Developing Student Representational Competence

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Representations in Science
Representations in Science

• Science uses a wide range of semiotic resources
  Graphs, diagrams, language, mathematics, etc.

• Students need representative competence
  in all of these semiotic systems


• How can representative competence be developed?
Representational competence

- Building on the work of De Cock (2012) and Linder et al (2014)
- Created a new definition that we believe can offer simple guidance to teachers on how to develop representational competence
Representational competence ($R$) is the ability to appropriately interpret and produce a set of disciplinary-accepted representations of real-world phenomena and link these to formalised science concepts.

Representational competence

Disciplinary accepted representations

Representational competence (R)

Science concepts

Real-world phenomena

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Why is this useful?

Gives teachers a structure for developing representational competence

Start with one vertex of the triangle and generate the other two
Representational competence

Disciplinary accepted representations

Science concepts

Real-world phenomena
Representational competence

Disciplinary accepted representations

Science concepts \rightarrow Real-world phenomena

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Representational competence

Disciplinary accepted representations

Science concepts

Real-world phenomena

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Similar to Jeopardy Physics
van Heuvelen & Maloney (1999)

Physics Active Learning Guide, Etkina & van Heuvelen
Definition:

Representational competence ($R$) is the ability to appropriately interpret and produce a set of disciplinary-accepted representations of real-world phenomena and link these to formalised physics concepts.

- Holistic $R$ is a sum of discrete competencies:

$$R_{TOTAL} = R_{GRAPH} + R_{MATH} + R_{DIAGRAM} + \ldots$$
Start off with a *semiotic audit* of the generic meaning making potential of line graphs.
Meaning making potential $R_{GRAPH}$

Across four quadrants

(1) (ii) (iii) (iv)

(v) (vi) (vii) (viii)

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• Graphs in 1-D kinematics

• Students have problems with 1-D kinematics graphs


• We have three graphs used in 1-D kinematics...
Representational competence

$R_{GRAPH}$

Position-time

Velocity-time

Acceleration-time

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Representational competence

$R_{GRAPH}$

8 shapes $\times$ 3 graphs $\times$ 2 quadrants

= 48 possible meanings

Sets of "allowed states"

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Representational competence in 1D-kinematics

The three graphs:

- Position-time
- Velocity-time
- Acceleration-time

$R_{GRAPh}$ for 1-D kinematics

Kinematics concepts

Real-world motion

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Trying it out...

iOLab Ansel 2020, Selen 2013
Task 1:

Given a situation with real-world motion, observe the shapes of the three graphs and explain these in terms of kinematics concepts.
Representational competence
Theme 4 – representational competence
Task 2:

Given a formal verbal description of how a kinematics concept changes over time, generate an example of the associated real-world motion and predict the shape of the three corresponding graphs.

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Representational competence

Constant acceleration

Rolled iOLab on an inclined table
Representational competence

Task 3:
Produce the real world motion that generates these shapes for the three graphs.
Summary

- New definition of Representational Competence ($R$)
- Links representations, real world and science concepts in a triangle form
- \[ R_{TOTAL} = R_{GRAPH} + R_{DIAGRAM} + \ldots \text{ etc.} \]
- Claim that we can practice representational competence by developing tasks from the triangle
• Semiotic audit—
  • What are the representations used?
  • What is the generic meaning making potential?

• $R_{GRAPH}$ appeared to be effectively practiced and developed through our tasks

• Starting with the representations proved challenging

• Shows the complexity of achieving representational competence
Summary

• This was just for one representational system!

• Students need to coordinate meanings across representational systems too (Airey & Linder, 2009)
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Thank you for Listening
References


