PROGRESS AND DIFFICULTIES IN STUDENT'S UNDERSTANDING OF VECTOR AND FIELD CONCEPTS IN ELECTROSTATICS:

A QUALITATIVE STUDY OF A SMALL GROUP OF UPPER SECONDARY STUDENTS.

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Introduction.

- Motivations for project.
- Metholodogy
- Implimentation.
- Research Questions.
- Student progressions through lessons.
- Conclusions.

Motivations for research

- Promote conceptual understanding.
  - Traditional methods typically ineffective. (Dykstra, et al., 1992, McDermott & Shaffer, 1992)
  - Student centered learning which allows students to explore concepts.
  - The use of guided inquiry is ideally suited for focusing learning on the development of scientific concepts (Loucks-Horsley, & Olson, 2000).
  - Helps reduces load on working memory – Cognitive Load Theory. (Plaas, Moreno & Brünken, 2010)

Research - Methodology.

- Case Study Methodology – Descriptive / Explanatory.
- Small sample (N=7), all male, socio-econimically disadvanted school, range of abilities
- Quantitiative analysis not appropriate.
- Opportiunity for qualitative analysis.

Implimentation of Classes

Pretest
(1 topic)

Content

Tutorial

Posttest
(All topics)

Implimentation of Classes

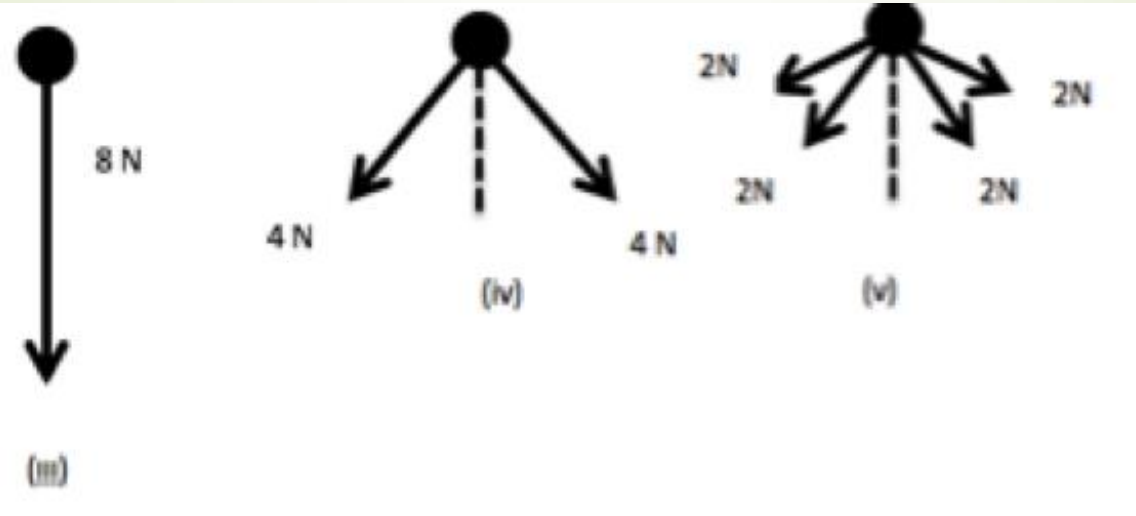
- Students were In groups of 2/3, completing the guided tutorial lesson.
- Peer discussion and peer tuitition was encouraged during the lesson.
- Checkouts at the end of each section.
  - All students submissions were to be in agreement.
  - Teacher to group dialogue – group to teacher dialogue ultilised when difficulties arose.

Research Questions

- How does the use of guided inquiry lesson enchace our students understanding of 2D vector addition.

