Team-Based Inquiry Learning in Linear Algebra

The marriage of Team-Based Learning, Inquiry-Based Learning, and Alternative Grading

By Sharona Krinsky

Introduction

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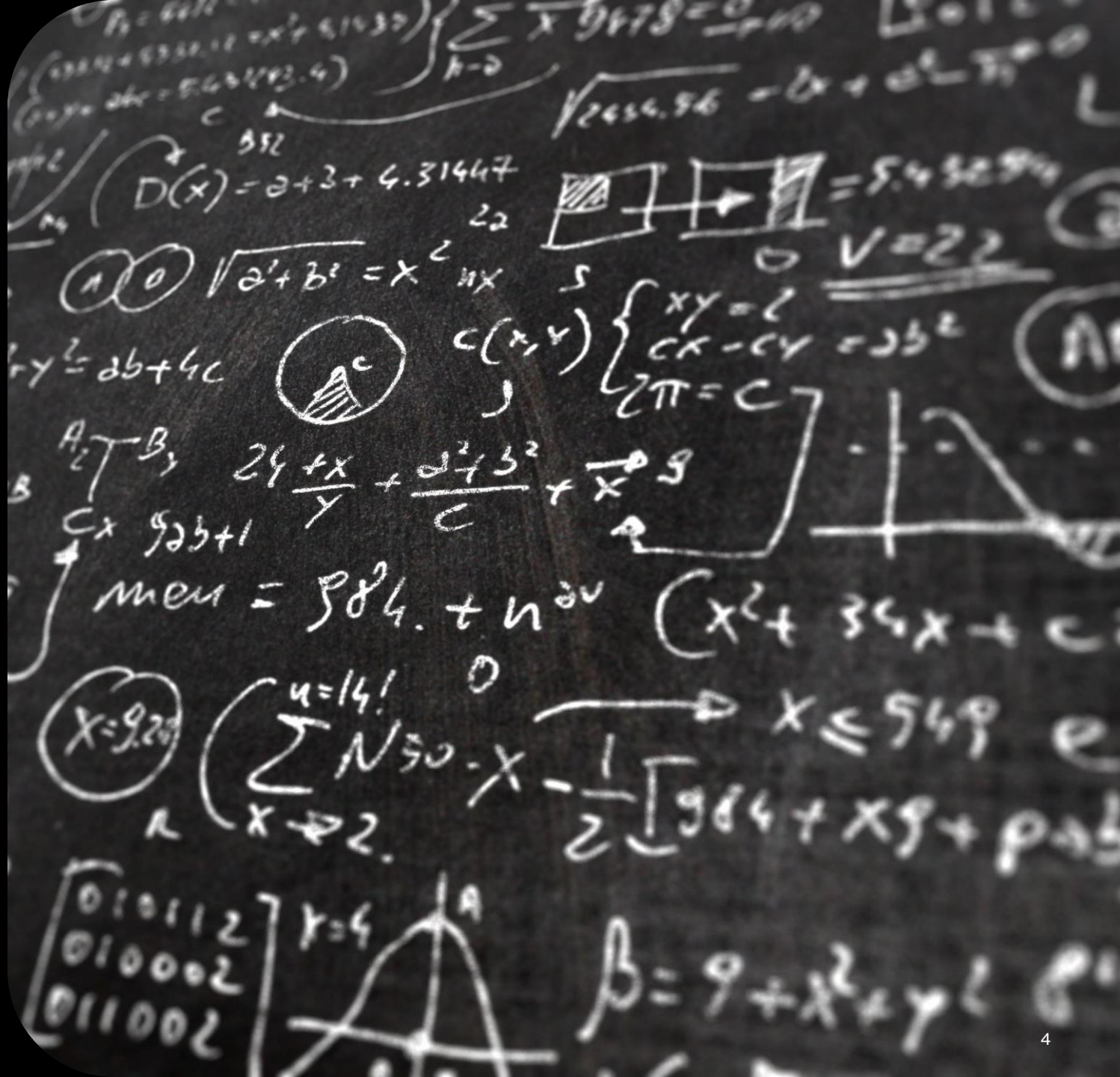
What is Team-Based Inquiry Learning?

- Team-Based Learning (TBL) is a cooperative learning strategy blending elements of flipped learning, inquiry-based learning, and problem-based learning.

