

MULTIPLE REPRESENTATIONS

Representations in physics are defined as “the many forms in which a certain physics concept is expressed, demonstrated, depicted, and communicated, such as words, graphs, algebraic expressions, pictures, free-body diagrams, data tables, etc.” [1].

WHAT IS FREE RECALL?

One of the simplest ways to unveil what students have learned is to ask them to recall what they remember. Free recall describes the act of recalling from memory everything that one remembers from a learning period and writing it down as individual pieces of information [2].

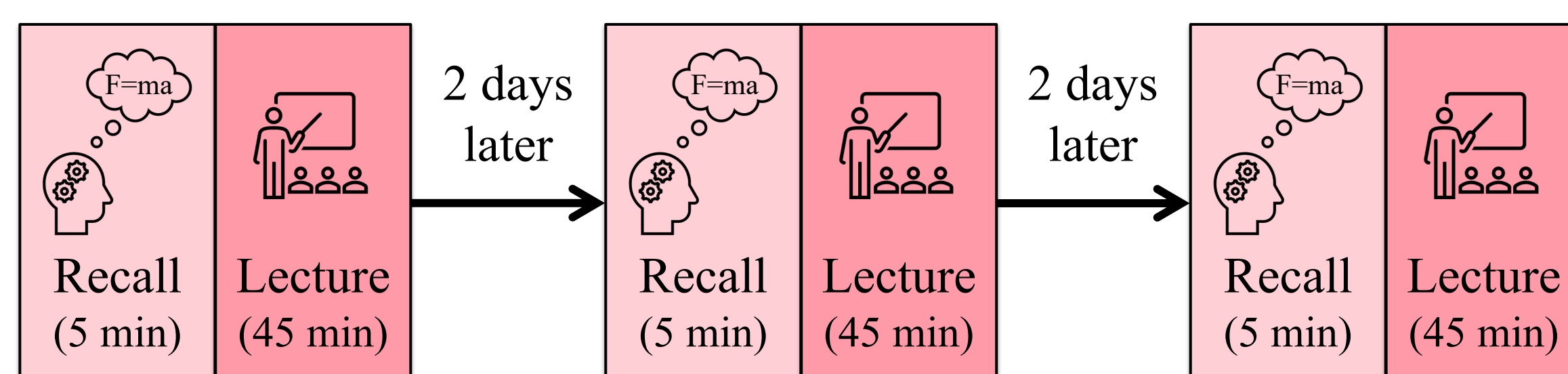
RESEARCH QUESTIONS

This study analyzed students’ free recall of a previous physics lecture to advance our understanding of not only how much students retain from a lecture, but also in what ways they remember and convey physics concepts. We asked the following research questions:

1. How many pieces of information do students recall from the previous lecture?
2. What types of representations do students use to convey their physics knowledge?
3. How often do the different types of representations co-occur?

METHOD

Participants were undergraduate students from introductory physics courses at WPI (Worcester Polytechnic Institute), a small, STEM university with four 7-week terms per year. The study occurred across three consecutive lecture periods.