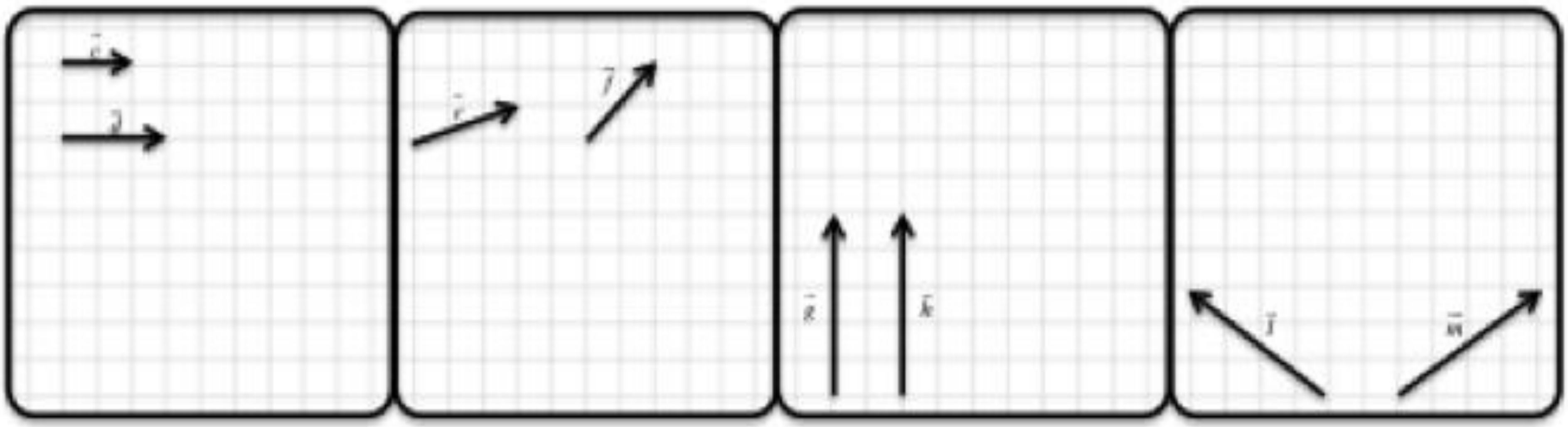
- How does their understanding of 2D vector addition transfer to electrostatic fields.

Student progression. Vectors Pretest



Concepts Used	Student Responses
Vector Addition Used	***3C***, 3D, 3G
Scalar Addition	3A, 3F, 3E
No Reasoning Submitted	3B
Correct Ranking for Setup	3B, ***3C,*** 3D

Student Progression – Vectors Lesson



Student Progression – Vectors Lesson

T: Consider if you removed the *e* and *f* vectors from the diagram and just used their horizontal and vertical vectors instead.

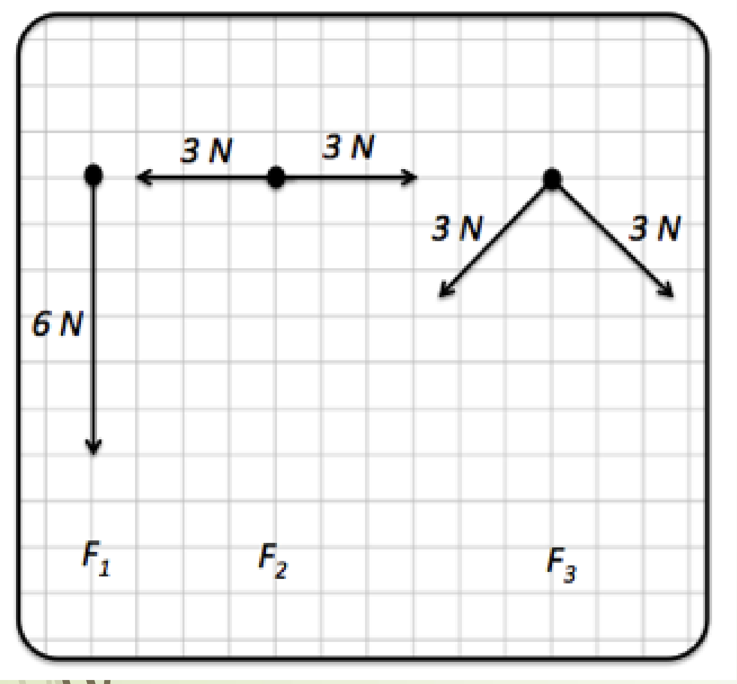
3C: Then we would add the horizontal and vertical components and use the tip to tail with these to find the resultant vector.

3D: That looks like it gives us the resultant vector we've drawn.

T: So explain to me how it produce that vector?