A Personal History of “Failure”

- Introduction to “Cooperative Learning” – circa 1984
- Use of Cooperative Learning in Calculus while a graduate TA at Ohio State – 1992-1997
- Use of Inquiry Learning in Calculus – Hughes-Hallett – 1995
- Use of Active learning in Developmental Math – circa 2009



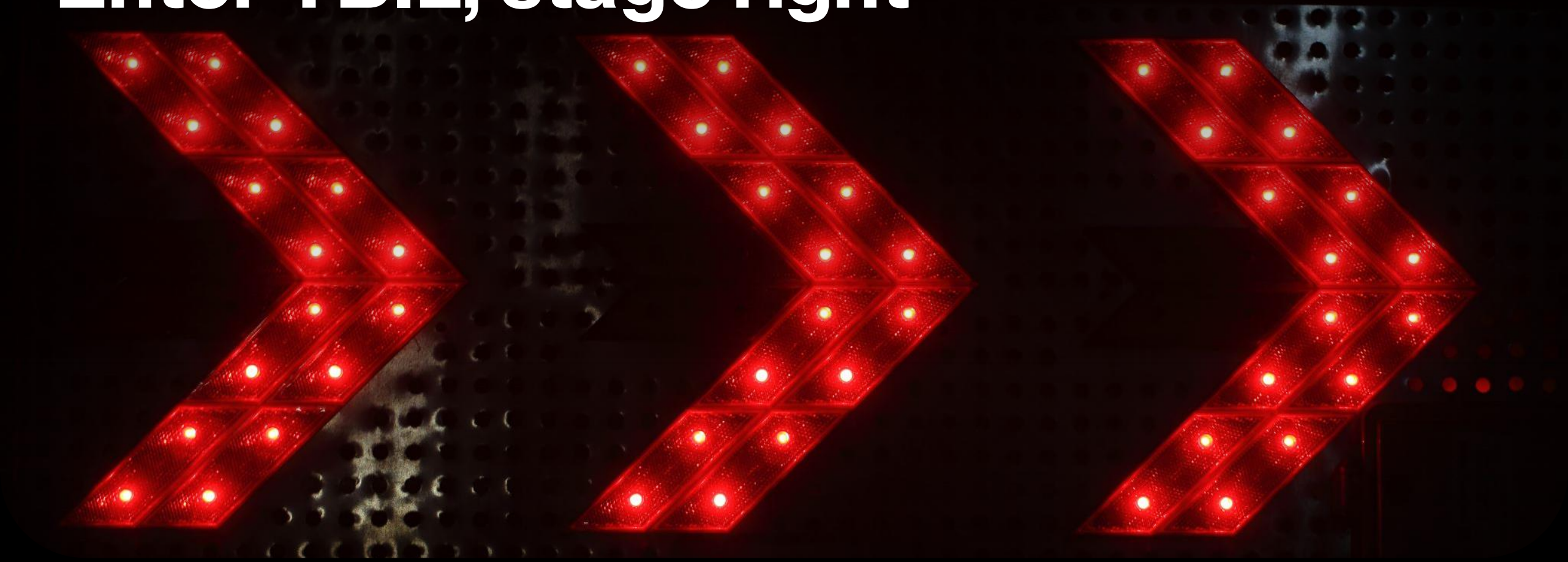
Adding in Grading Reform – 2016

- Calculus 1, 2, and 3 with Active Calculus and Standards Based Grading
  + Success!! (But still difficult) – 2016 - 2018
- Quantitative Reasoning with Statistics in Dual Enrollment environment and iClickers with groups
  + Success! (Sort of) – 2016-2019
- Quantitative Reasoning with Statistics – redesign to accommodate no developmental math and over 40 sections with 15 instructors – some success, still not very engaging/inquiry based – 2017 – 2020 (Spring)
- **COVID**
- Fall 2020 – do you want to teach Linear Algebra???

