem 1, despite spending a significant amount of time studying. However, after switching to a business major she is succeeding tremendously. This goes to show that though anyone can learn at least a little more chemistry than they knew before, there are many people who simply cannot expand their chemistry knowledge to the depth that chemistry courses require.



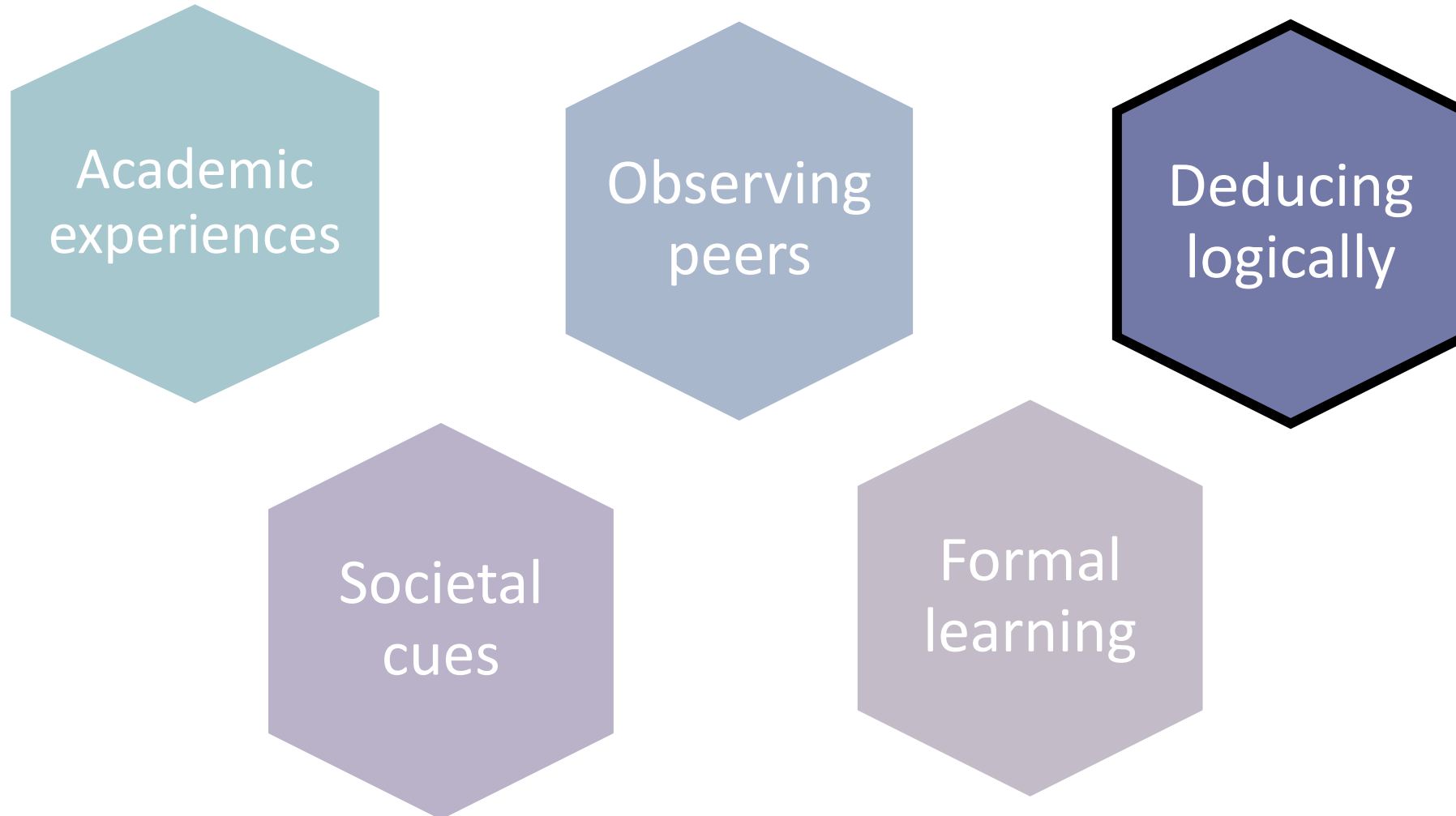
Students learned mindset beliefs by observing differences among their peers' abilities.

Observing
peers

I have always noticed that people tend to have different levels of intelligence from birth. Although smart people typically work hard in school, I have noticed how other people have a much easier time picking up on things than others with a decent amount of consistency. ... I have never seen anyone that I thought did not have much intelligence vastly improve how much intelligence they have.

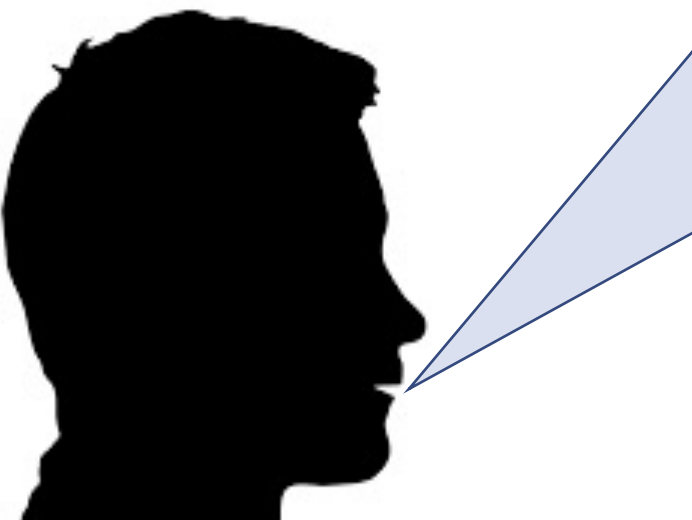


Students reasoned from scientific principles to explain their mindsets.



Students used blank slate reasoning to justify a growth mindset.


Deducing
logically



We can grow our knowledge and understanding, so intelligence must be changeable. At one point in time, we all knew nothing about chemistry. So then how could people become chemistry majors or professors if we couldn't change our chemistry knowledge and understanding?

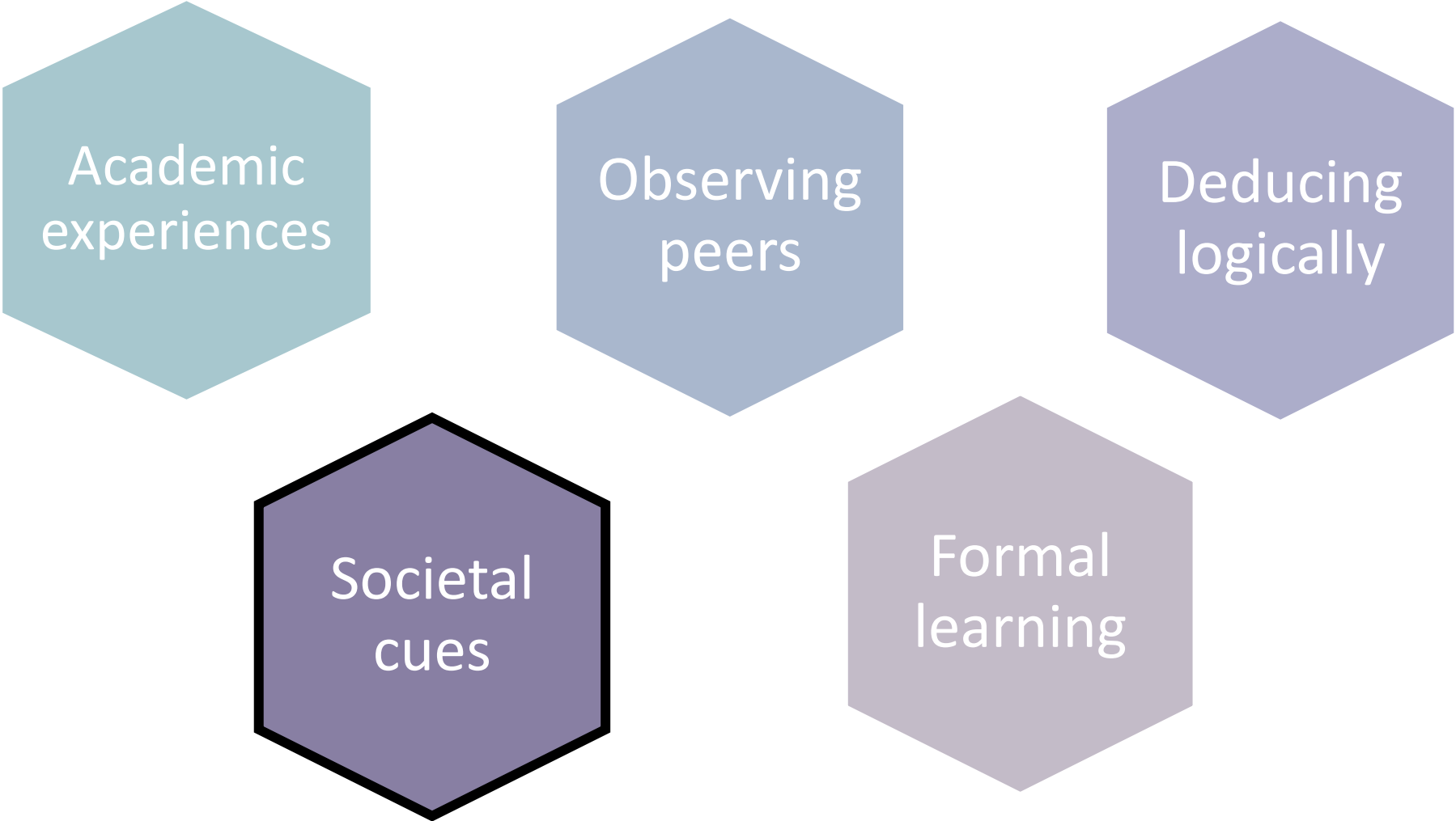
Students thought that brain plasticity was evidence of a growth mindset.