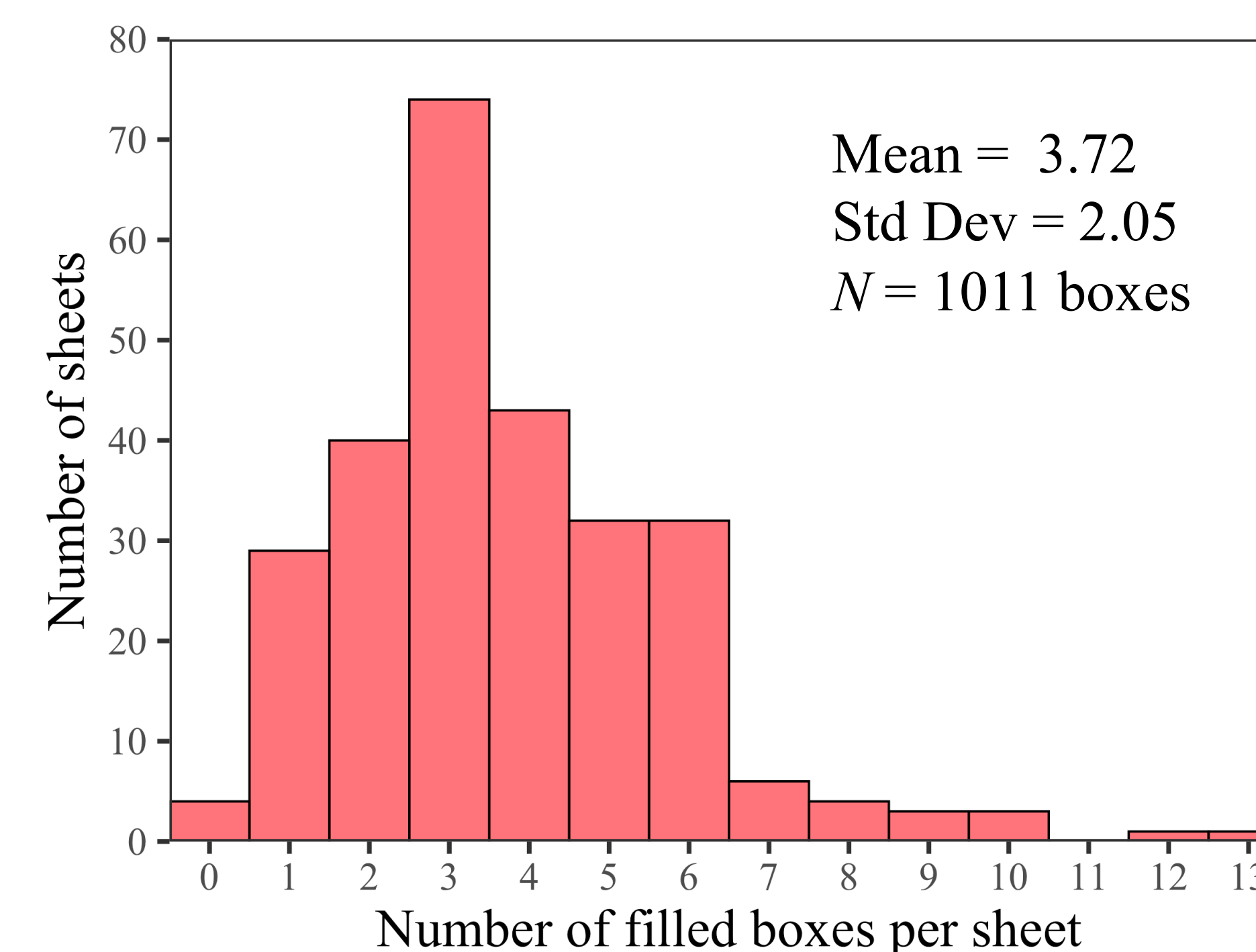
Recall Prompt: “list as many ideas/concepts as you can remember from the most recent lecture of the class, using one box for one idea/concept.”

RESULTS

RQ 1: How many pieces of information do students recall from the previous lecture?

On average, the number of filled boxes per student was 3.72 with a standard deviation of 2.05.

This number might be somewhat lower than expected but could be explained by the fast-paced lectures that are required due to the 50-minute lecture timeslots over a 7-week period.



RQ 2: What types of representations do students use to convey their physics knowledge?

Representation	Code Count
Diagram	141
Math	421
Words	752

The representation with the highest usage in the data set was *Words*, followed by *Math*, and then *Diagram*.

