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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 representational competence
  in all of these semiotic systems

  See for example: Kozma & Russell (2005) Tippett (2011)
  Kohl & Finkelstein (2008) De Cock (2012) Linder et al (2014)
  Airey (2009; 2013; 2015) Airey & Eriksson (2019)

- How can representational 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

A new 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 science concepts.

Volkwyn, et al (2020)

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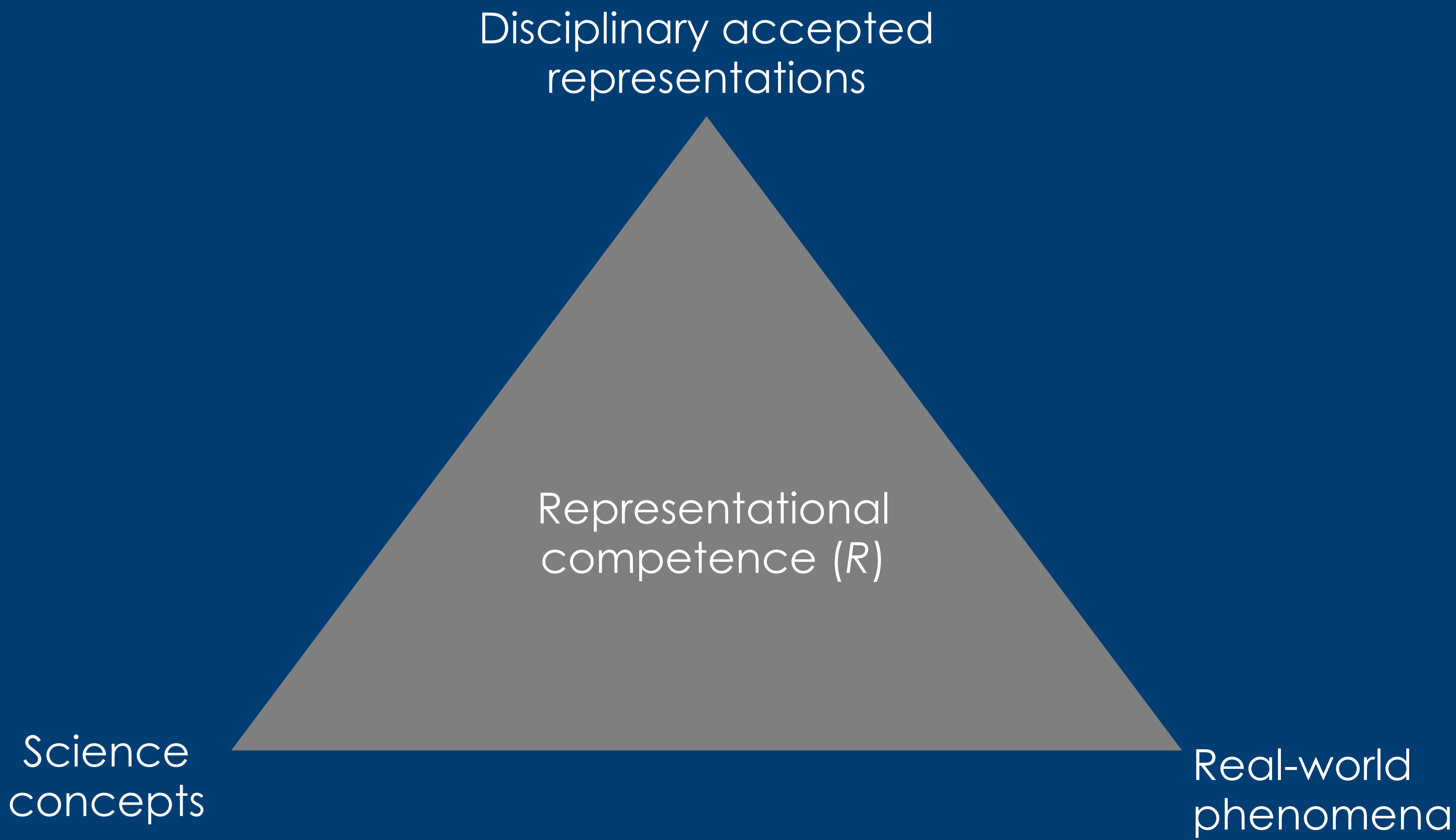
Representational competence