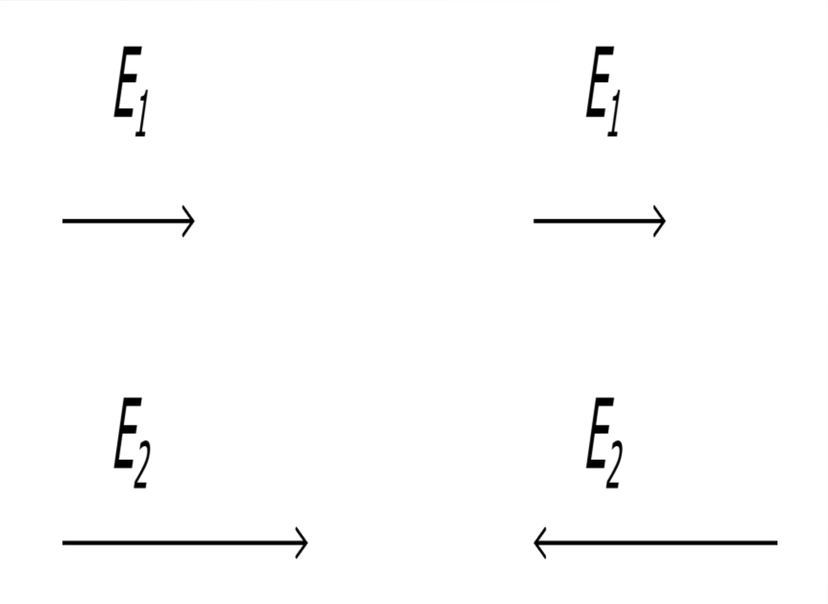
3C: Cause the vectors are pointing in different directions, we don't add them directly. We just add the components instead and use them to find the final vector.

Student Progression – Vectors Posttest



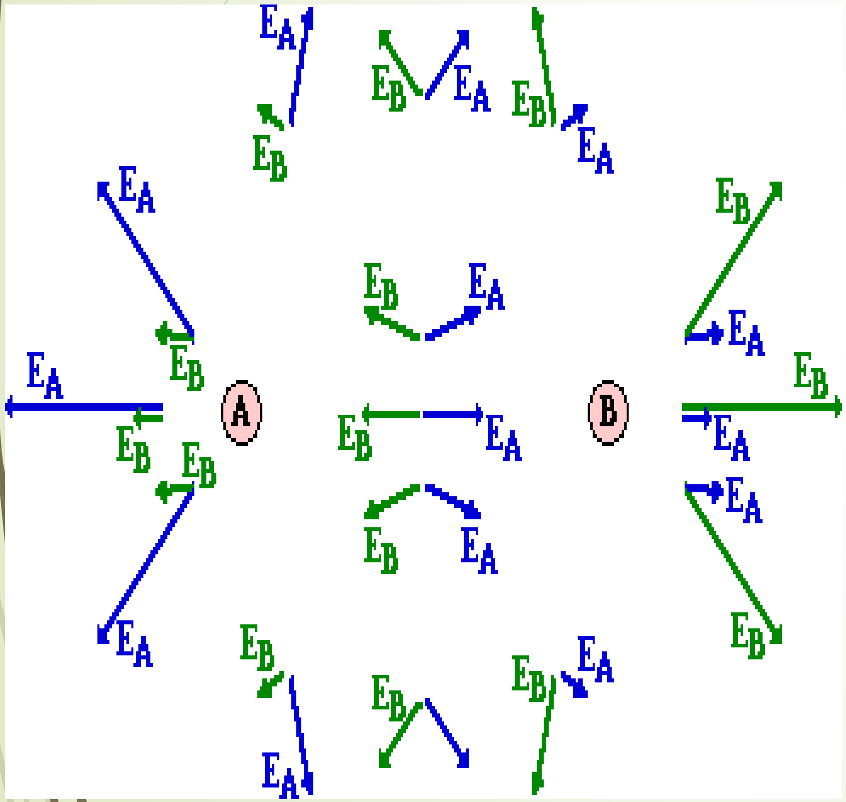
Concepts Used	Student Responses
Correct Outcome for Setup	***3B, 3C, 3D, 3G***
Vector Addition	***3B, 3C, 3D, 3G***
Scalar Addition	3A, 3E
No Reasoning Submitted / Reasoning unclear	
Not completed / Absent	3F

Student Progression- Electric field as vectors.