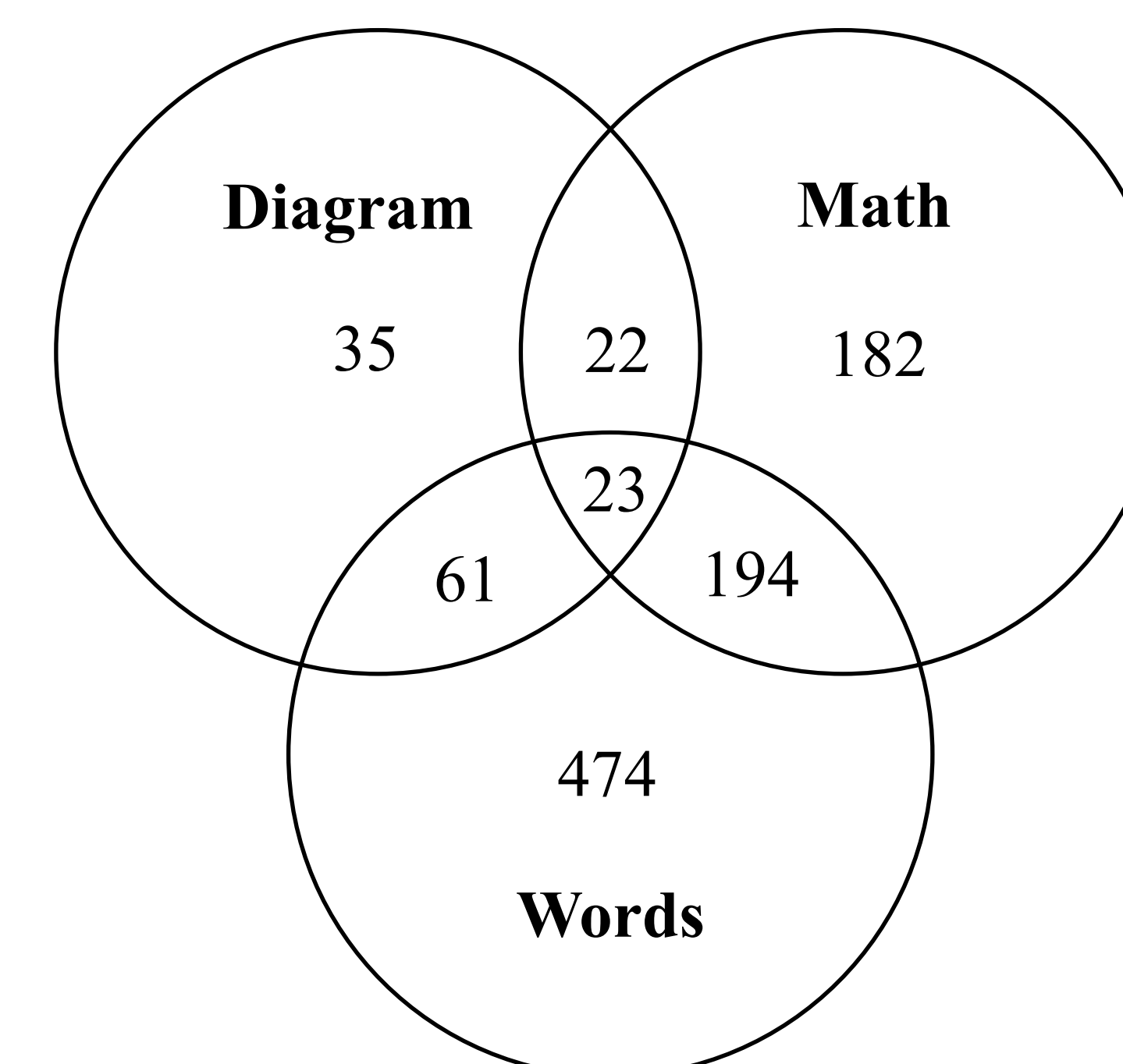
This result indicates that students are most comfortable with verbally describing the concept shortly after learning.

RQ 3: How often do the different types of representations co-occur?

While the majority of responses only included a single representation, 30% of the boxes contained two or three representations, with *Words* and *Math* representing the largest co-occurrence group.


The ability to incorporate multiple representations could indicate greater detail and more expert-like mental representations of knowledge.


