

# Investigating students' difficulties with differential equations in physics

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# MS225 – Introduction to Differential Equations

- Service taught to physics students and prospective mathematics teachers.
- Methods course that teaches students to solve various first and second order ODEs.
- Designed to allow students bring their expertise back to their subjects.
- 2+1 structure.
- 80% final exam.

# Research Questions

**1-What is the precise nature of difficulties physics students encounter in their study of differential equations?**

- Aim 1: Identify the difficulties.

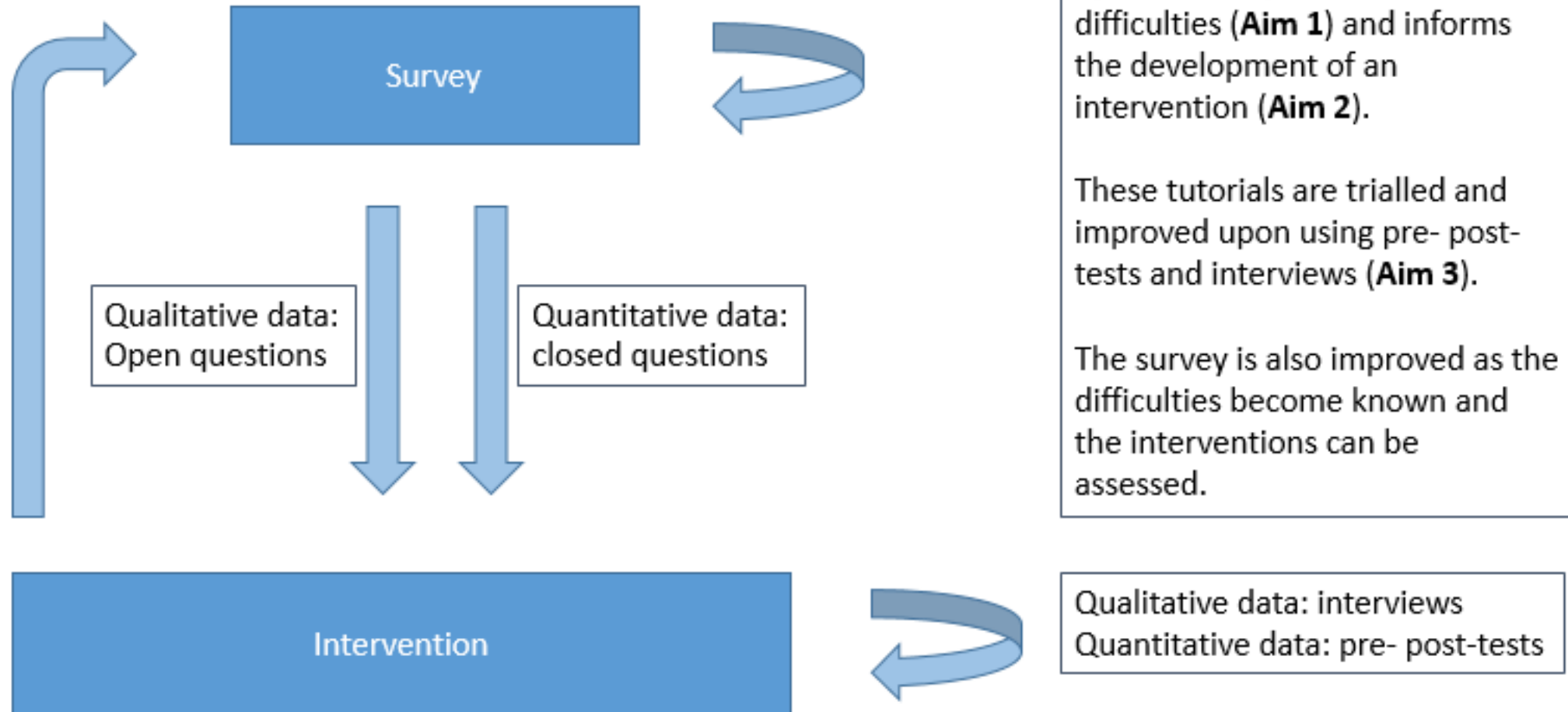
**2-How best can these issues be addressed?**

- Aim 2: Develop an intervention (set of tutorials) that counteract the issues.
- Aim 3: Evaluate and improve the intervention.