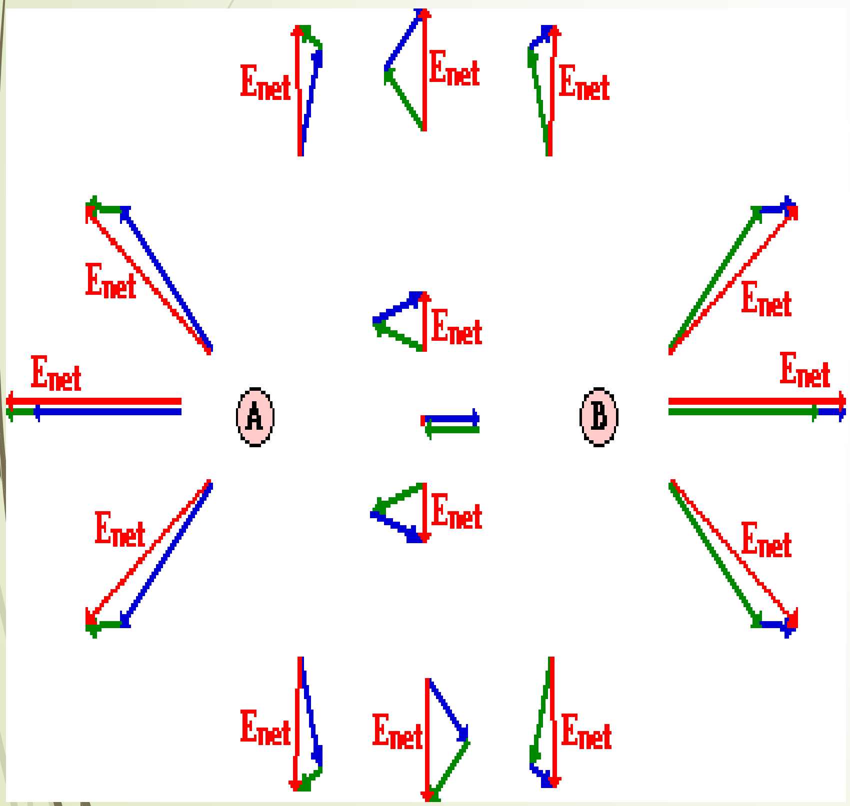
- Applying Vector concepts to field representation.
- Review basic operations.

Student Progression- Electric field as vectors.



- 2D Addition of Vectors.
- Can the students reason why we do this?

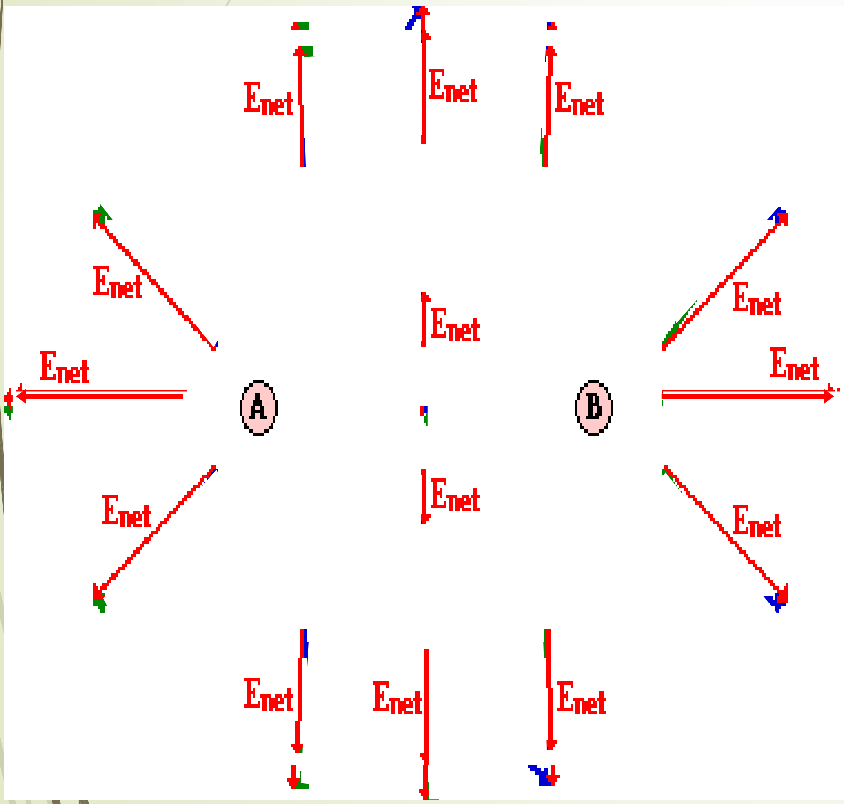
Student Progression- Electric field as vectors.



- 2D Addition of Vectors.
- Can the students reason why we do this?

"the green arrow goes out and up a bit, but the blue brings it back in"

Student Progression- Electric field as vectors.