Number of representations per box	Count
1	691
2	277
3	23




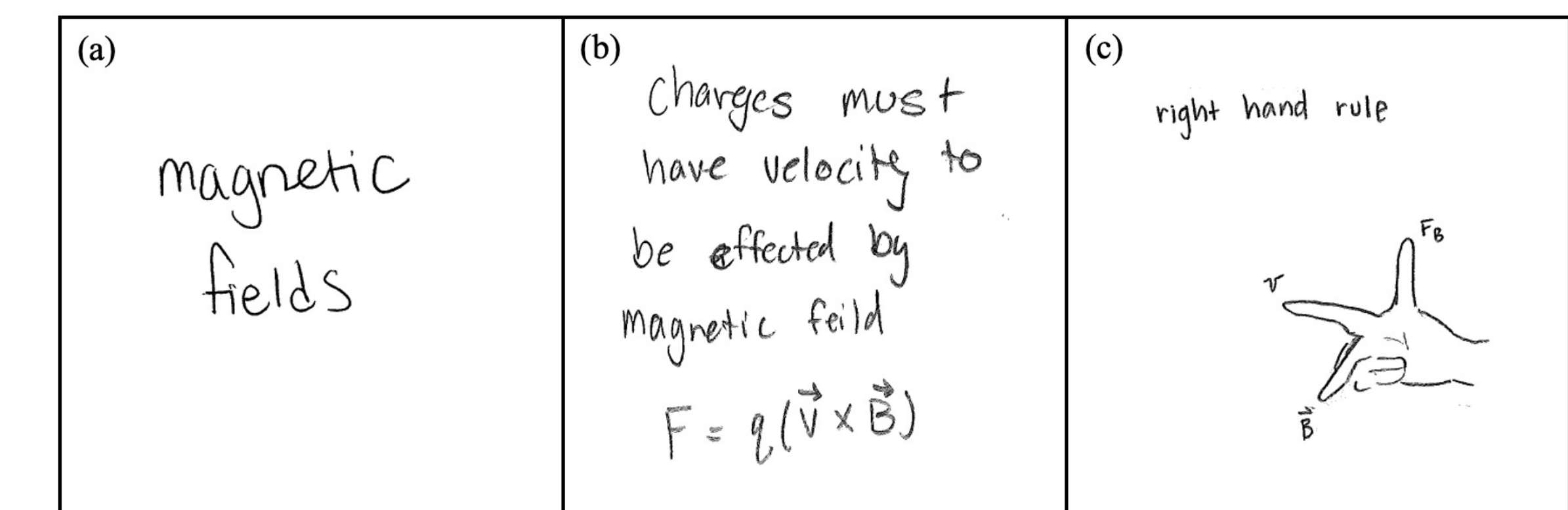
CODING

A content analysis was conducted on 272 recall sheets with *a priori* codes defined below which were derived from representation literature.

 **Diagram** – a student’s knowledge is expressed through a drawing or visualization of a physics topic or problem.

 **Math** – a student’s knowledge is expressed through a physics equation, expression, or mathematical symbols.

 **Words** – a student’s knowledge is expressed through a verbal description of a physics topic.



FUTURE DIRECTIONS

This work is a preliminary study introducing the question of what types of representations do students use when describing their physics knowledge through a free recall activity. Future work is needed to further investigate representations in free recall of physics information, including:

- What representation is used by a professor vs. the representation recalled by the student for a concept
- Whether number of recalled ideas can predict grade
- The level of elaboration for each recalled idea
- Subcategories within each representation

ACKNOWLEDGEMENTS

Thanks to Snehalata Kadam, Hektor Kashuri, and Aidan Zlotak for allowing my study to be run in their classrooms. Thanks to the students for participating.

Contact: acmederer@wpi.edu

REFERENCES

- [1] P. Klein, A. Müller, and J. Kuhn, Phys. Rev. Phys. Educ. Res. **13**, 010132 (2017).
 [2] H. L. Roediger and J. D. Karpicke, in *Encyclopedia of Social Measurement* (Elsevier, 2005), pp. 479–486.