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Movie Physics

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Motivation

- Movies are a real and tangible part of the world.
- Opportunity to develop reasoning skills and physics knowledge.
- Interesting context for educational researchers to examine what students transfer.
- Make further strides in helping students be informed skeptics of the future.

Background

Prior use of video clips in instruction:

- Daley (2004) – "exhibition" in high school classes.
- Dennis (2002) – exercises, "visual word problems"
- Everitt (1999) – "mini block reviews"

Little prior research of how students think of movies and their role in learning physics.

Overarching Goal

Investigate whether and how movies can be used to help introductory students to learn physics.

Research Questions

1. To what extent do students transfer learning from classroom and/or personal experiences to explain the physics underlying movie clips? **Phase I**
2. What factors mediate the cognitive processes through which students associate their prior knowledge with the movie clips? **Phase II**
3. To what extent can we use movie clips and supporting instructional materials to help students learn physics?

Framework: Transfer of Learning

- Contemporary perspective of transfer.
- Transfer from classroom / personal experiences to situations in action movie segments.
  - Lobato's[1] "actor-oriented" transfer perspective.

Did not pre-decide what should transfer, but examined everything students transferred.

[1]Lobato, (2003)

Phase I – Methodology

- Grounded Approach
- 8 video clips: Plausible and questionable physics.
- Individual, think-aloud, semi-structured interviews.
- Question strategy: Explore students' connections to physics and personal experiences.
- Interviews videotaped, reasoning patterns analyzed.

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Video	Major Physics Themes
Pearl Harbor	Projectile motion
Speed (bus jump)	Projectile motion
Matilda	Newton's laws and circular motion
Speed (bus turn)	Circular motion
Mission to Mars	Gravity and rotation
Tommy Boy	Projectile motion and circular motion
Speed 2	Momentum and collisions
Tango and Cash	Projectile motion and electricity

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Phase I – Data Sources

- 13 students
  - 5 in 1st semester algebra-based physics
  - 8 in 2nd semester algebra-based physics
- 3 physics experts interviewed
  - Faculty
  - Post-doc
  - Graduate student

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Phase I – Results & Conclusions
Students

- Reasoned spontaneously about each clip.
- Used general physics terms, but relevant application lacking.
- Correctly pointed out instances of incorrect physics.
- More precise connections with everyday experiences than concepts covered in class.
- Tended to rely on physical intuition rather than on understanding of physics underpinnings.

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Phase I – Results & Conclusions
Experts

- Few differences with students regarding major physics themes or concepts.
- Experts presented their themes and concepts in a more structured manner.
- Experts relied less on intuition or personal experiences, more on physics-based reasoning.

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Phase II – Methodology

1/2

- Drilling and prompting questions
- Incorporated stimuli
  - Toy setups, Demonstrations, and Drawing
- Culled from 8 videos to 4 videos based on:
  - Student engagement
  - Reasoning difficulty
  - Physics topics

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Phase II – Methodology

2/2

- 4 videos
  - *Speed*
  - *Matilda*
  - *Mission to Mars*
  - *Speed 2*
- Common theme: Newton's laws

No intent to assess student understanding of these concepts, rather assess potential of these videos to help students learn.

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Phase II – Data & Analysis

1/3

- 12 participating students:
  - 6 non-science majors -- 2nd semester conceptual physics
  - 6 engineering majors -- 1st semester calc-based physics
- Videotaped, transcribed and coded each interview by two independent researchers.
- Inter-rater reliability
  - ~ 75% before discussion.
  - ~ 95% after discussion.

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Phase II – Data & Analysis

2/3

- Phenomenographic coding for:
  - Reasoning (logic, intuition, or p-prims[2])
  - Source (classroom or everyday experience)
  - Epistemic Mode (authority or self-constructed[3])
  - Recognition (instances or similarities)
  - Confidence Level (weak)

[2] diSessa, (1988) [3] Hammer & Elby, (2003)

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Phase II – Data & Analysis

3/3

- Selected 2 students from each group who were most articulate and representative.
- Compared codes from 4 transcripts in 2 ways:
  1. Comparing engineering and non-science students across all movies.
  2. Comparing all movies for each student group.

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Phase II – Results & Conclusions

2/4

- Engineering vs. non-science students :
  - Engineering students tended to rely more on intuition.
  - Non-science students tended to cite personal experiences and knowledge from authority.
  - Use of logic and concepts from class across all videos was relatively the same for the two groups.

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Phase II – Results & Conclusions 3/4

- In comparing videos for non-science students:
  - In *Speed* and *Matilda*, tended to used more on concepts covered in class.
  - In *Mission to Mars* tended to rely on intuition while explaining artificial gravity.
  - Epistemic mode tended to change from reliance on authority to self-constructed knowledge as session progressed.

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Phase II – Results & Conclusions 4/4

- In comparing videos for engineering students :
  - Relied less on classroom concepts and more on intuition for *Mission to Mars* and *Speed 2*.
  - Tendency to rely more on intuition increased as session progressed.
  - Tendency to construct personal knowledge decreased as session progressed.
  - All through the videos they relied on logical reasoning and *not* on knowledge from authority.

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Summary

Video clips may potentially help…

- keep students engaged in learning.
- motivate them to construct their own knowledge.
- Facilitate students to refine their own raw intuition[4] toward understanding physics concepts underpinning each video.

[4] Elby, (2001)

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Current and Future Work

Phase III of project:

- Develop instructional material that utilizes action movie clips to learn a concept: e.g. Artificial gravity
- Pilot-test activity with small groups of students outside of class.
- Classroom implementation.

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Thank You!

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