Deducing
logically



I believe that intelligence is something that is malleable. Just as scientists are learning that the brain is actually able to heal itself ... I also believe it's possible to change one's intelligence in the same way. ... I believe this because of my own experience with concussions. My brain was able to repair itself (to what extent, I will find out) after concussions. In the same way, I believe that by taking care of your brain, you can actually change its structure and performance ... So, likewise, one can change his or her IQ.

Students' mindsets were influenced by societal cues.



Classes separated by students' abilities implies a fixed mindset.

Societal
cues

[My elementary and middle school classes] were all separated not based off your home room, they were based off of your level of intelligence, and it was pretty clear. ... I was in the higher English group ... you could see their books were longer, their books were shorter. And the math you were doing, you could completely tell in your homeworks with you and your friends when you were looking at it, like, you're doing so much more work and you learn their math a lot earlier. So, I think I realized that there was definitely a difference in intelligence levels at a young age.

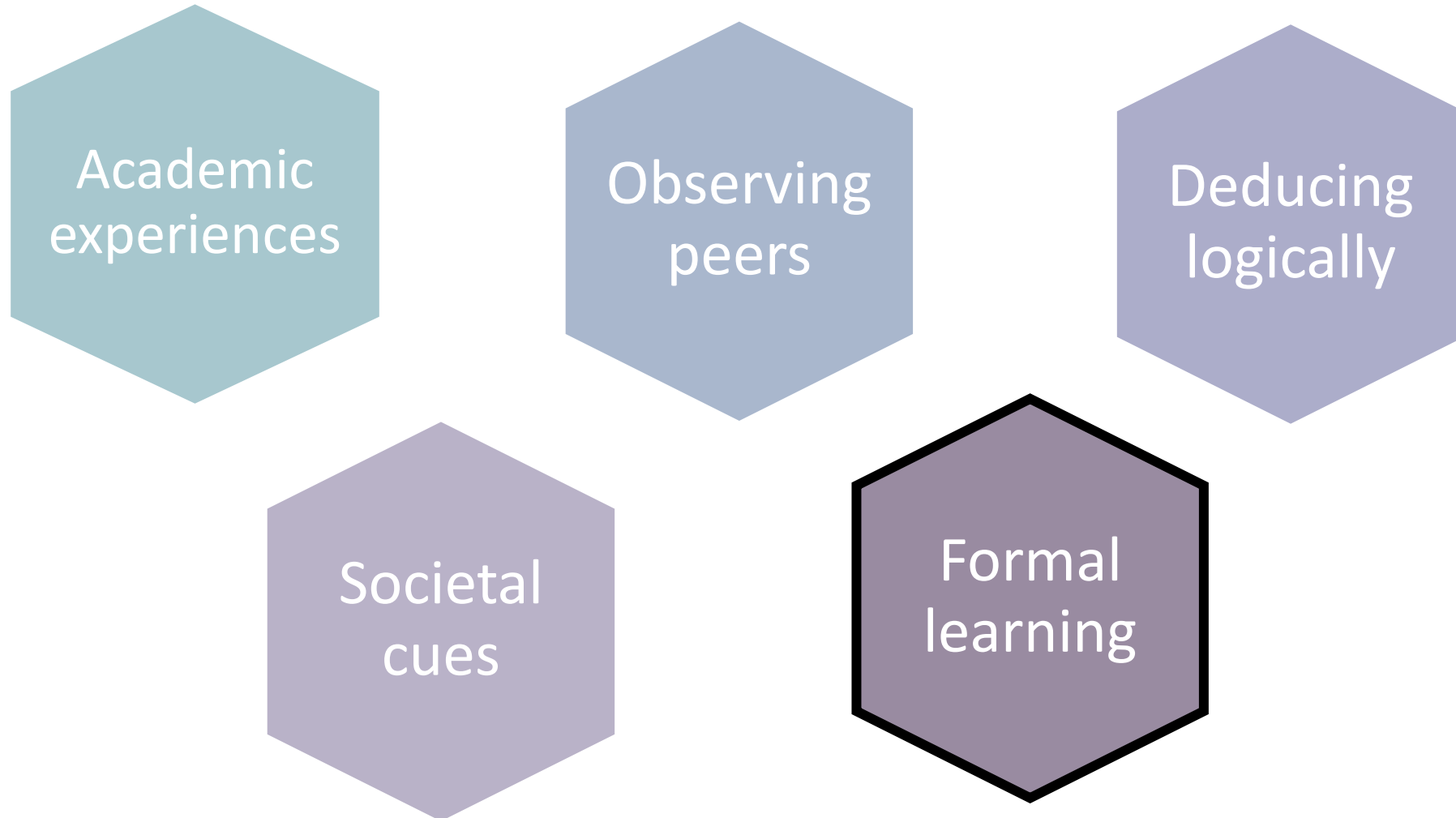


IQ testing implies a fixed mindset.

IQ and similar testing standards currently in place lay out the idea that intelligence is an inherent trait that is simply something that one possesses.




Students learned about intelligence in psychology courses.



Some students reported learning that intelligence is fixed.

Formal
learning



[In] AP psych, and in high school, we did a bunch of intelligence and IQ stuff. And all those thoughts. And I remember it teaching like, “intelligence is like your innate-what you're capable of doing.”

Other students reported learning that intelligence is malleable.

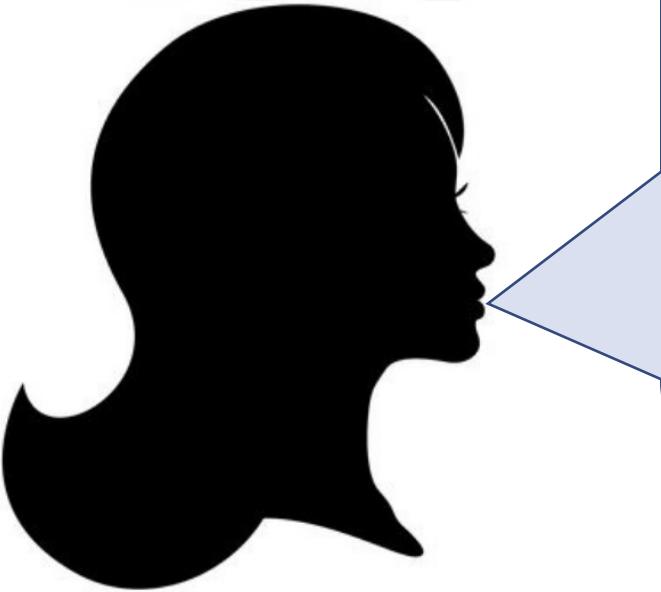
Formal
learning

I was more-or-less explicitly told in my high school AP Psychology and [Peer Learning Assistant Pedagogy Seminar] that intelligence is malleable and is the capacity to improve one's amount of learned knowledge and skills.



Some students reported learning about intelligence in the context of a nature-nurture debate.

