Problem solving strategies with representational format and topic

Bashirah Ibrahim & N. Sanjay Rebello

Department of Physics, Kansas State University

Some relevant previous studies on performance on the same task with different representational modes

- Use qualitative or quantitative approach e.g. area under graph v/s equations
- Distracters in visual representations cue incorrect answers
- Students views’ on the nature of problem effect on approach used

Current study

What are the differences / similarities in students’ strategies when solving problems with the same representational format across different topics?

Method

19 engineering majors; calculus-based physics

Six non-directed tasks in kinematics and work; individual interviews

Tasks in graphical, linguistic and symbolic forms

Code problem solving strategy and responses

Compare students’ actions with same type of representation across topics
Examples of Tasks

1. The force applied in moving a 5kg box on a frictionless horizontal surface is given by

   \[ \vec{F}(x) = (3x - 2) \hat{i} \text{ N.} \]

   Determine the work done in moving the box to a distance of 5m if its initial position is 1m.

2. You are driving at a speed of 60 m s\(^{-1}\) when suddenly you see a van 60 m directly ahead of you also travelling in the same direction at a constant speed of 40 m s\(^{-1}\). You immediately apply the brakes and your car starts slowing down at 0.8 m s\(^{-2}\). Determine whether a collision will take place.

Definition of Terms

**Equations**: manipulate equations or calculus only

**Qualitative approach**: graphs included with slope or area under graph determined

**Qualitative approach + Equations**: find area / slope under graph and manipulate equations

**Qualitative approach by rote**: determine area / slope of graph mechanically with no understanding

**Diagram and equations dissociated**: diagram not considered for mathematical part of problem

**Diagram and equations related**: diagram considered for mathematical part of problem
Results

1. Strategy to solve for a value from symbolic representations in work and kinematics (n = 19)

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Equations; No Qualitative Approach</th>
<th>Equations; Qualitative Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equations; No Qualitative Approach</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>Equations; Qualitative Approach</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

Consistent approach across topics for tasks posed in symbolic form

Results

2. Strategy to solve for a value from graphical representations in work and kinematics (n = 19)

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Equations</th>
<th>Qualitative + Equations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equations</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Qualitative approach by rote</td>
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<td>5</td>
</tr>
</tbody>
</table>

Inconsistent approach across topics for tasks posed in graphical form
Results

3. Strategy to solve for a value from linguistic representations in work and kinematics (n = 19)

<table>
<thead>
<tr>
<th>Work</th>
<th>Diagram and equation dissociated</th>
<th>Diagram and equation related</th>
<th>Equations only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagram and equation dissociated</td>
<td>10</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Diagram and equation related</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

Consistent approach across topics for tasks posed in linguistic form

Conclusions (1 of 2)

Representational mode impacts on problem solving approach

- **symbolic**: solve problem using equations

- **graphical**:
  - solve problem qualitatively,
  - use rote memory

- **linguistic**:
  - generate visual representation,
  - dissociate representation and equations
Conclusions (2 of 2)

No direct influence of topic on approach to generate quantitative solution

- Equations used for symbolic & graphical formats in all topics
- Visual representations used in linguistic format in all topics
- Topic impacts approach for interpreting different types of representations (Ibrahim & Rebello, PRST-PER, 2012)

Thank you

bibrahim@phys.ksu.edu