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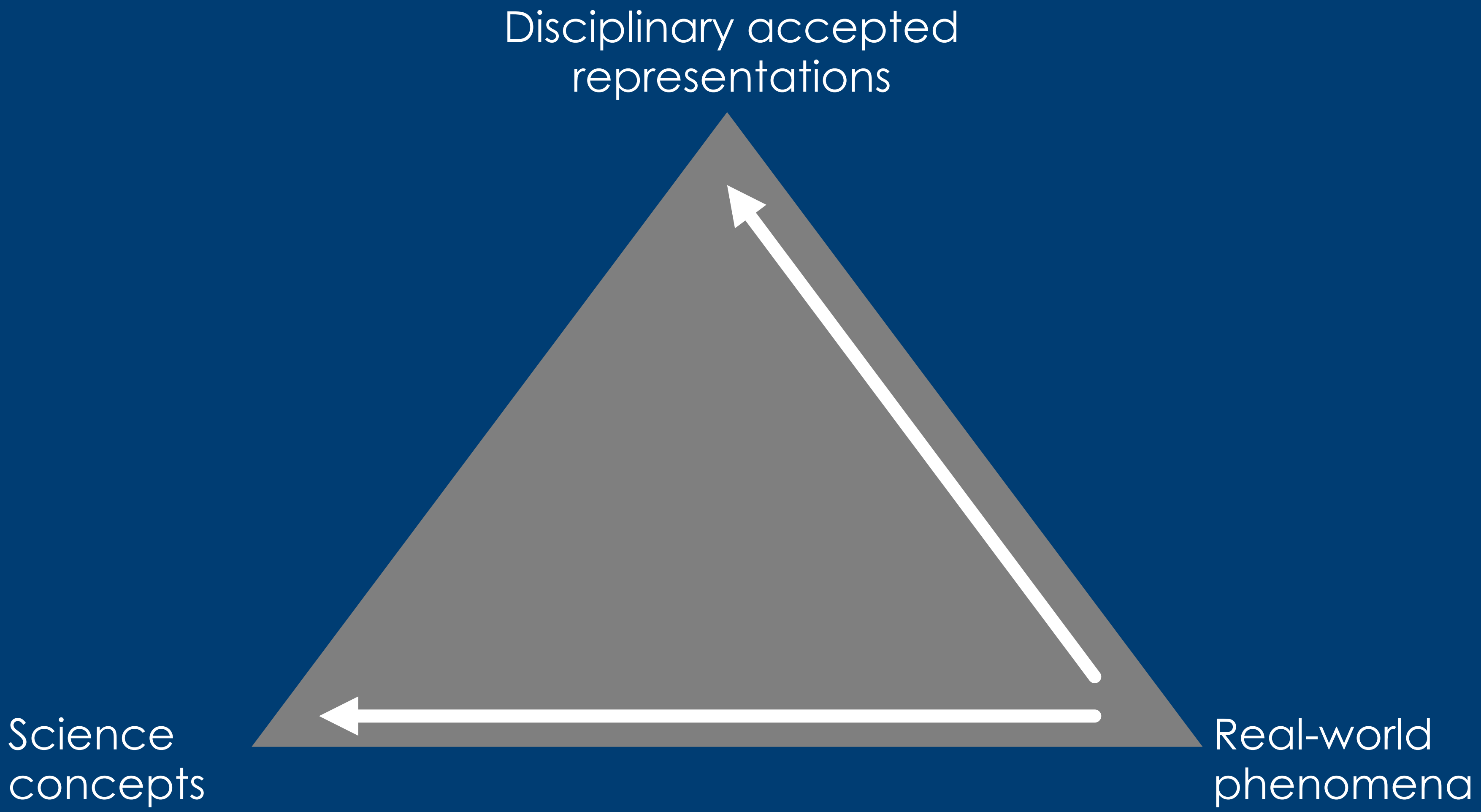
Why is this useful?

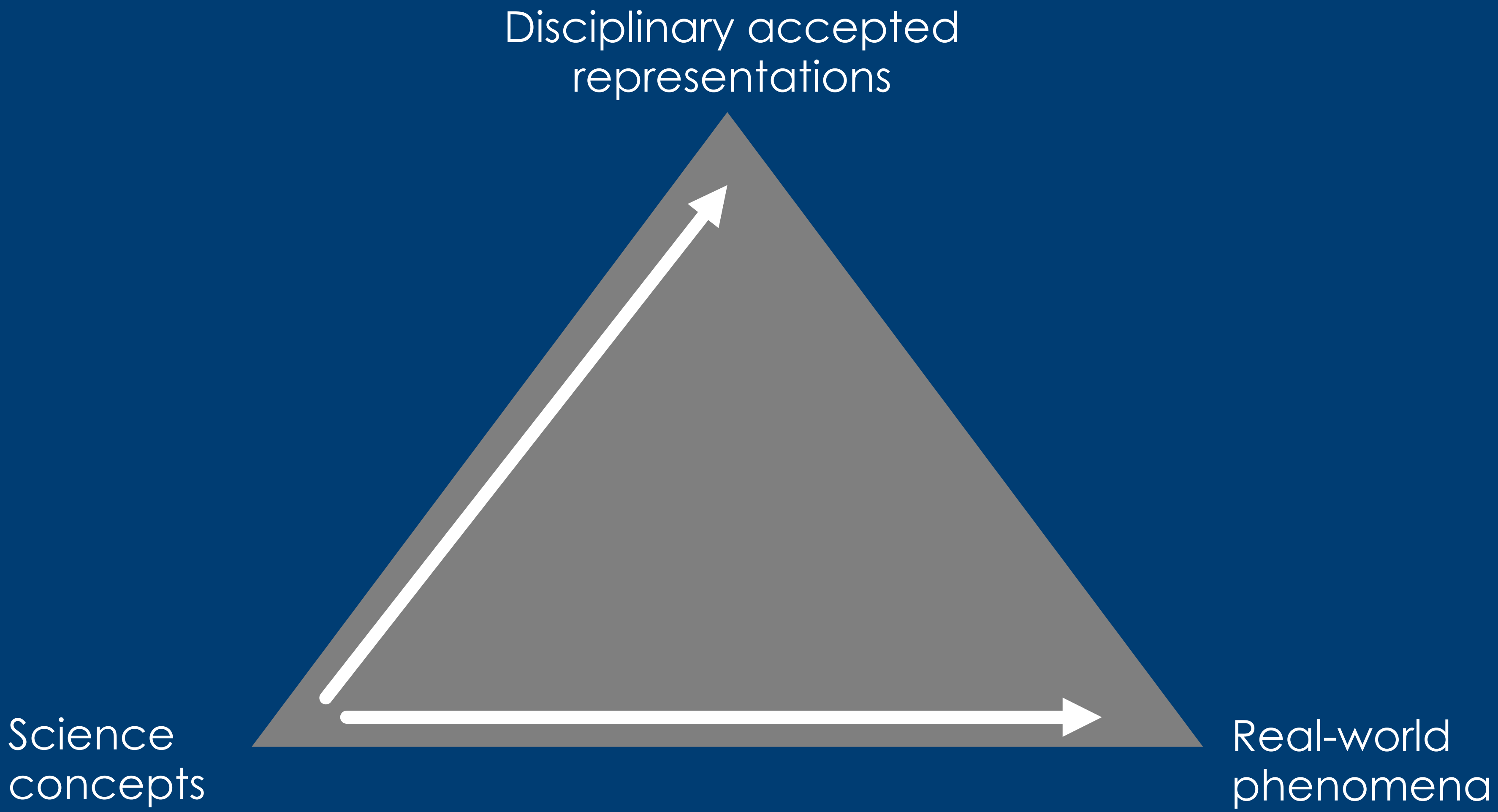
Gives teachers a structure for developing representational competence