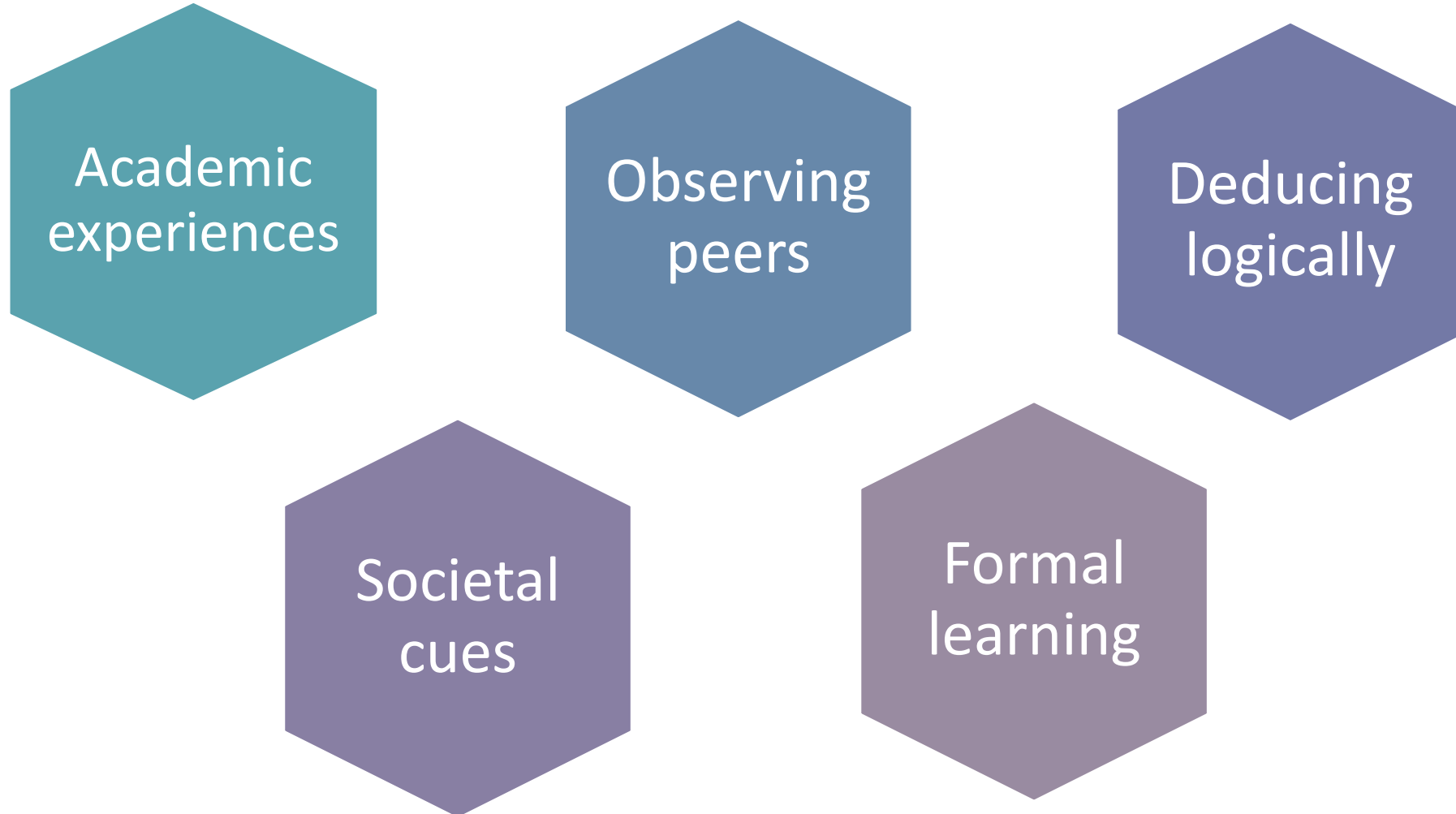
Formal
learning



When I wrote my paper on drug addiction and nature versus nurture, I think I kind of held the same stance that nature does play a very important role in it and how you're inclined to be addicted to things, but nurture, or your environment, is ultimately going to decide if you do. So yeah, I do think it [the malleability of intelligence] varies from person to person. I want to say genetics is more important, but then as soon as I say that, I think that it just varies.

Reflect: What could you do in your classes or existing interventions to foster a growth mindset based on these 5 sources?

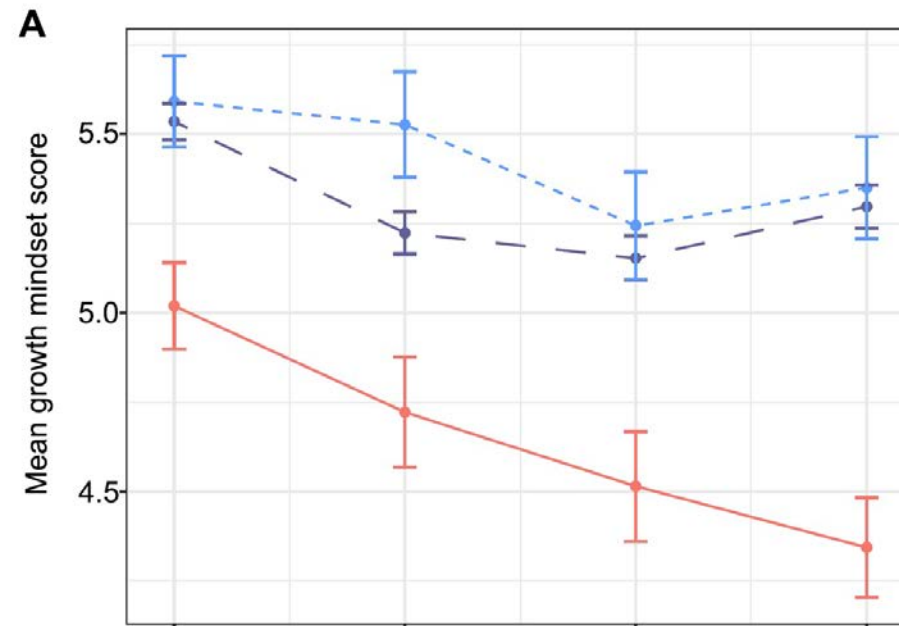
<https://jamboard.google.com/d/1xQncySULd3eHW3XKa382Z21KQ-oiUd3ExCjI5aH5aSw/edit?usp=sharing>



Measuring Mindset: An unexpected lesson

Measuring Mindset: An unexpected lesson

In this study, we explored how students' mindsets changed over time



The mindset survey

Indicate your level of agreement: 1 = strongly disagree to 5 = strongly agree

1. You have a certain amount of intelligence and you can't really do much to change it.
2. Your intelligence is something about you that you just can't change very much.
3. No matter who you are, you can significantly change your intelligence level
4. To be honest, you can't really change how intelligent you are.
5. You can always substantially change how intelligent you are.
6. You can learn new things, but you can't really change your basic intelligence.
7. No matter how much intelligence you have, you can always change it quite a bit.
8. You can change even your basic intelligence level considerably.

The mindset survey

Indicate your level of agreement: 1 = strongly disagree to 5 = strongly agree

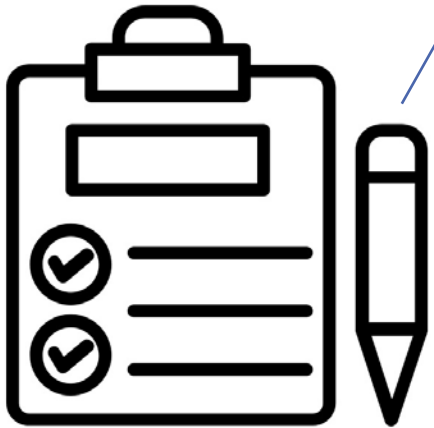
1. You have a certain amount of **intelligence** and you can't really do much to change it.
2. Your **intelligence** is something about you that you just can't change very much.
3. No matter who you are, you can significantly change your **intelligence** level
4. To be honest, you can't really change how **intelligent** you are.
5. You can always substantially change how **intelligent** you are.
6. You can learn new things, but you can't really change your basic **intelligence**.
7. No matter how much **intelligence** you have, you can always change it quite a bit.
8. You can change even your basic **intelligence** level considerably.

How do you define intelligence?

<https://jamboard.google.com/d/1xQncySULd3eHW3XKa382Z21KQ-olUd3ExCjI5aH5aSw/edit?usp=sharing>



Responses made it clear we had a problem.



This is an extremely subjective questionnaire since each person defines intelligence differently. If we go by the definition that it is the ability to reason and problem-solve, that can definitely be modified by study. As far as the ease by which you can learn, that can't be changed.

Students conceptualize intelligence in different ways

Knowledge or Abilities? How Undergraduates Define Intelligence

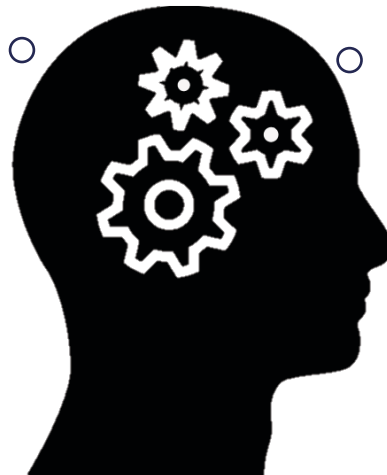
**Lisa B. Limeri,^{†*} Jun Choe,[†] Hannah G. Harper,[†] Hannah R. Martin,[‡]
Annaleigh Benton,[§] and Erin L. Dolan[†]**

2020, CBE - Life Sciences Education

Students conceptualize intelligence in different ways

Ability to
process
information

Possessing
knowledge




Intelligence is possessing knowledge

Once you attain knowledge, whether that's through studying or reading or observing, once you have that knowledge you're considered intelligent. Like, you have that intelligence.



