The Beginning of a Vector Skills Assessment: Instrument Revision

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Introduction

- Vector addition and subtraction is important in introductory physics
- Students struggle greatly with vector addition and subtraction skills [1][2]
- Students in algebra-based physics courses at NDSU were given a multiple choice (MCQ) and free response (FRQ) version of a vector skills assessments (VSA) [1]

Why?

- For the VSA to accurately measure vector skills, we need relevant distractors
- Roughly half of students draw a vector that is not an option on the MCQ
- We want to remove unused options and add common errors that aren't currently present

How?

- 122 students (n=122) , 8 questions each
- Record x and y components of all vectors initially coded as "other"
- Plot results to distinguish between "sloppy but correct" and genuine misunderstanding
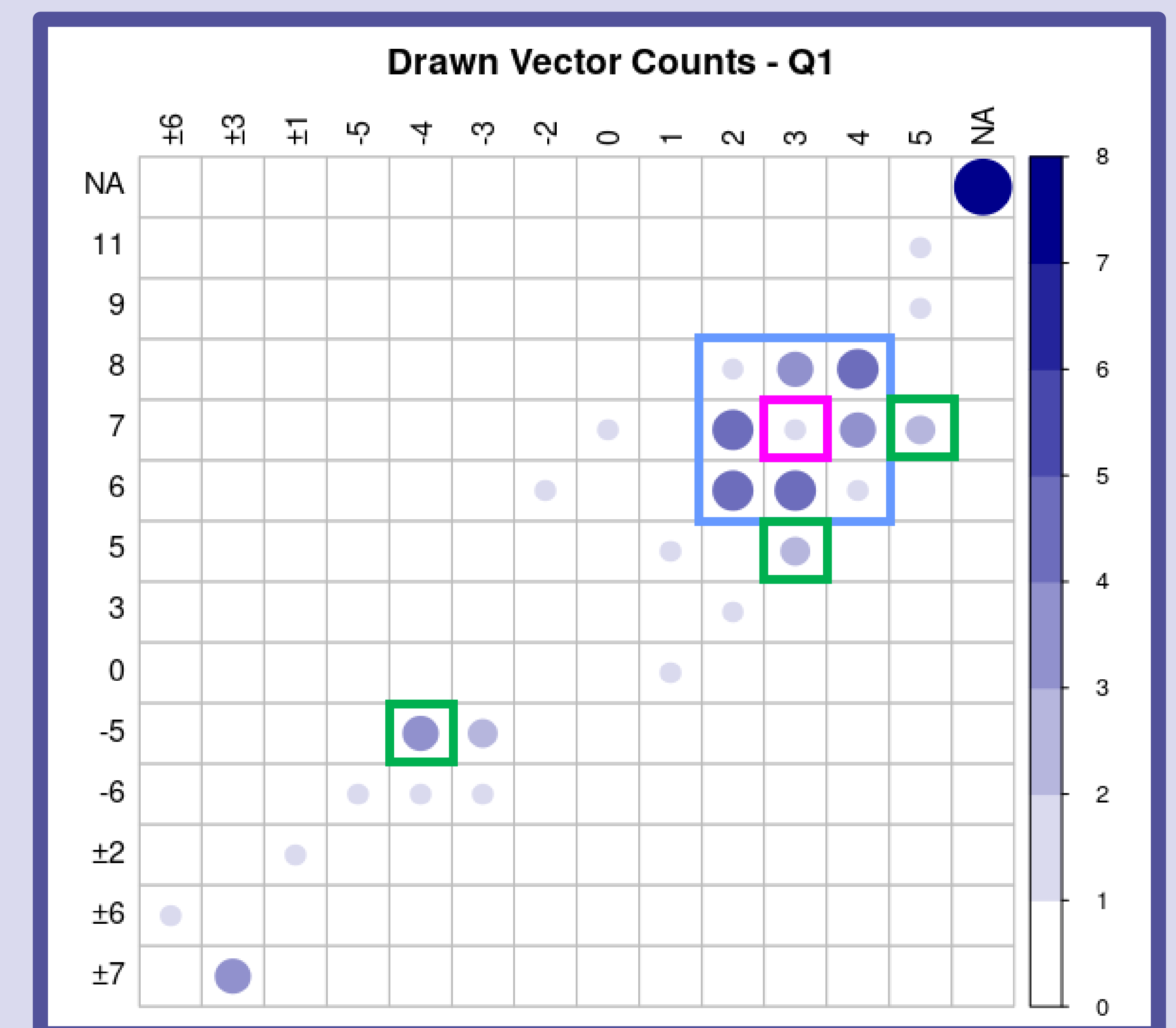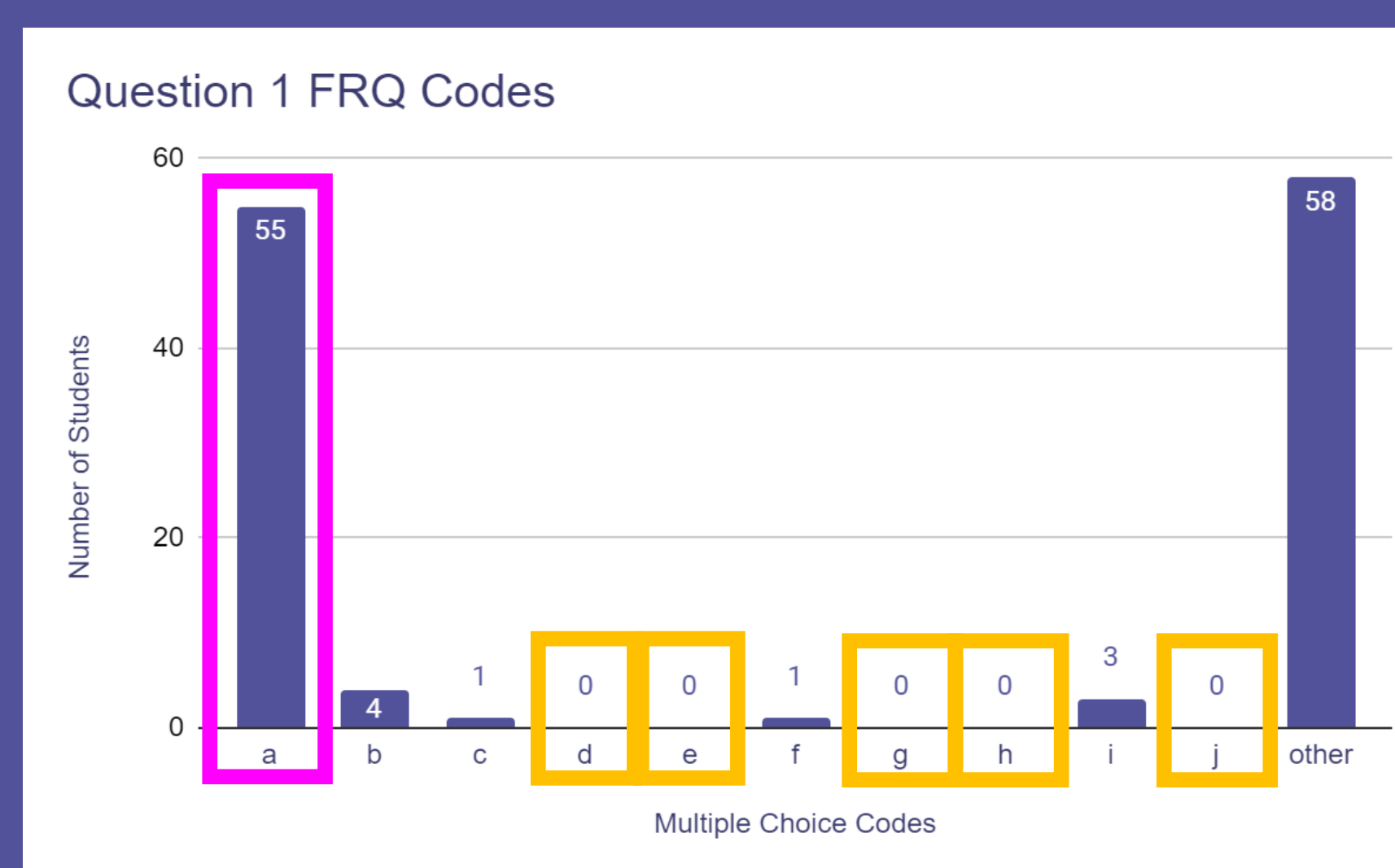- Identify candidates for inclusion and removal