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

Representational competence



Representational competence



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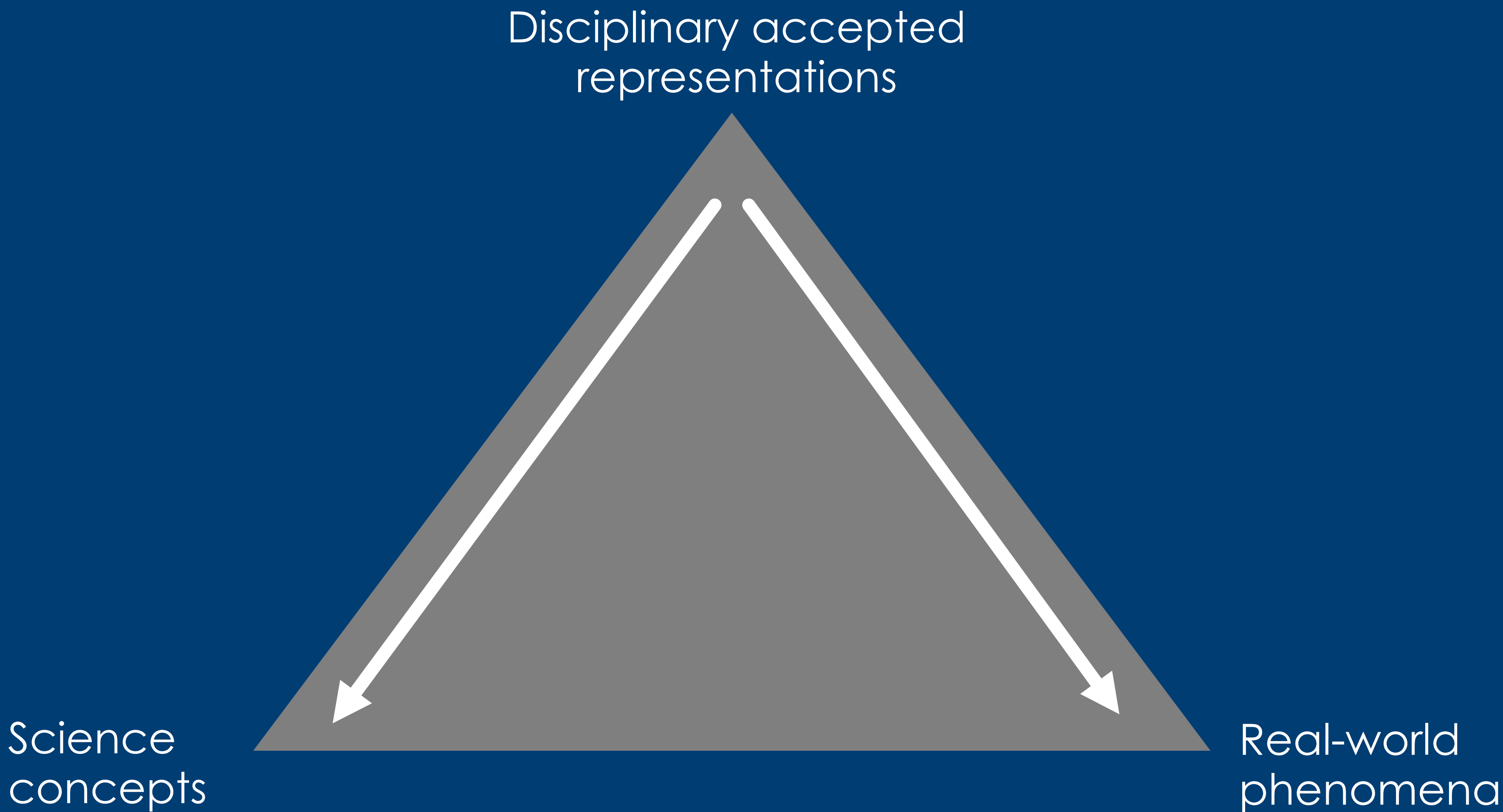
Representational competence



Similar to Jeopardy Physics

van Heuvelen & Maloney (1999)

Physics Active Learning Guide, Etkina & van Heuvelen

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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:

$$R_{TOTAL} = R_{GRAPH} + R_{MATH} + R_{DIAGRAM} + \dots$$

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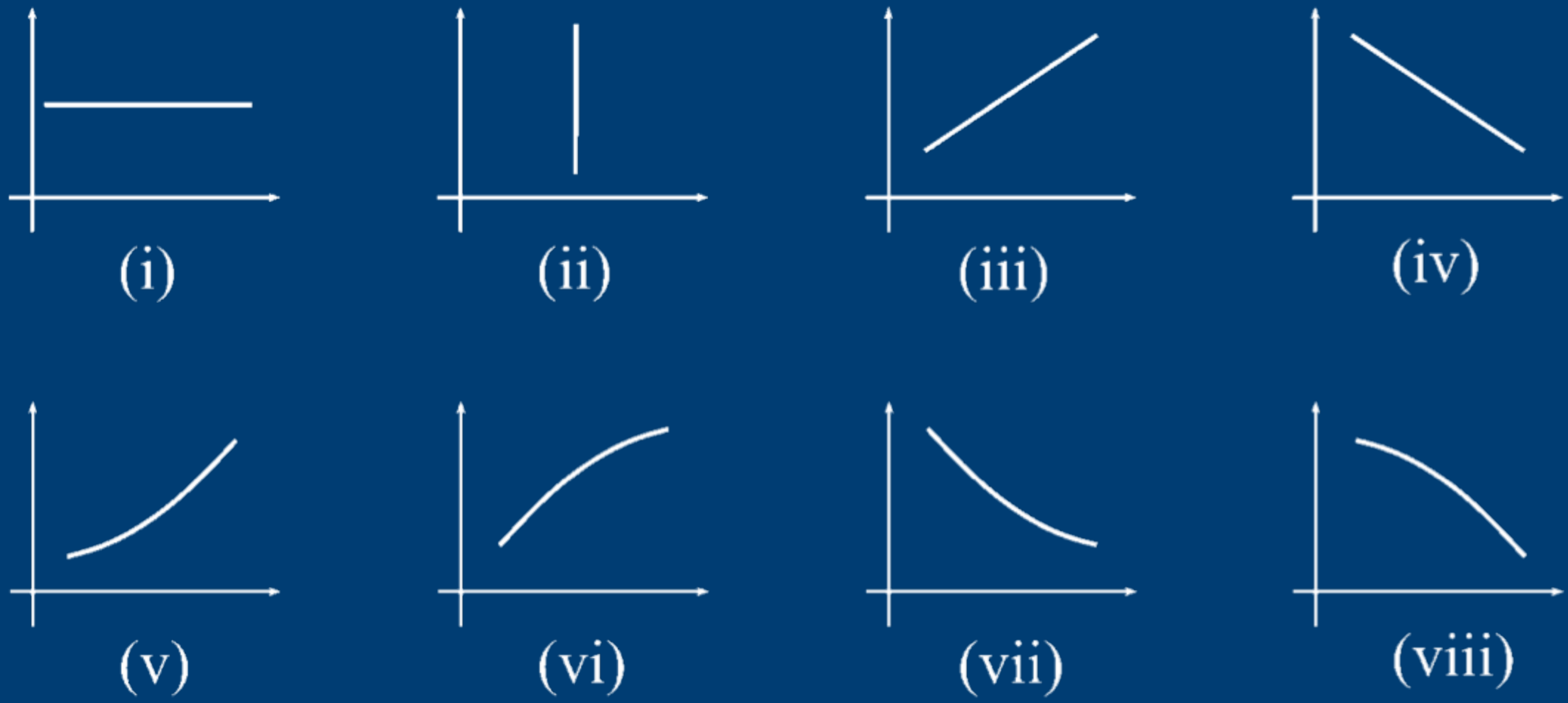
Start off with a semiotic audit of the generic meaning making potential of line graphs

Meaning making potential R_{GRAPH}



Across four quadrants

An Example…

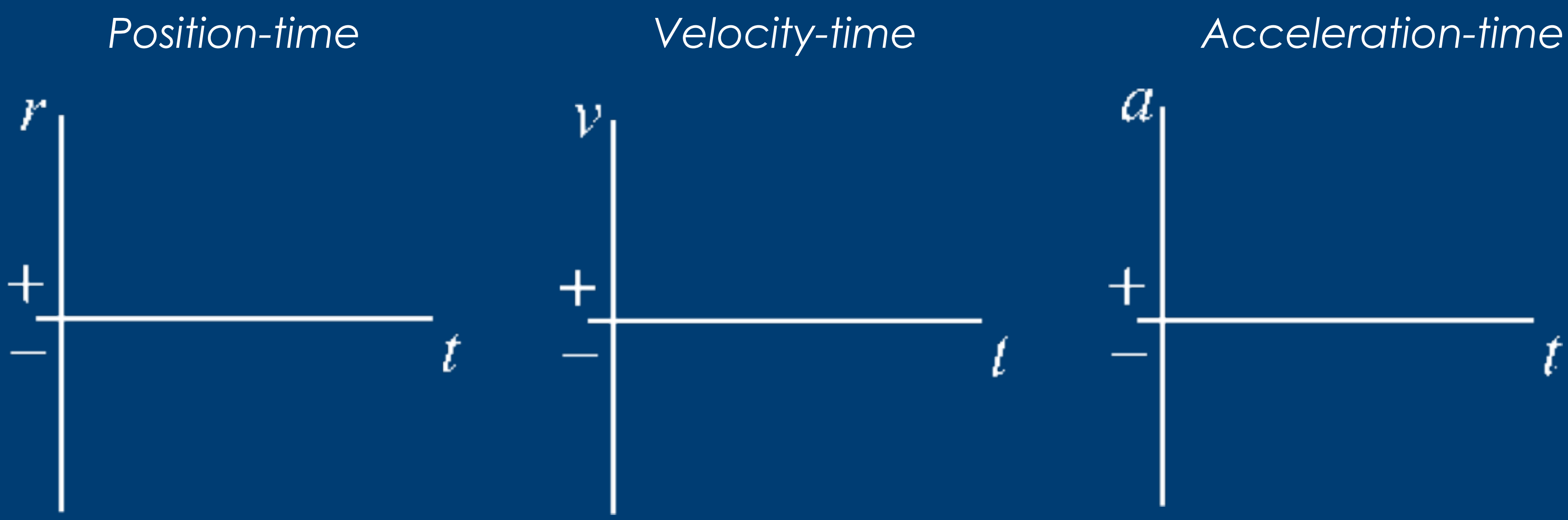
- Graphs in 1-D kinematics
- Students have problems with 1-D kinematics graphs

  Goldberg & Andersson (1989) Bollen et al (2016), Ivanjek et al (2016), McDermott et al (1987) de Cock (2012)