Intelligence is ability to process information



Intelligence is more like how well you can apply previous knowledge you have into situations. ... Knowledge is more like content, like how many facts can you memorize ... intelligence is what you can do with knowledge. Like, can you understand how things relate to each other and use knowledge they have from one experience and apply it to a whole different experience to explain other things?

How students define intelligence may affect how they respond to the mindset survey

Students who define intelligence as knowledge say it is changeable.



At one point in time, we all knew nothing about chemistry. So then how could people become chemistry majors or professors if we couldn't change our chemistry knowledge and understanding?

Students who define intelligence as abilities expressed varied opinions.

I think that you can change your general intelligence. You can do this through doing brain games. These games sharpen your problem-solving ability and learning skills.

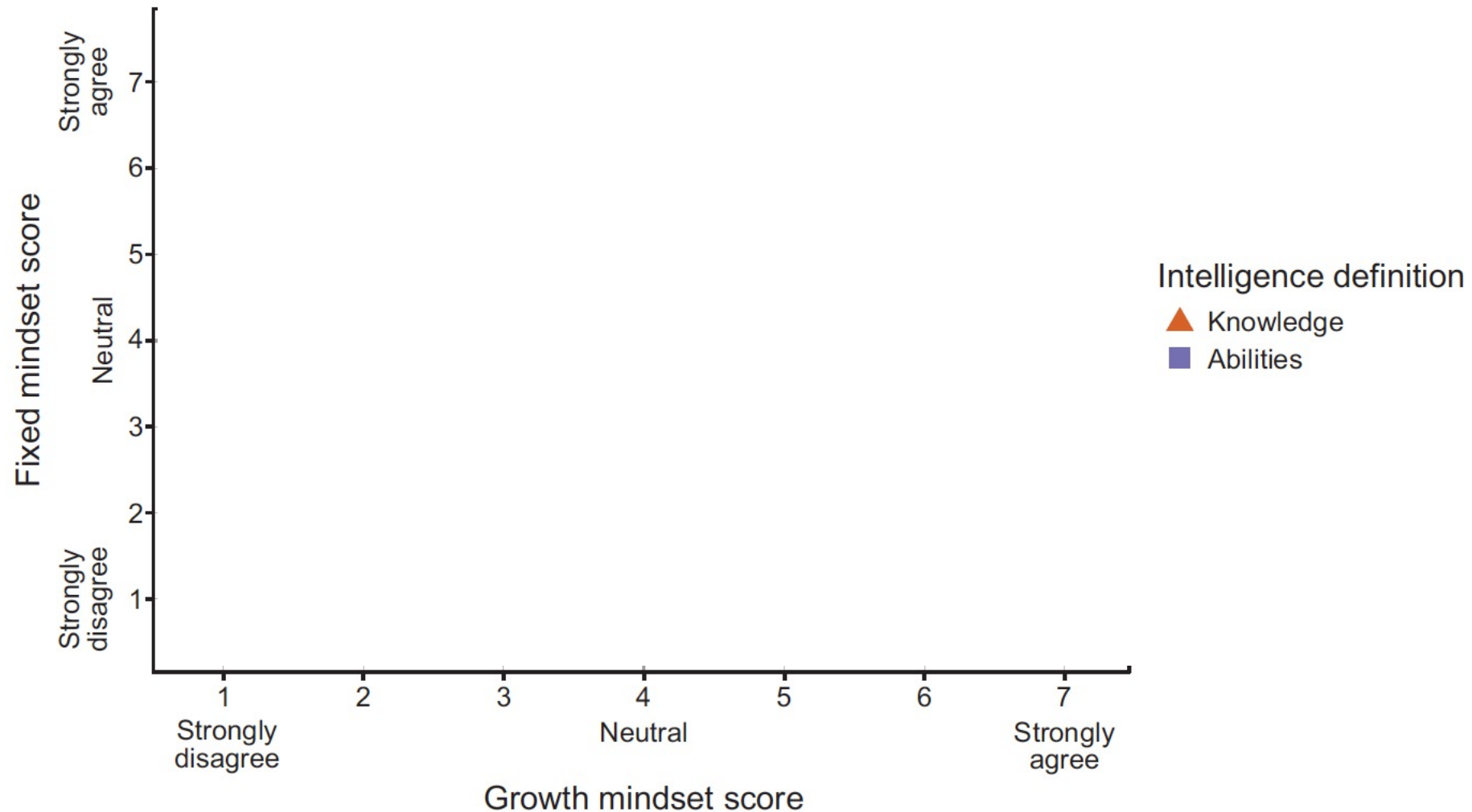


Students who define intelligence as abilities expressed varied opinions.

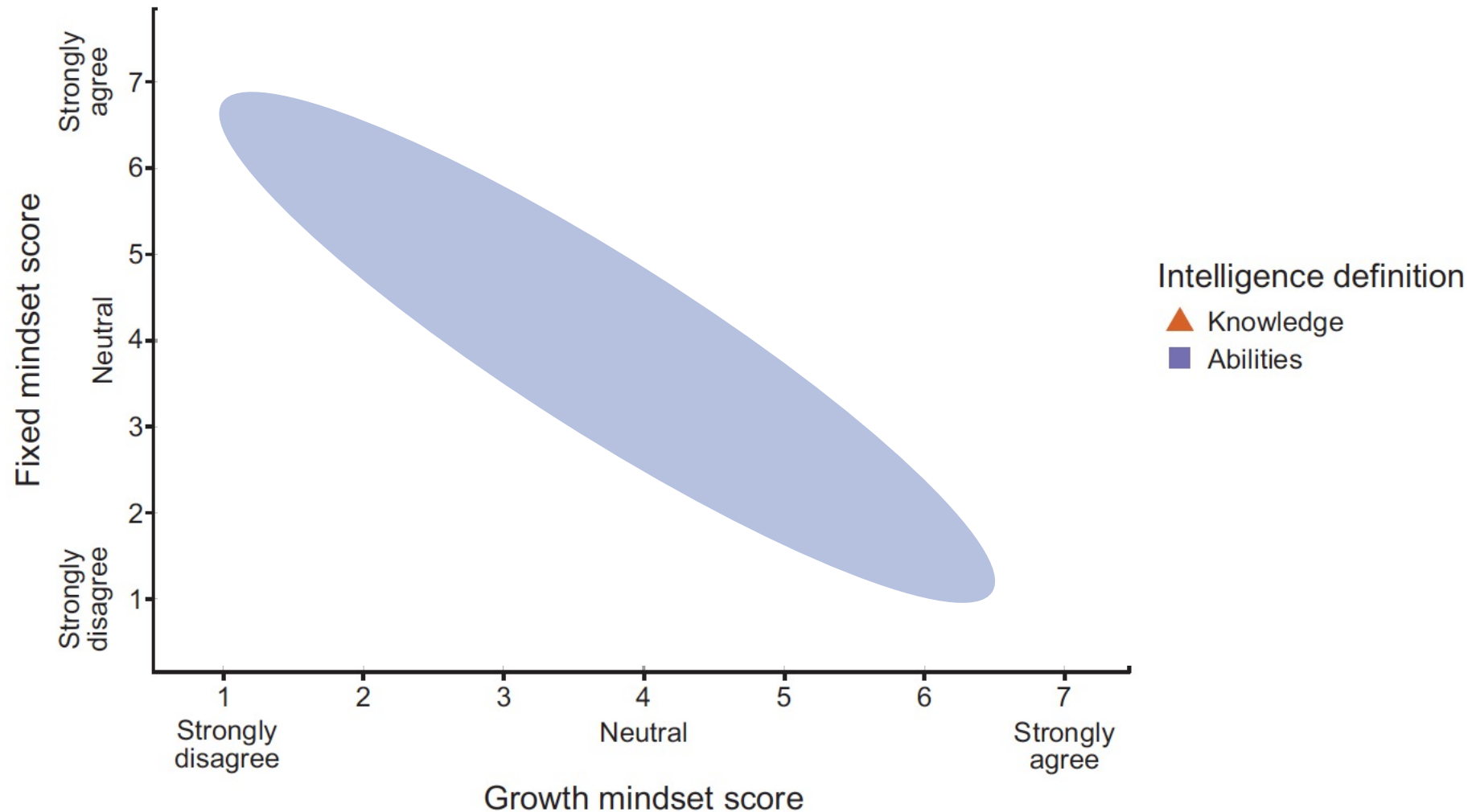


Basic intelligence isn't something that can be changed that much. Some people learn better than others, have better memorization skills, or understand subjects better than others. Putting in work and learning new things won't change this, it would just make someone more knowledgeable in that subject.