Multiple Choice Question (MCQ)

Free Response Question (FRQ)

1.) What is $\vec{A} + \vec{B}$ ($\vec{A}$ plus $\vec{B}$)? Show your steps (by drawing!) and answer in the grid below.

FRQ Matching to MCQ

Question 1 FRQ Codes

Drawn Vector Counts - Q1

■ correct   ■ drawing error   ■ discarded   ■ added

Question 1 Revisions

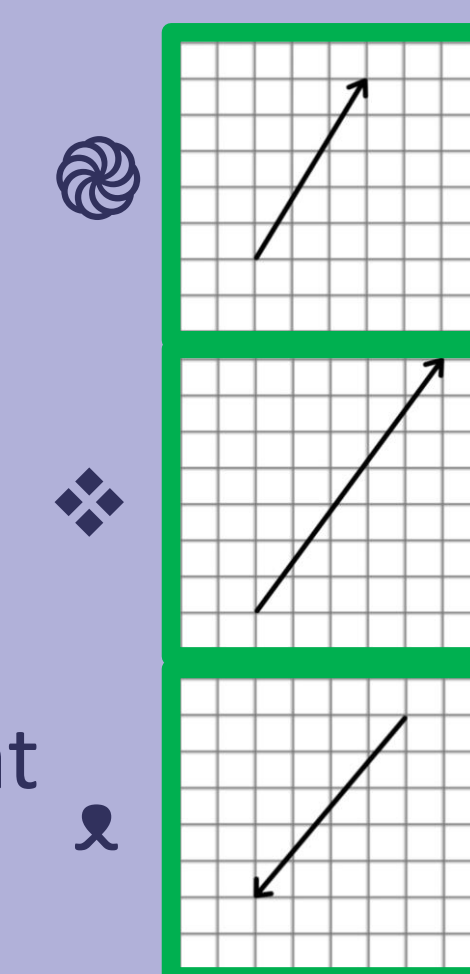### Discarded Options

- d · g · j
- e · h

When matching FRQ to MCQ, options d, e, g, h, and j had no matches

Added Options

(3,5)   ❖ (5,7)   (-4,-5)   ❖

These 3 vectors are often drawn and are different enough from the correct answer that we do not think the student is being careless

Summary and Future Work

- Identified MC options to discard and add for each question
- Generate new MCQ sheet with the new options
- Combine with Factor Analysis to determine relevance of each question
- Use combined work to create a Vector Skills Assessment

Sources:
[1] Buncher, J. B. (2015). Algebra-Based Students and Vector Representations: Arrow vs. ijk. *American Association of Physics Teachers*, 75-78.
[2] Nguyen, N. L., & Meltzer, D. E. (2003). Initial understanding of vector concepts among students in introductory physics courses. *American journal of physics*, *71*(6), 630-638.