- We have three graphs used in 1-D kinematics…

Representational competence

R_{GRAPH}



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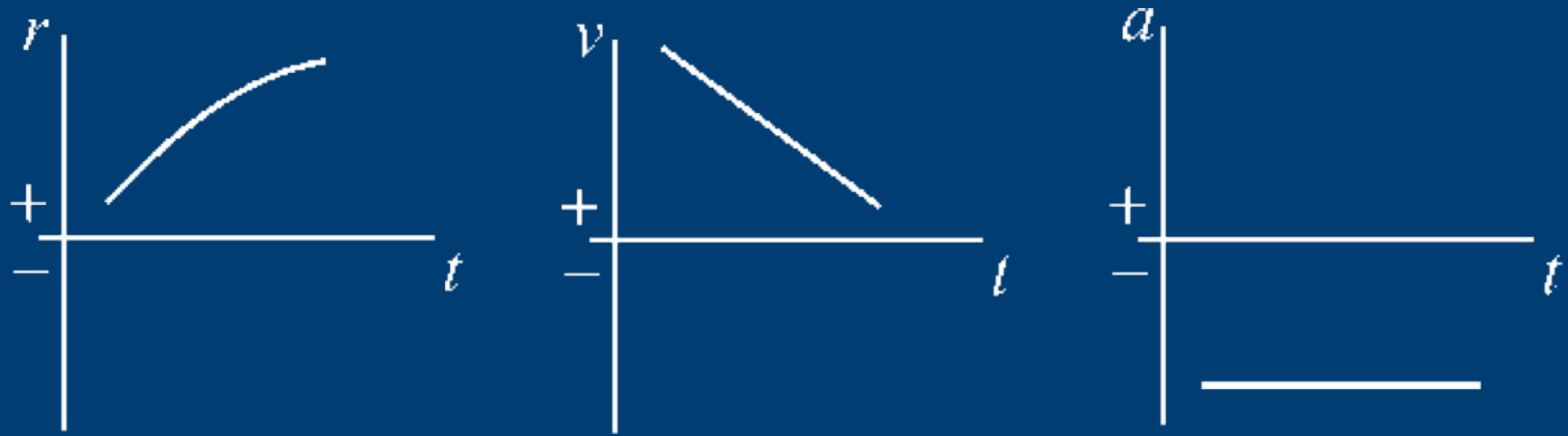
Representational competence R_{GRAPH}

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

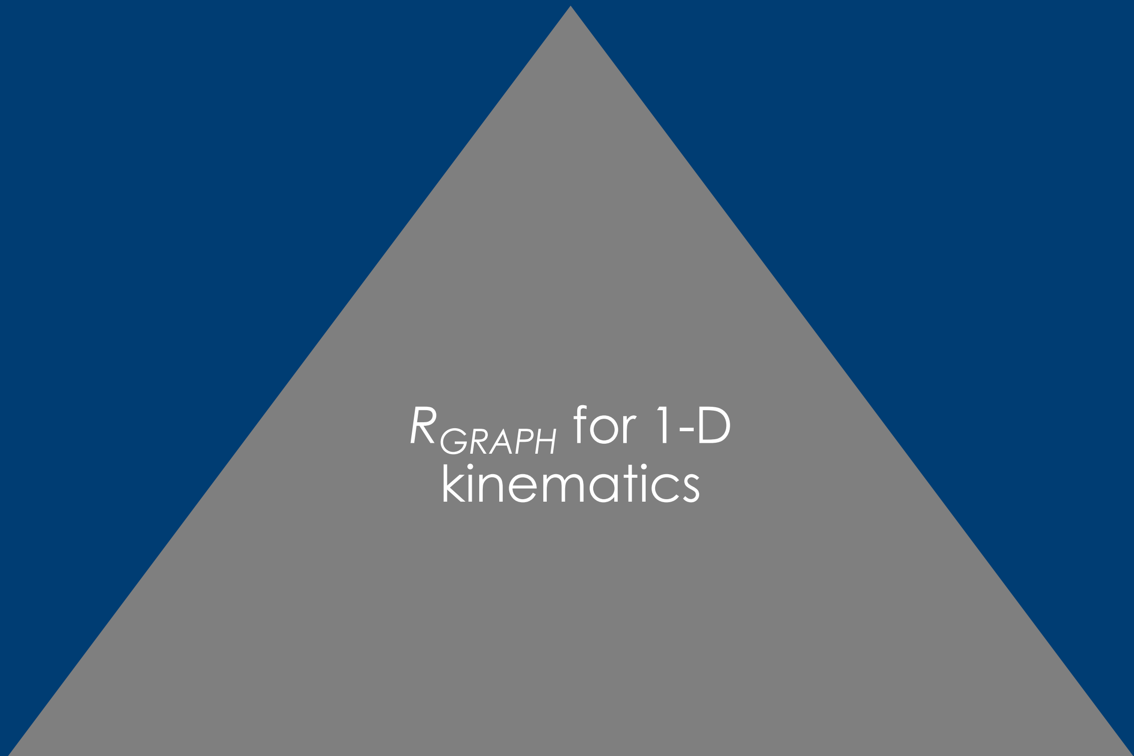


8 shapes × 3 graphs × 2 quadrants
= 48 possible meanings
Sets of ”allowed states”

Representational competence In 1D-kinematics

The three graphs:

Position-time
Velocity-time
Acceleration-time

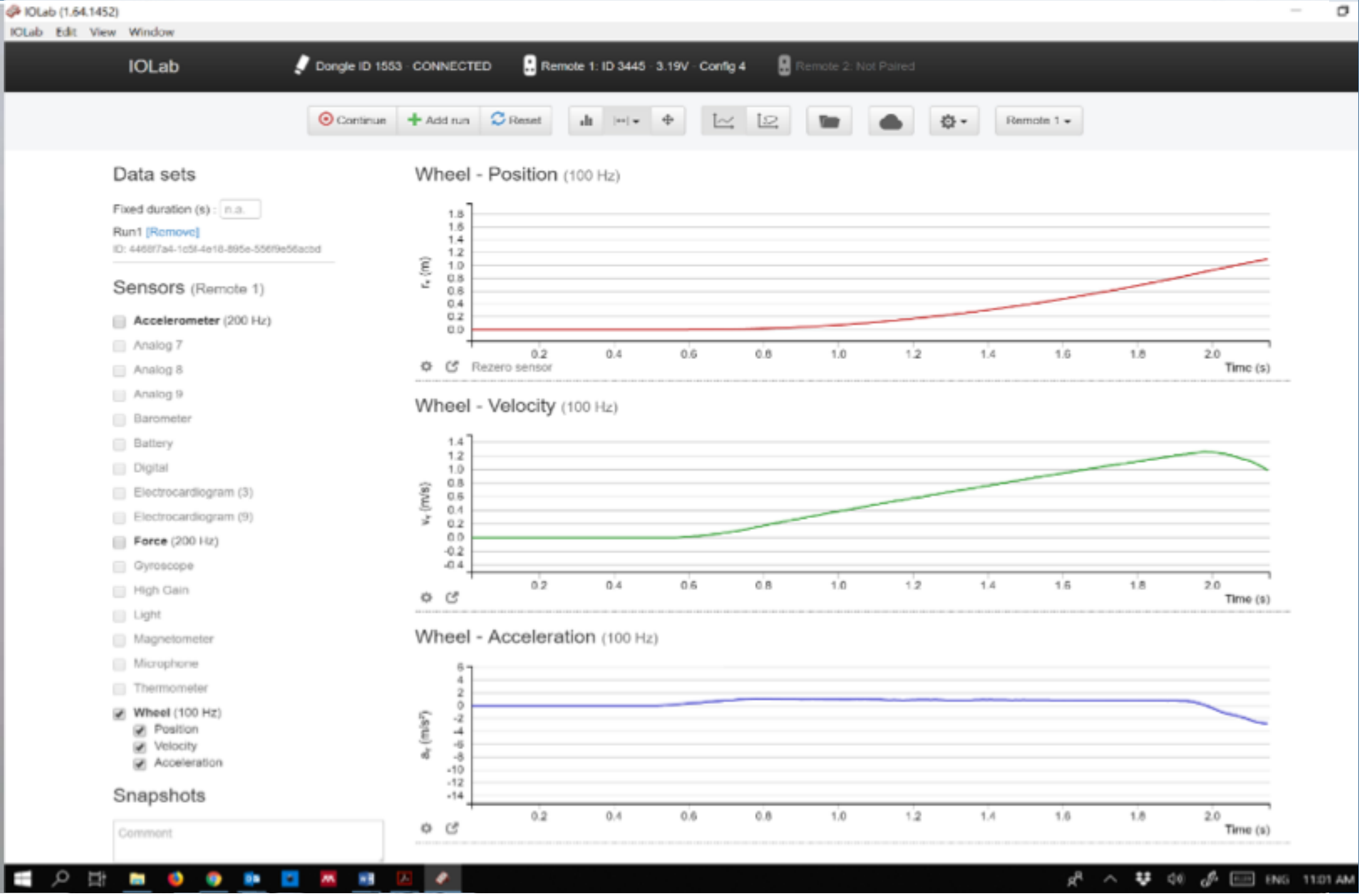


Kinematics concepts

Real-world motion

Trying it out…

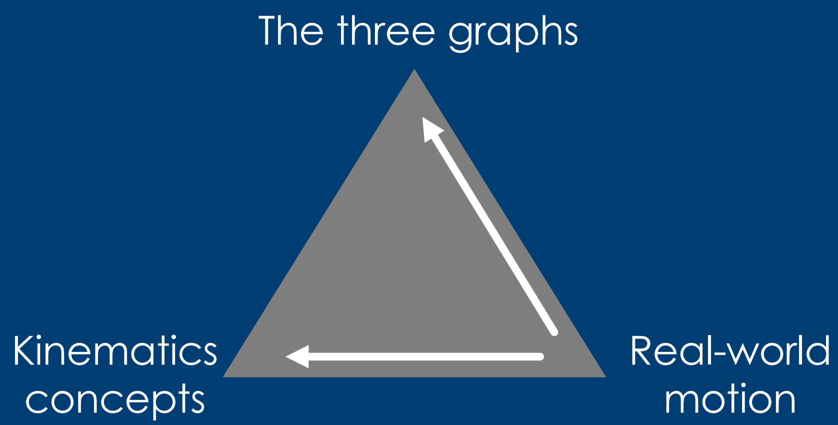