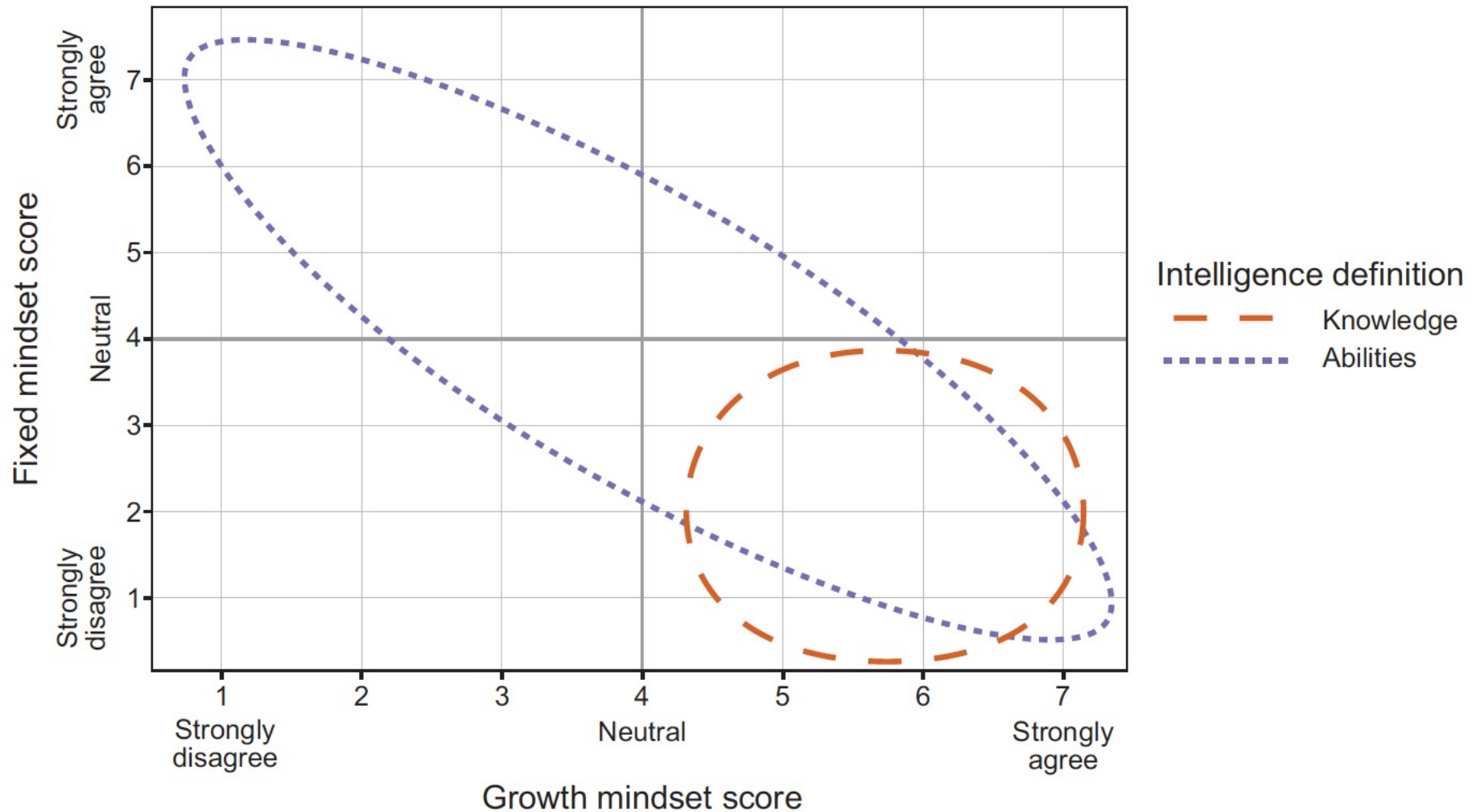
How students define intelligence may affect how they respond to the mindset survey



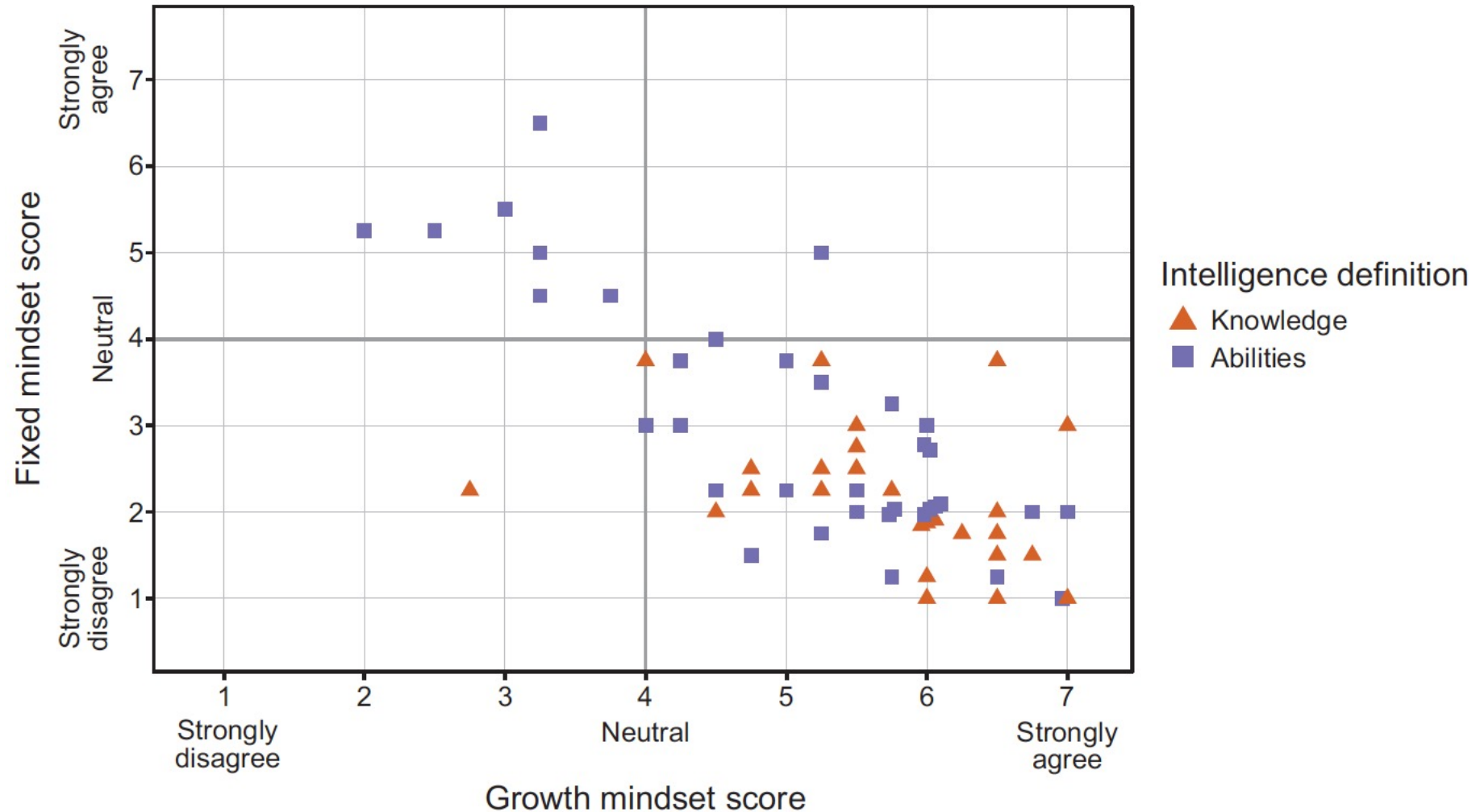
How students define intelligence may affect how they respond to the mindset survey



How students define intelligence may affect how they respond to the mindset survey



How students define intelligence may affect how they respond to the mindset survey



The mindset survey is not a trustworthy way to measure mindset because undergraduates don't interpret the items consistently



What tools did/do you use to collect data in your research?

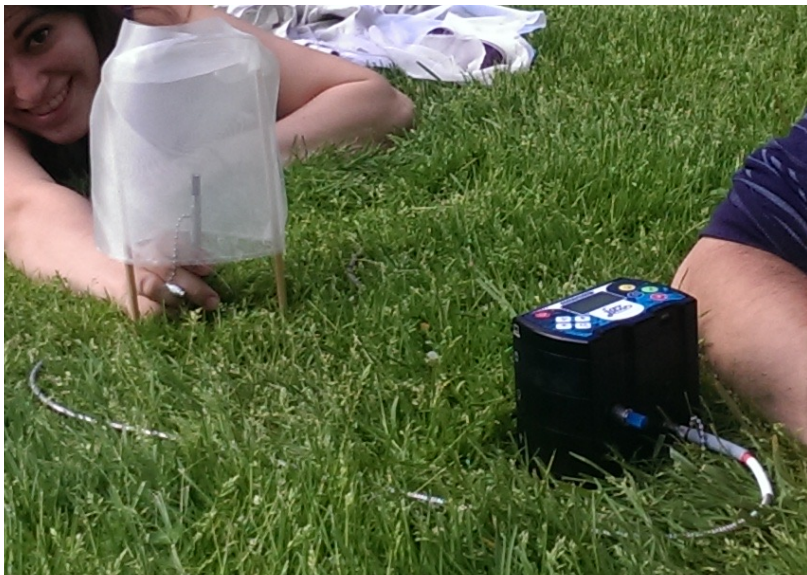
How do you know the data they produce are trustworthy?