- 2D Addition of Vectors.
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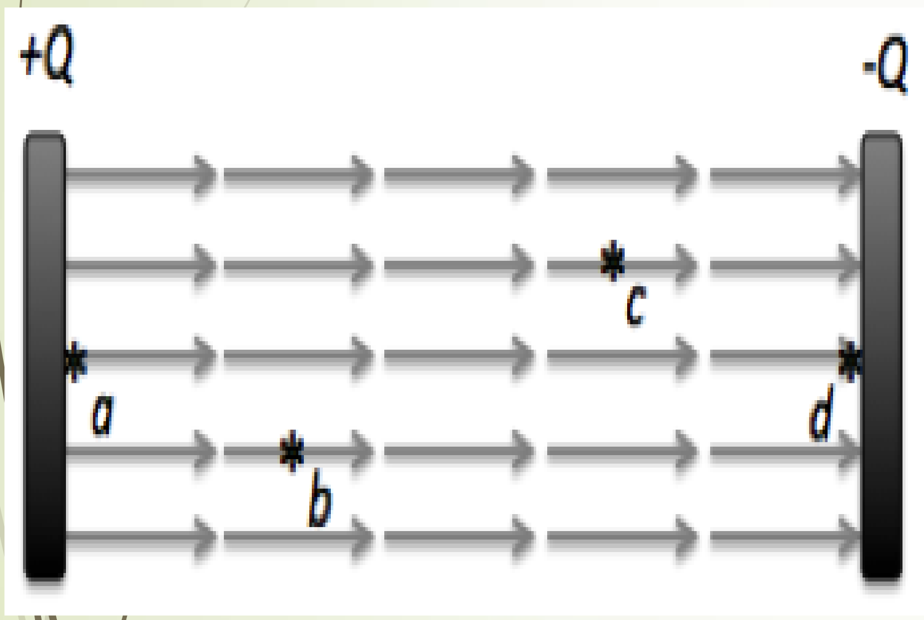
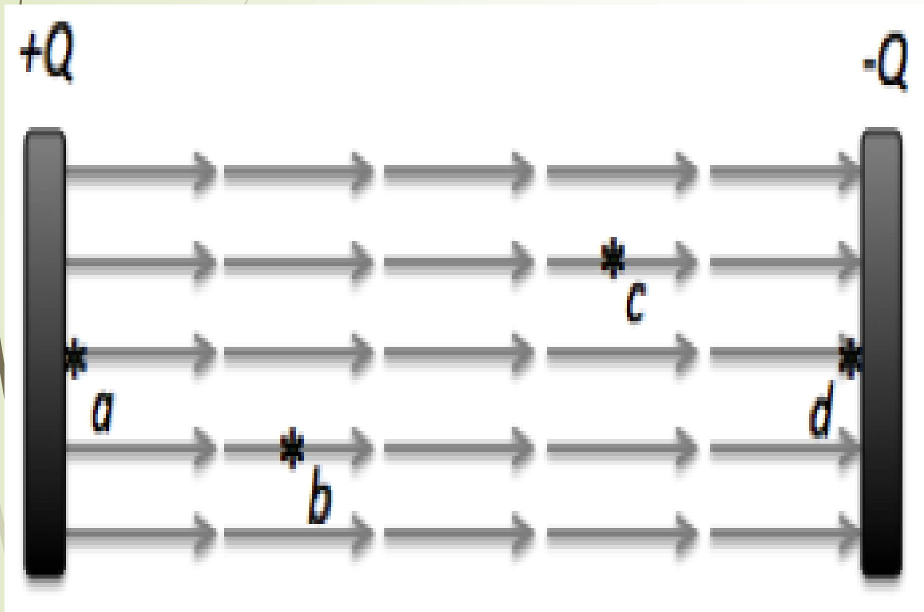
Student Progression- Electric field as Vectors