iOLab Ansel 2020, Selen 2013



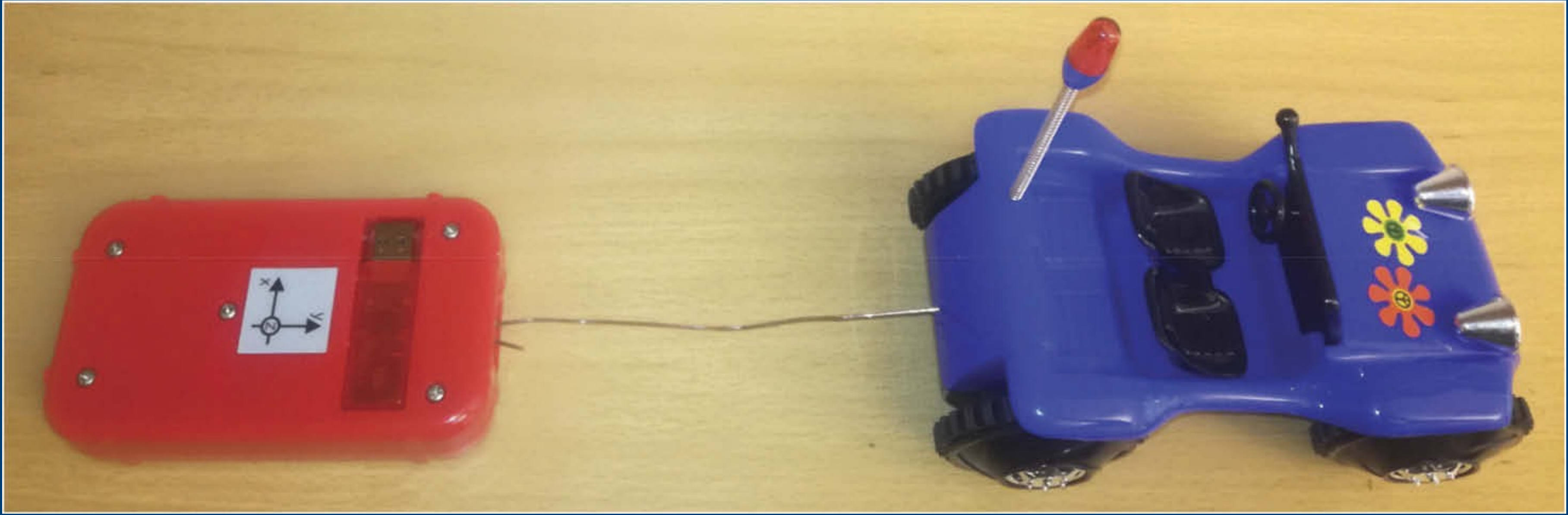
Representational competence

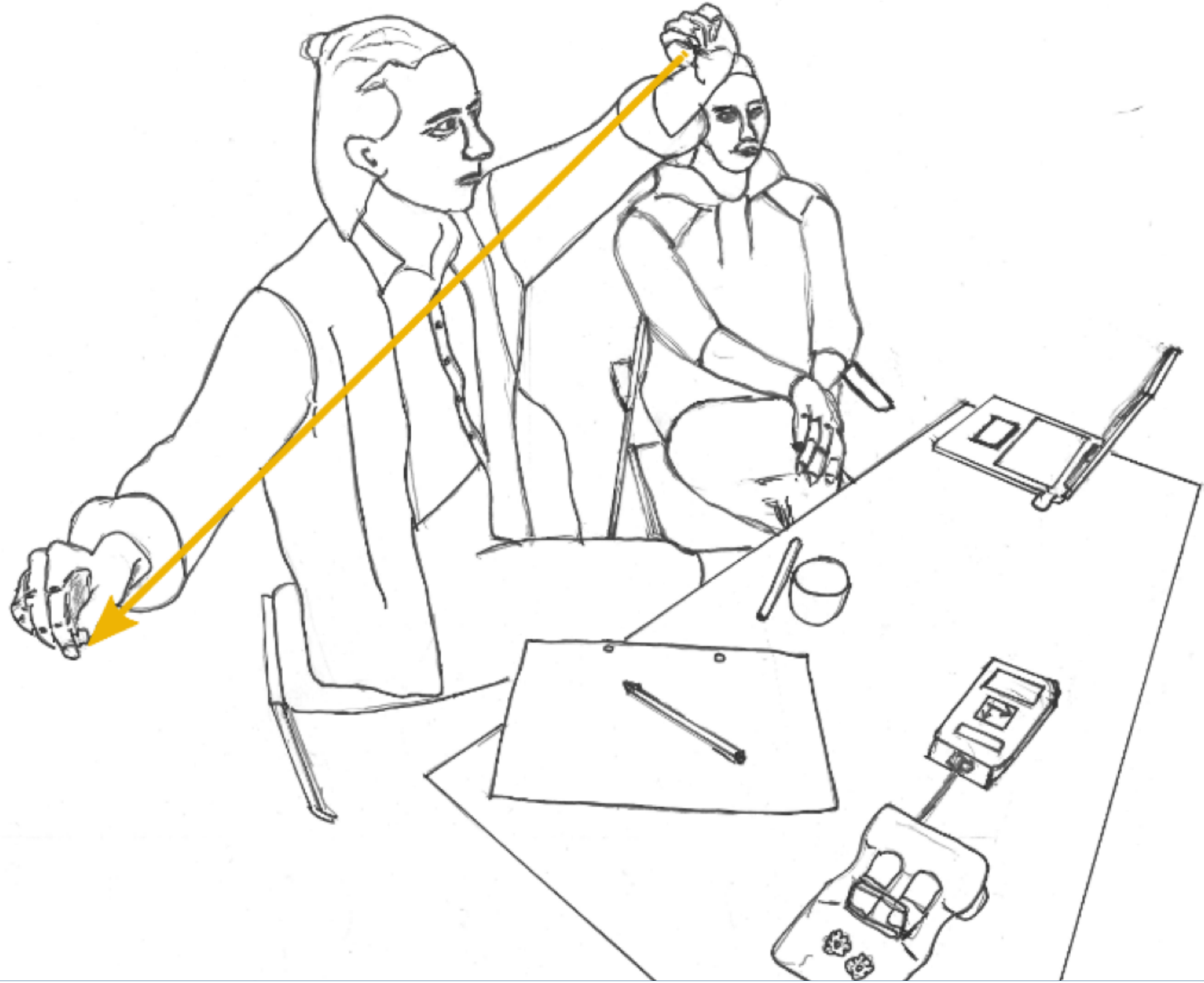
Task 1:

Given a situation with real-world motion, observe the shapes of the three graphs and explain these in terms of kinematics concepts



Representational competence





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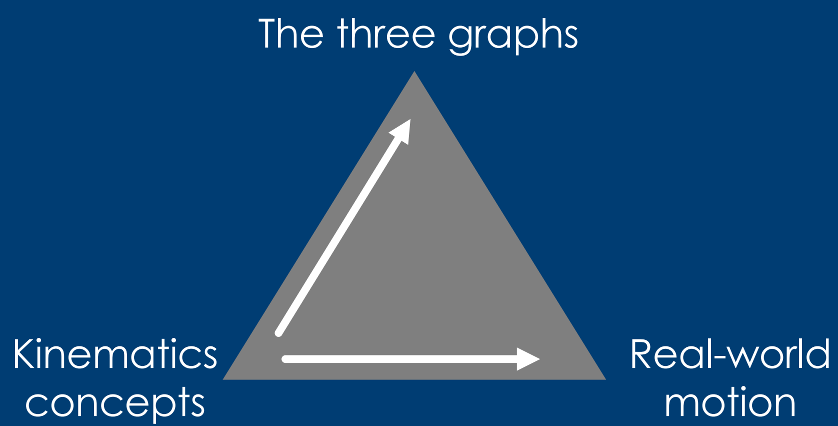
Representational competence

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



Representational competence

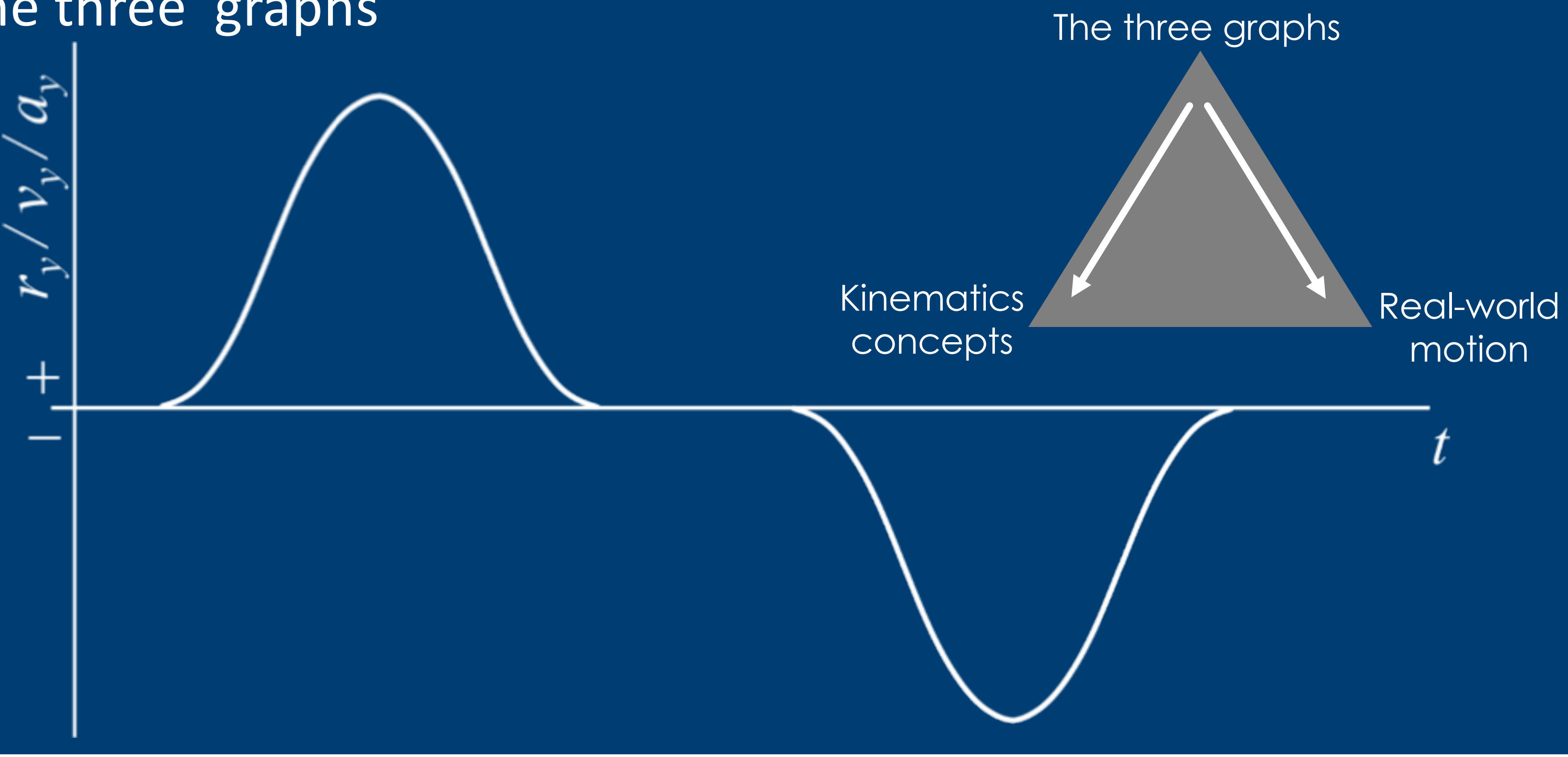
Constant acceleration

Rolled iOLab on an inclined table

Representational competence

Task 3:

Produce the real world motion that generates these shapes for the three graphs



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Summary

- New definition of Representational Competence (R)
- Links representations, real world and science concepts in a triangle form
- $R_{TOTAL} = R_{GRAPH} + R_{DIAGRAM} + \ldots$ etc.
- Claim that we can practice representational competence by developing tasks from the triangle

Summary

- 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

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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

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