# Research Methodology

Design Diagram



# Results

Q1. Find  $x$  and  $y$  if

- $5=3+x$
- $4=3+xe^{-y}$

Q2. What are differential equations, and why are they useful?

- **Survey 1.0**

- Prior mathematical learning
- Conceptual issues in the study of DEs
- Transfer
- Modelling

- **Trial intervention**

- **Survey 2.0**

- Additional questions
- Survey 1 vs 2

- **Intervention x2**

- Pre- Post-testing
- Interviews

$$\frac{dT(t)}{dt} = -k(T(t) - T_0) = \underline{-kT(t)} + kT_0 \quad \& \quad \frac{dv(t)}{dt} = g - cv(t) = -c(v(t) - \frac{g}{c})$$

$$\int \frac{1}{A+Bx} dx$$

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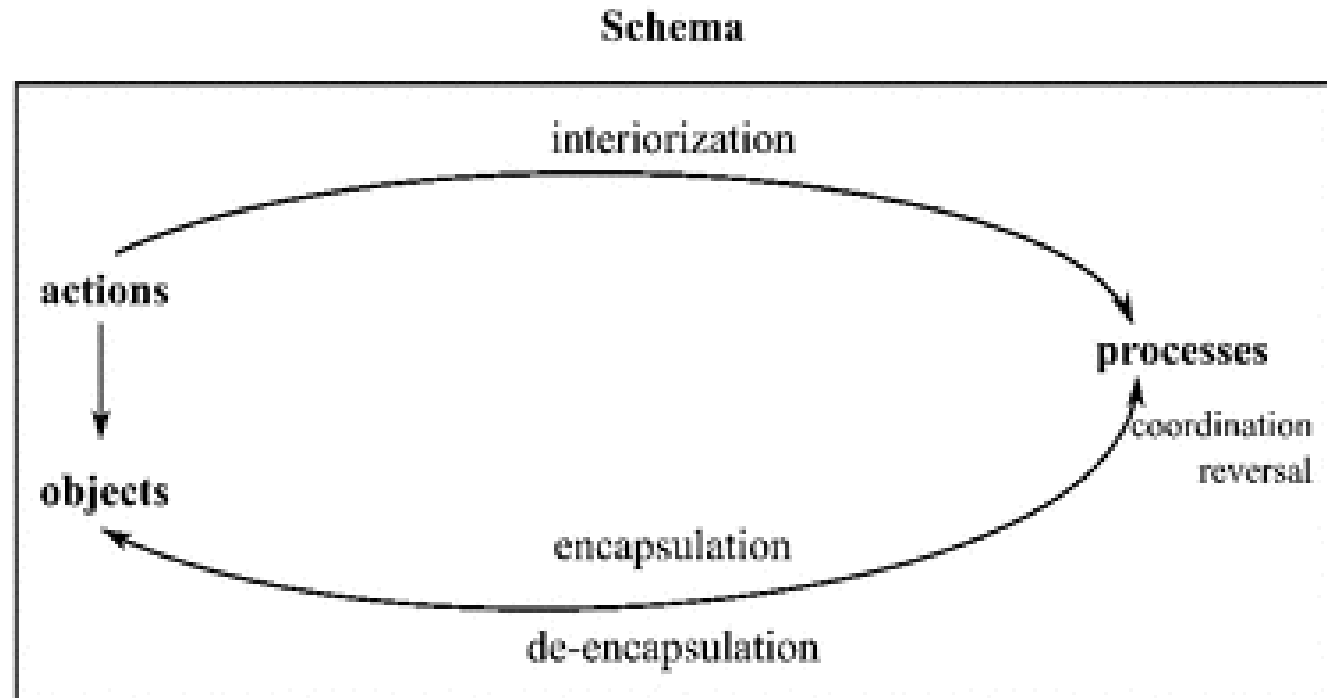
## 2014-2015 vs 2015-2016

- Content: foster conceptual understanding of DEs and the application of DEs to a physics environment **in addition to** procedural competence
- Methodology: encourage cooperative learning and students constructing their own knowledge through discussion **in addition to** allowing time to for individuals to practice the various solution techniques

# APOS Theory

- Action  $\longrightarrow$  Process  $\longrightarrow$  Object  $\longrightarrow$  Schema.
- Constructivist
- A theory of how mathematical concepts can be learned
- Genetic decomposition?

- $f(x) = 2x^2 + 3x - 1.$





Thanks for your time.  
Questions?