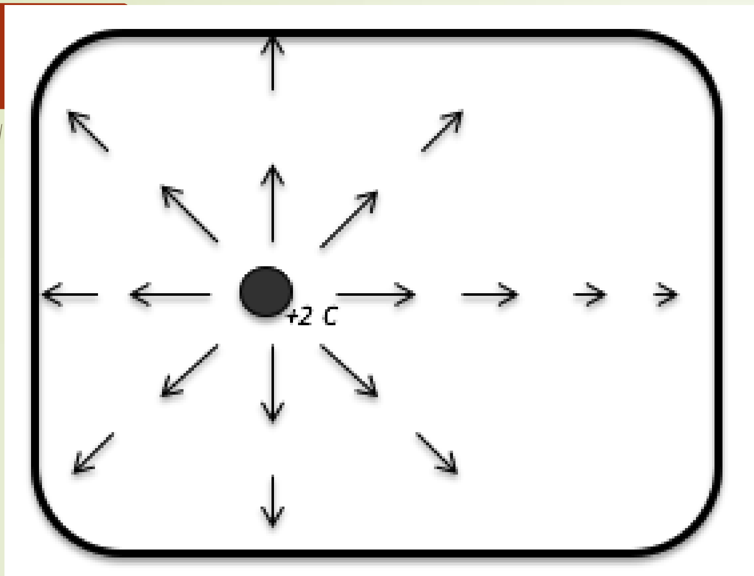


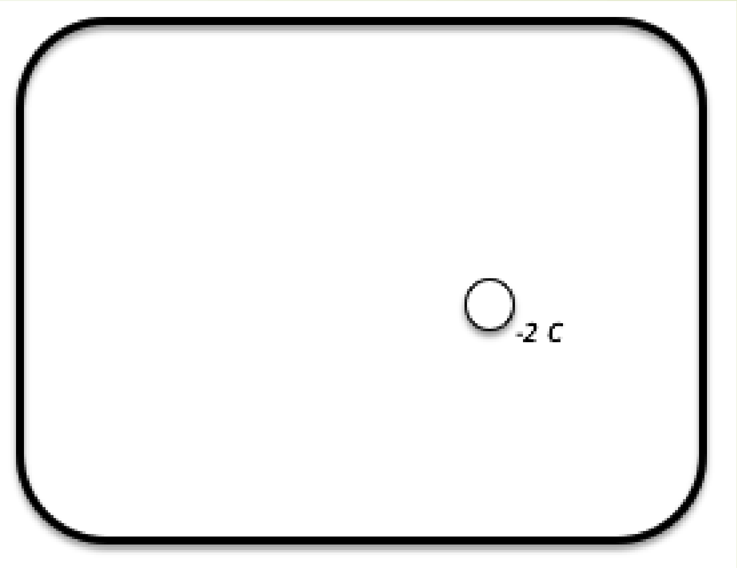
- Can they rank the field?
- Can they explain the variation of the field?

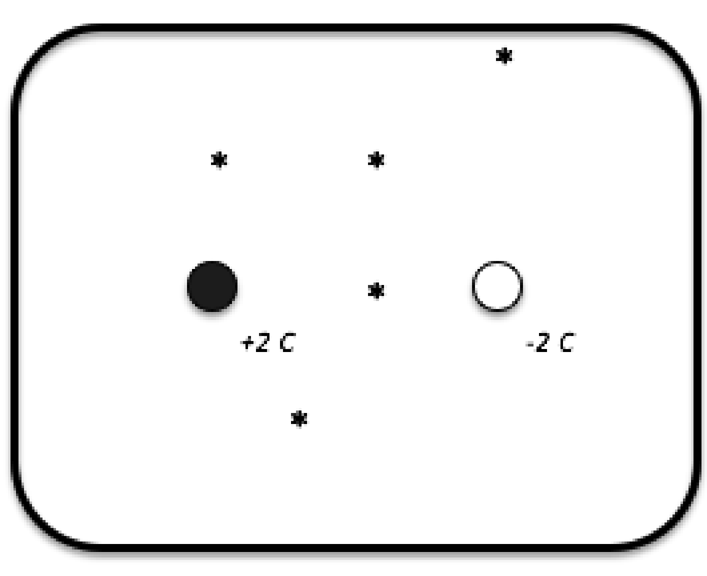
Student Progression- Electric field as Vectors

