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.

Richard Moynihan, Paul van Kampen, Odilla Finlayson, Eilish McLoughlin
Introduction.

- Motivations for project.
- Methodology
- Implementation.
- 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-economically disadvantaged school, range of abilities

- Quantitative analysis not appropriate.

- Opportunity 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 tuition 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 utilised when difficulties arose.
Research Questions

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

- How does their understanding of 2D vector addition transfer to electrostatic fields.
# Student progression. Vectors Pretest

<table>
<thead>
<tr>
<th>Concepts Used</th>
<th>Student Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vector Addition Used</strong></td>
<td><strong>3C, 3D, 3G</strong></td>
</tr>
<tr>
<td>Scalar Addition</td>
<td><strong>3A, 3F, 3E</strong></td>
</tr>
<tr>
<td>No Reasoning Submitted</td>
<td><strong>3B</strong></td>
</tr>
<tr>
<td><strong>Correct Ranking for Setup</strong></td>
<td><strong>3B, 3C, 3D</strong></td>
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</tbody>
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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

<table>
<thead>
<tr>
<th>Concepts Used</th>
<th>Student Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct Outcome for Setup</td>
<td>3B, 3C, 3D, 3G</td>
</tr>
<tr>
<td>Vector Addition</td>
<td>3B, 3C, 3D, 3G</td>
</tr>
<tr>
<td>Scalar Addition</td>
<td>3A, 3E</td>
</tr>
<tr>
<td>No Reasoning Submitted / Reasoning unclear</td>
<td></td>
</tr>
<tr>
<td>Not completed / Absent</td>
<td>3F</td>
</tr>
</tbody>
</table>
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.

- Can the students reason why we do this?
Student Progression - Electric field as Vectors

- Can they rank the field?

- Can they explain the variation of the field?
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.
Conclusions

- We observed difficulties with concepts related to vector addition pre-instruction.

- Student progress was outlined during our lessons, showing 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 collection moving forward.
References:


Thanks for listening

- Richie Moynihan
- Rmoynihan.occ@lmetb.ie
- Twitter: @RmoynihanOCC
- Questions?