It's important that data collection tools are calibrated properly

Validation is an *ongoing process*

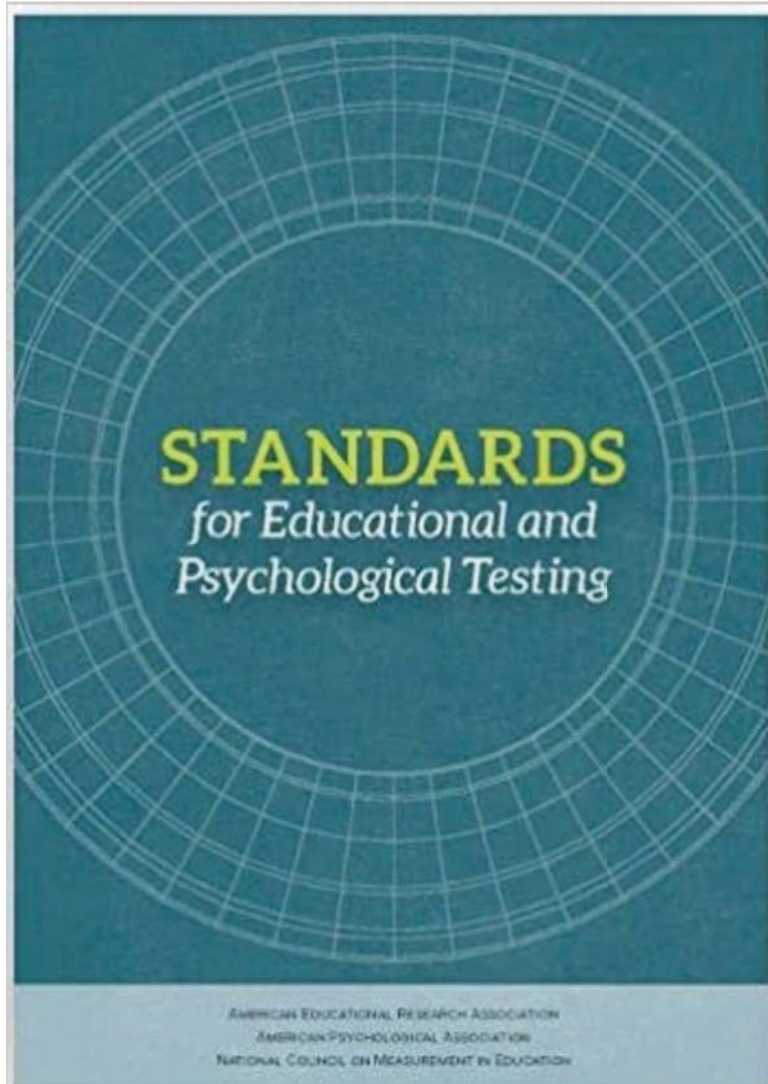
Calibrate and check your instruments each time you use them



It's important that data collection tools are calibrated properly



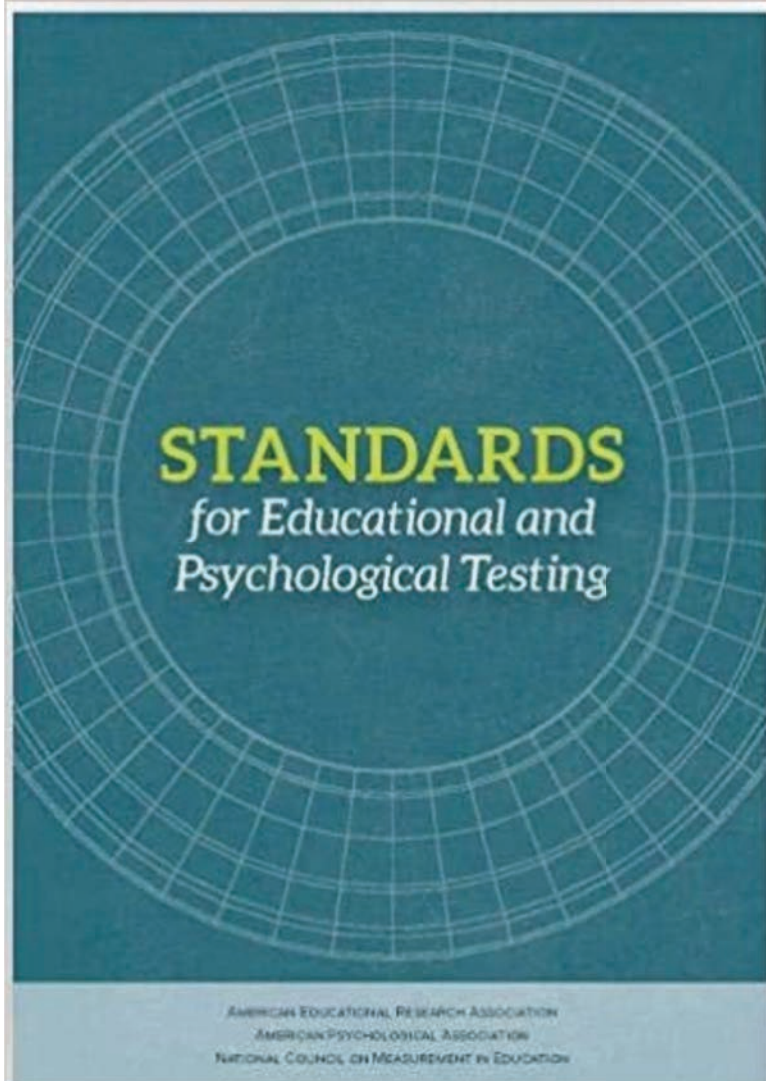
What is validity?



“Validity refers to the degree to which evidence and theory support the interpretations of test scores for proposed uses of tests.”

Standards is now available as a free PDF:
<https://www.testingstandards.net/open-access-files.html>

A strong validity argument is supported by multiple types of evidence



- Does the content of the items match the theory? *(evidence based on content)*
- Do participants understand the items the way you intended? *(evidence based on response process)*
- Are items measuring the same thing correlated with each other? *(evidence based on internal structure)*
- Do the relationships among variables align with theory? *(evidence based on relations to other variables)*

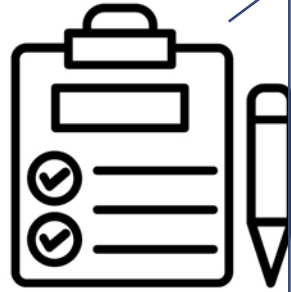
What happens if we don't have strong evidence of validity?

Your intelligence is your knowledge. I think they completely go hand in hand



What happens if we don't have strong evidence of validity?

Your intelligence is your knowledge. I think they completely go hand in hand



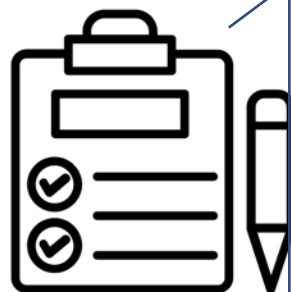
Selects "Somewhat Agree" to:

- No matter who you are, you can significantly change your chemistry intelligence level.
- You can always substantially change how intelligent you are in chemistry.



What happens if we don't have strong evidence of validity?

Your intelligence is your knowledge. I think they completely go hand in hand



Selects "Somewhat Agree" to:

- No matter who you are, you can significantly change your chemistry intelligence level.
- You can always substantially change how intelligent you are in chemistry.