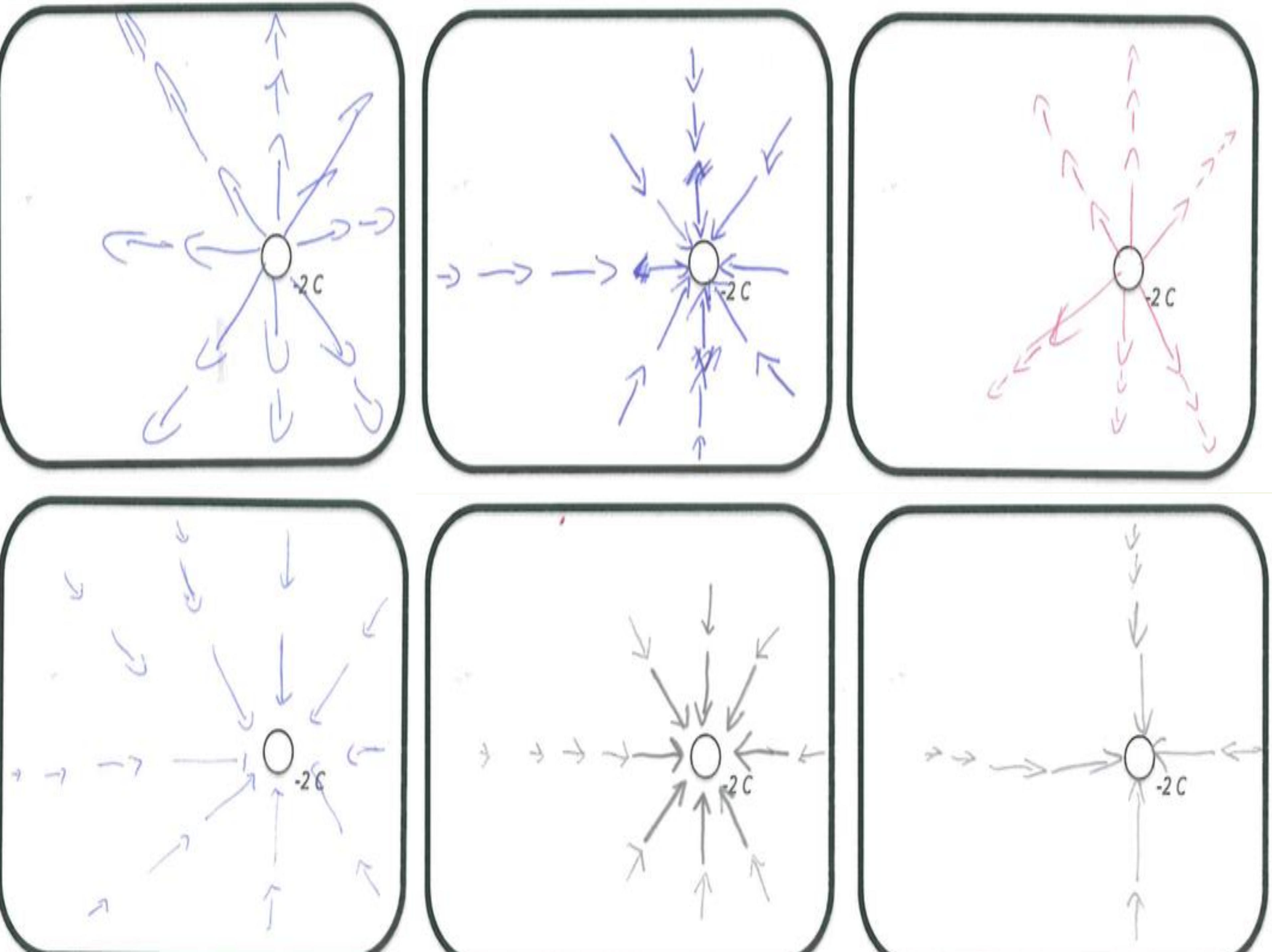


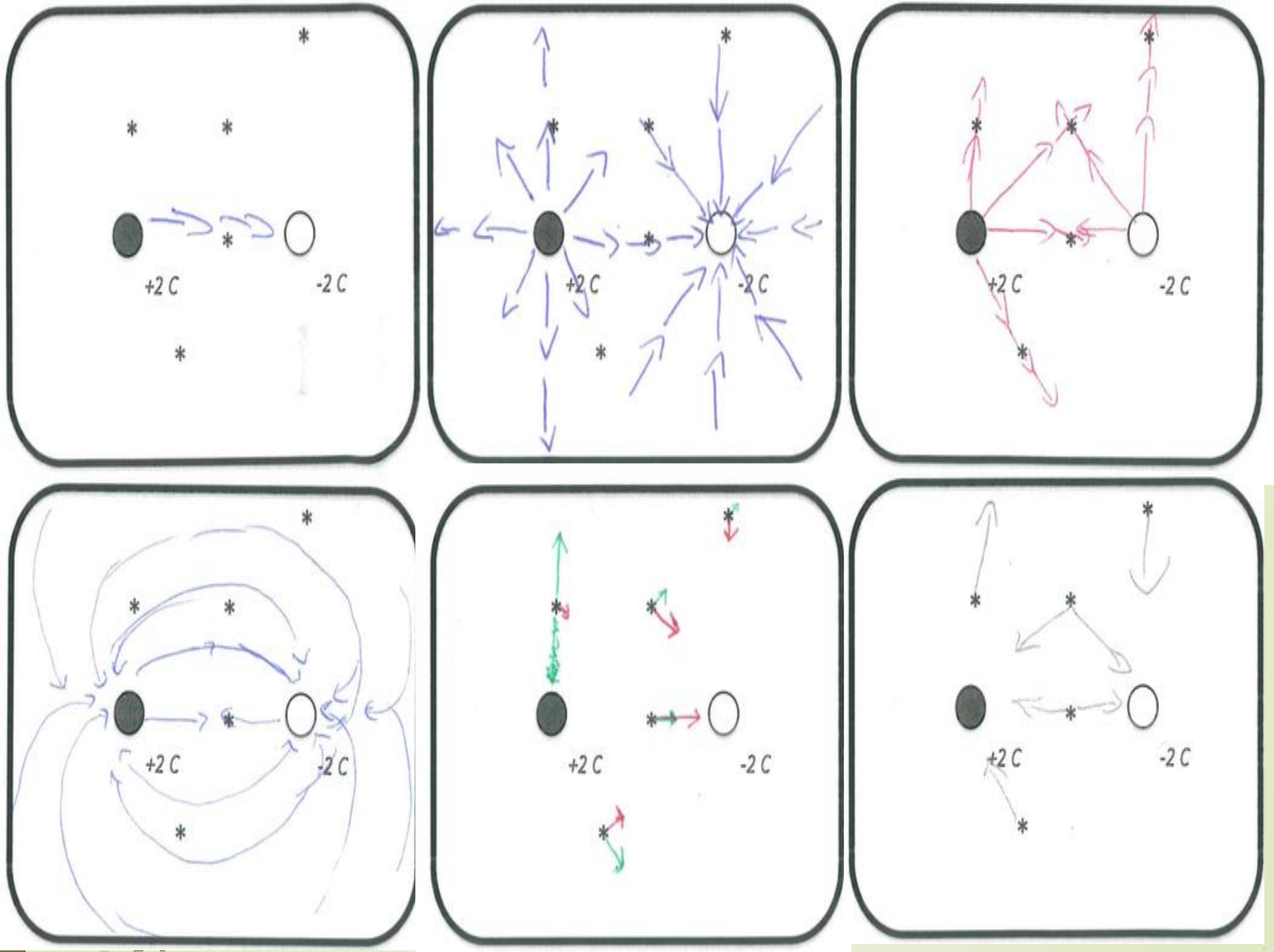
- 3B: *E=F/q, there is not change.*
- 3E: *There is no variation as the vectors as the same.*
- 3C: *There is no variation as all the arrows point in the same direction and are all the same length so they are the same strength.*


+2 C


-2 C


+2 C
-2 C


-2 C
-2 C
-2 C
-2 C
-2 C
-2 C


+2 C
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-2 C

Conclusions

- We observed difficulties with concepts related to vector addition pre-instruction.
- Student progress was outlined during out lessons, showed students could highlight and explain the use of key concepts in vector addition
- Posttest results showed more capable students could apply vector addition, focusing on using a graphical method over a mathematical method.
- Our students experienced difficulty in transferring these vector concepts to an electrostatic field context.

Conclusions

- Student dialogues and interviews give clearer insight into student thinking than the use of pretests, worksheets and posttests.
- Student's real time dialogue could be a potential tool for assessment in the classroom – (research in this field would be useful)
- Expanded role in data collecton moving forward.

References:

- Dykstra, D. I., Boyle, C. F., & Monarch, I. A. (1992). Studying conceptual change in learning physics. Journal of Science Education (72), pg 615 - 652.
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- Plass, J. L., Moreno, R., & Brünken, R. (2010). *Cognitive load theory*. Cambridge University Press.
- McDermott, L. C., & Shaffer, P. S. (1992). Research as a guide for cirriculum development: an example from introductory electricity. Part I: investigation of student understanding. American Journal of Physics (60), 994 - 1002.

Thanks for listening

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- Questions?