Problem solving strategies with representational format and topic

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AAPT winter meeting
4th - 8th February 2012
Ontario, California.

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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

Mayer, 1982; Koendinger &Nathan, 2004; Meltzer, 2005;
Kohl &Finkelstein, 2005 ; 2006; Sabella 1999

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Current study

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

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Method

19 engineering majors; calculus-based physics

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

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Tasks in graphical, linguistic and symbolic forms

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Code problem solving strategy and responses

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Compare students' actions with same type of representation across topics

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Examples of Tasks

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

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

   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 you car starts slowing down at 0.8 m s^{-2}.Determine whether a collision will take place.

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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

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Results

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

		Kinematics	
	Strategy	**Equations; No Qualitative Approach**	**Equations; Qualitative Approach**
Work	**Equations; No Qualitative Approach**	**16**	**0**
	Equations; Qualitative Approach	**0**	**3**

Consistent approach across topics for tasks posed in symbolic form

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Results

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

		Kinematics	
	Strategy	**Equations**	**Qualitative + Equations**
Work	**Equations**	**6**	**8**
	Qualitative approach by rote	**0**	**5**

Inconsistent approach across topics for tasks posed in graphical form

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Results

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

		Kinematics		
	Strategy	**Diagram and equation dissociated**	**Diagram and equation related**	**Equations only**
Work	**Diagram and equation dissociated**	**10**	**0**	**6**
	Diagram and equation related	**0**	**3**	**0**

Consistent approach across topics for tasks posed in linguistic form

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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

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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 representations (Ibrahim & Rebello, PRST-PER, 2012)

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Thank you

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