Describing her struggles in organic chemistry:

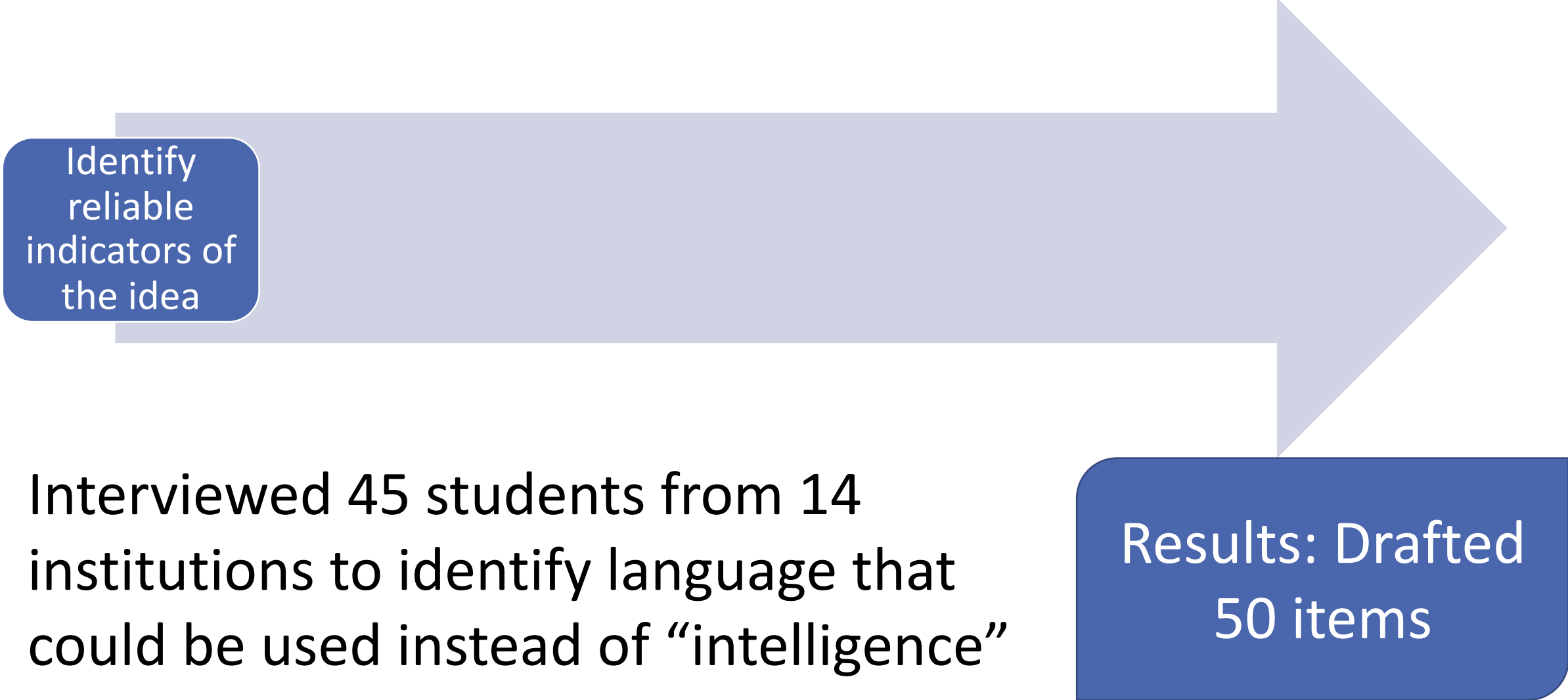
It's the way your brain works. It's kind of how people say that you're either math-minded or you're english-minded. I think it's either, you can see this part of science or you can't. ... I think that you have to have a level of intelligence to be in organic chemistry to understand it. And if you don't have that, as much as you work, it's just simply not going to work.



Developing a new measure of mindset beliefs that can be used with undergraduate science & math students



Mindset measure development process

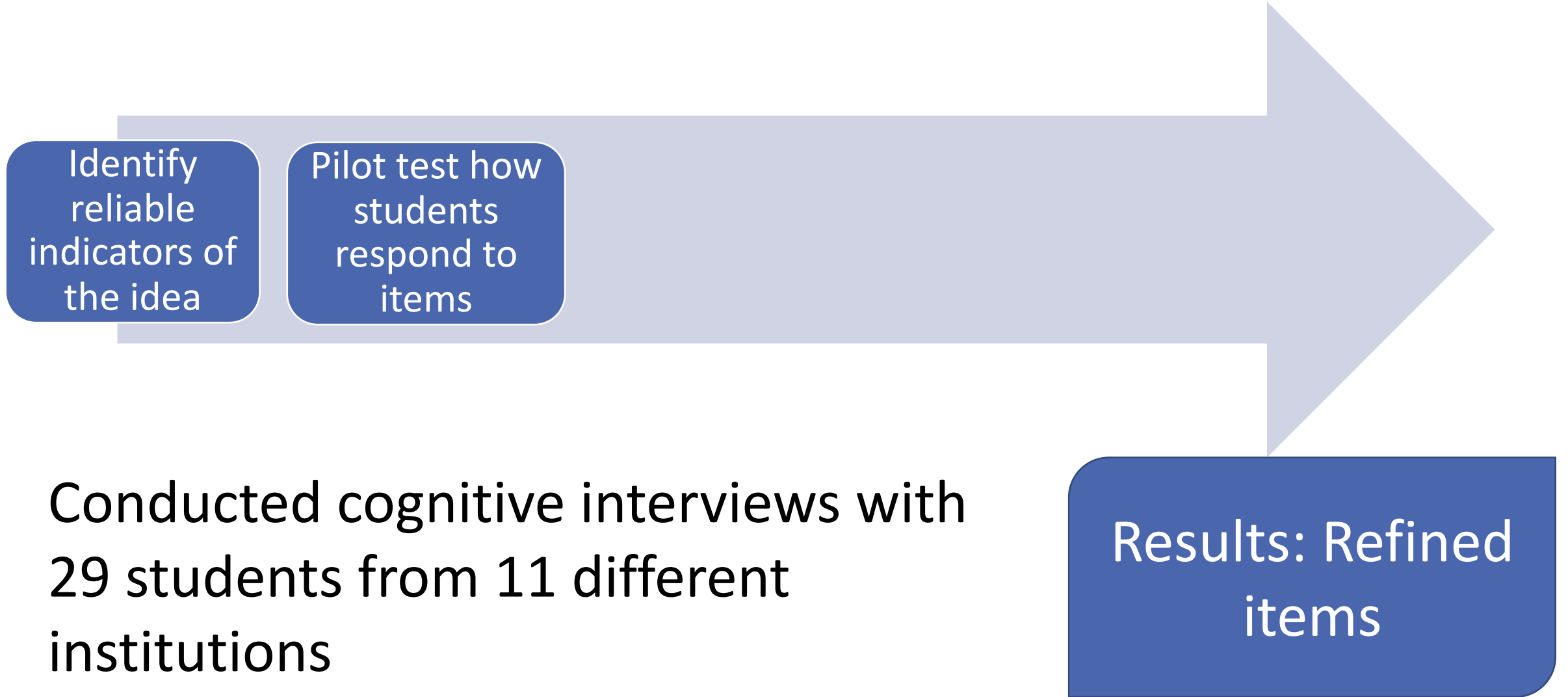


Identify
reliable
indicators of
the idea

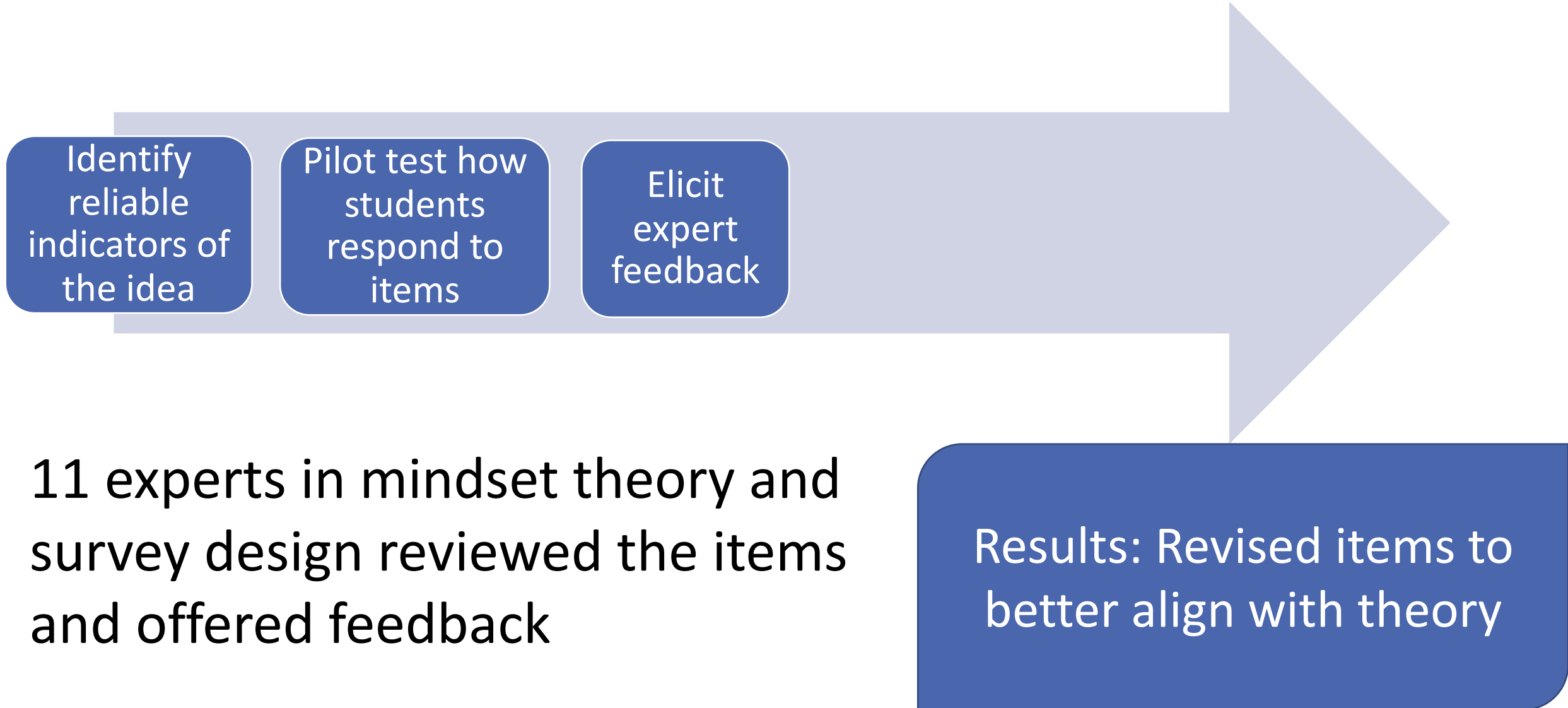
Interviewed 45 students from 14 institutions to identify language that could be used instead of “intelligence”