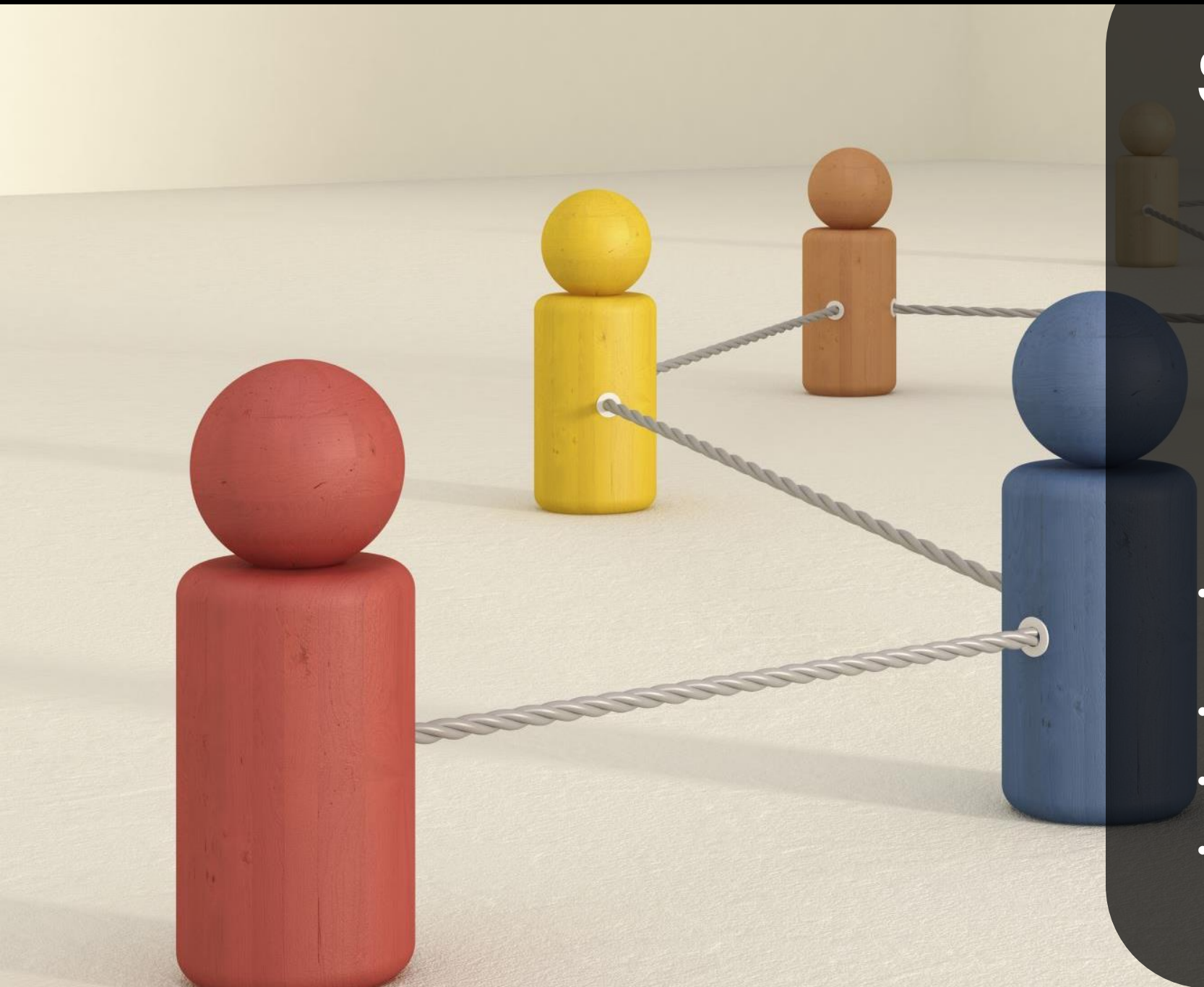
Things about Linear Algebra (from my perspective)

1. I never took the lower division Linear Algebra class.
2. I took the upper division Linear Algebra class with insufficient preparation as a first semester freshman.
3. That was over 35 years ago.
4. I stopped my Ph.D. research in part by running into issues with the holes in my background regarding Linear Algebra.
5. I had not touched linear algebra since the 20th century.
6. We were in COVID.
7. This course is the first more “formal” class as far as expectations of mathematical writing precisions, “proving” things, etc.

Enter TBIL, stage right



Structured



- Pre-class work (Readiness Assurance Process)
- In class collaboration
- High structure
- Biggest key – the four S’s

The Four S’s

Present a Significant Problem

All teams get the Same Problem

Teams are asked to make a Specific Choice (constrained choice)

Teams commit to their decision by publicly and Simultaneous Reporting it.

Spanning Sets (EV2)

Activity 2.2.7 We'd prefer a more methodical method to decide if every vector in $\mathbb{R}^n$ belongs to some spanning set, compared to the guess-and-check method we used in Activity 2.2.6.

(a) An arbitrary vector $\begin{bmatrix} ? \\ ? \\ ? \end{bmatrix}$ belongs to span $\left\{ \begin{bmatrix} 1 \\ -1 \\ 0 \end{bmatrix}, \begin{bmatrix} -2 \\ 0 \\ 1 \end{bmatrix}, \begin{bmatrix} -2 \\ -2 \\ 2 \end{bmatrix} \right\}$ provided the equation

$$x_1 \begin{bmatrix} 1 \\ -1 \\ 0 \end{bmatrix} + x_2 \begin{bmatrix} -2 \\ 0 \\ 1 \end{bmatrix} + x_3 \begin{bmatrix} -2 \\ -2 \\ 2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \\ ? \end{bmatrix}$$

has...

A. no solutions.

B. exactly one solution.

C. at least one solution.

D. infinitely-many solutions.

Let's look at an Example

Image and Kernel (AT3)

Activity 3.3.2 Let $T : \mathbb{R}^2 \to \mathbb{R}^3$ be given by

$$T\left(\begin{bmatrix} x \\ y \end{bmatrix}\right) = \begin{bmatrix} x \\ y \\ 0 \end{bmatrix} \qquad \text{with standard matrix } \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}$$

Which of these subspaces of $\mathbb{R}^2$ describes the set of all vectors that transform into $\vec{0}$?