Results: Drafted
50 items

Mindset measure development process



Mindset measure development process



Undergraduate Lay Theories of Abilities (ULTrA) Survey

Mindset beliefs

The extent to which mental abilities can be improved

I can vastly improve my ability to think creatively.

Universality beliefs

The distribution of the potential for high levels of ability

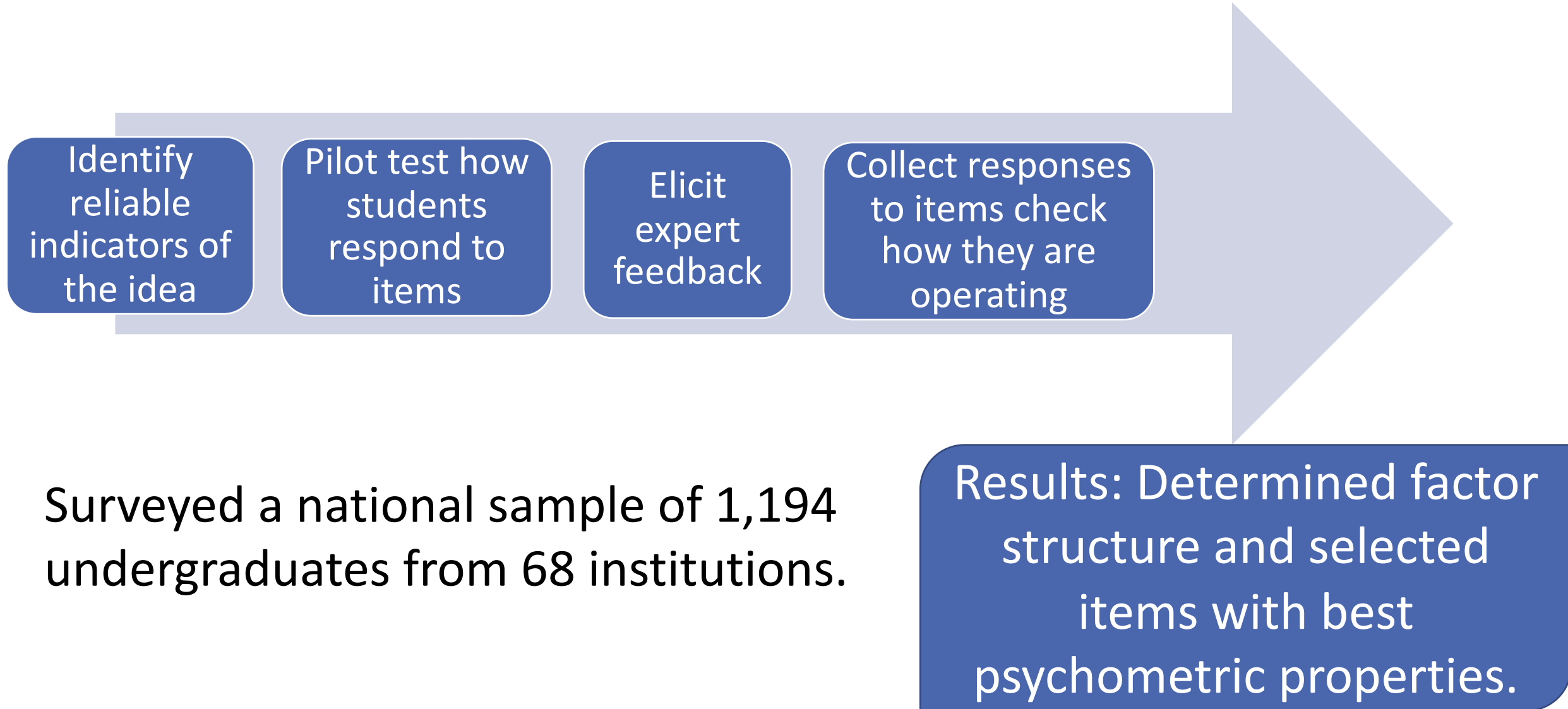
Only some people can become great at applying knowledge to solve challenging problems.

Brilliance beliefs

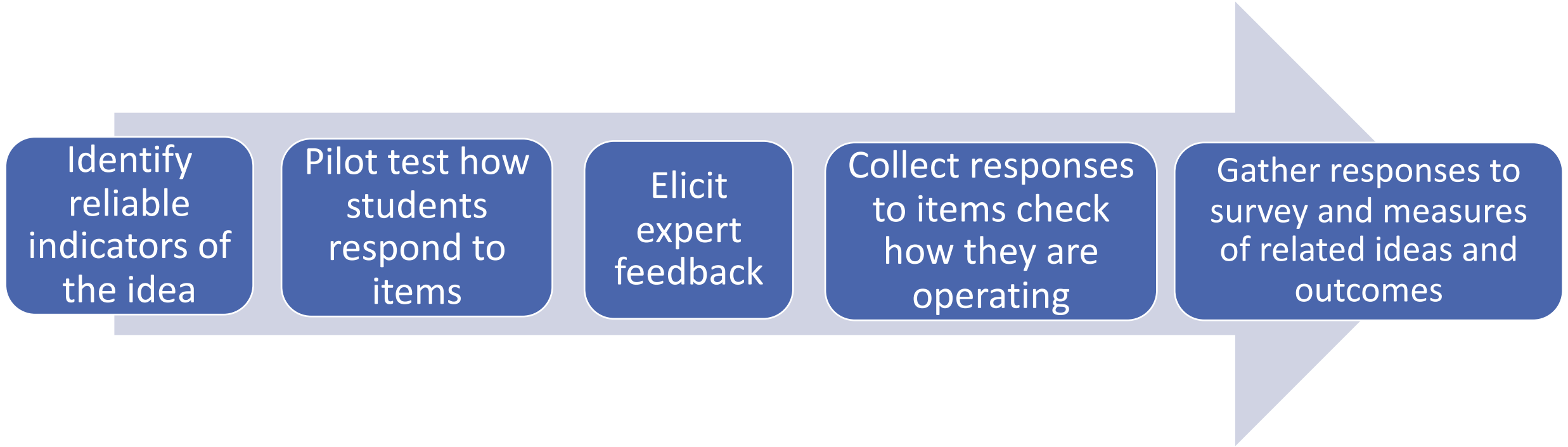
The extent to which success in a field requires innate brilliance

People who are highly successful in STEM have a natural talent for it.

Mindset measure development process



Mindset measure development process



This fall: Will survey another national sample of students along with measures of related constructs.

Results: Final survey with strong evidence of validity.

Thank you!

- Biology Education Research Group at UGA
- VIP@UGA
- Erin Dolan & the Social Psychology of Research Experiences & Education (SPREE) research group

Funding:

- National Science Foundation
- Center for Integrated Research on Teaching and Learning at UGA



Get involved!

Do you want to:

- help make the ULTrA Survey strong,
- have confidence you can use this new measure in your context, and
- learn about your students?

I am looking for instructors of intro science and math courses to:

- offer their students course credit for completing a survey
- Provide me participants' grades at the end of the term
- Help me apply for IRB approval for this study at their institutions

***Offering instructors a small financial stipend for their time and help*

Email me! llimeri@ttu.edu or put your email in the jamboard or chat