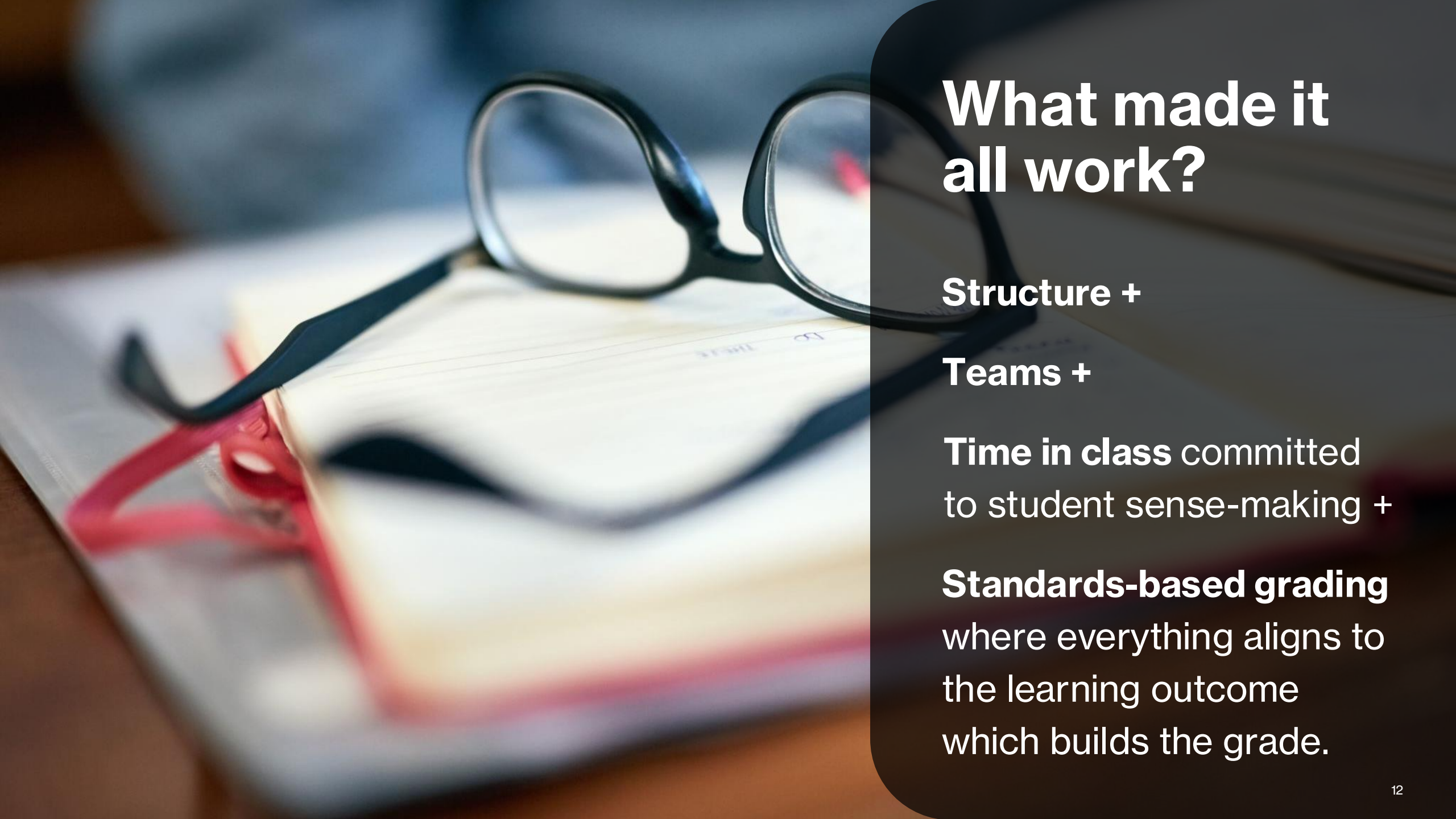
A. $\left\{ \begin{bmatrix} a \\ a \end{bmatrix} \middle| a \in \mathbb{R} \right\}$

B. $\left\{ \begin{bmatrix} a \\ 0 \end{bmatrix} \middle| a \in \mathbb{R} \right\}$

C. $\left\{ \begin{bmatrix} 0 \\ 0 \end{bmatrix} \right\}$

D. $\left\{ \begin{bmatrix} a \\ b \end{bmatrix} \middle| a, b \in \mathbb{R} \right\}$

Here's another example.



What made it all work?

Structure +

Teams +

Time in class committed to student sense-making +

Standards-based grading where everything aligns to the learning outcome which builds the grade.

Keep in Touch!

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