AAPT– abstract Summer 2022

Research on advanced learning technologies indicate that various emotional experiences or affect (e.g., engagement, boredom, frustration, confusion, worry) are triggered in specific situations. These emotions can facilitate or inhibit student learning, suggesting that emotional experiences should not be overlooked in the design of online learning environments. This presentation will showcase our web-based interactive video-enhanced tutorials (IVETs), which guide students through an expert-like problem-solving approach for a challenging problem involving a given topic, such as conservation of energy. IVETs include video narration by a live person interspersed with branching multiple choice questions that include feedback, allowing students who require less guidance to navigate the tutorials quickly, while students who struggle receive more support according to their needs. This presentation will highlight the design principles that guided the development of each IVET, with a particular focus on students' emotional experience. Data collected from log files, surveys, and student interviews will be shared.

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Incorporating Affect in the Design of Interactive Web-based Problem-Solving Tutorials

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Introductory Physics at UC

Algebra-based Physics

- primarily health science majors
- 13 sections of 135 each/yr (~1500 students)
- Lab taught by graduate TAs

Calculus-based Physics

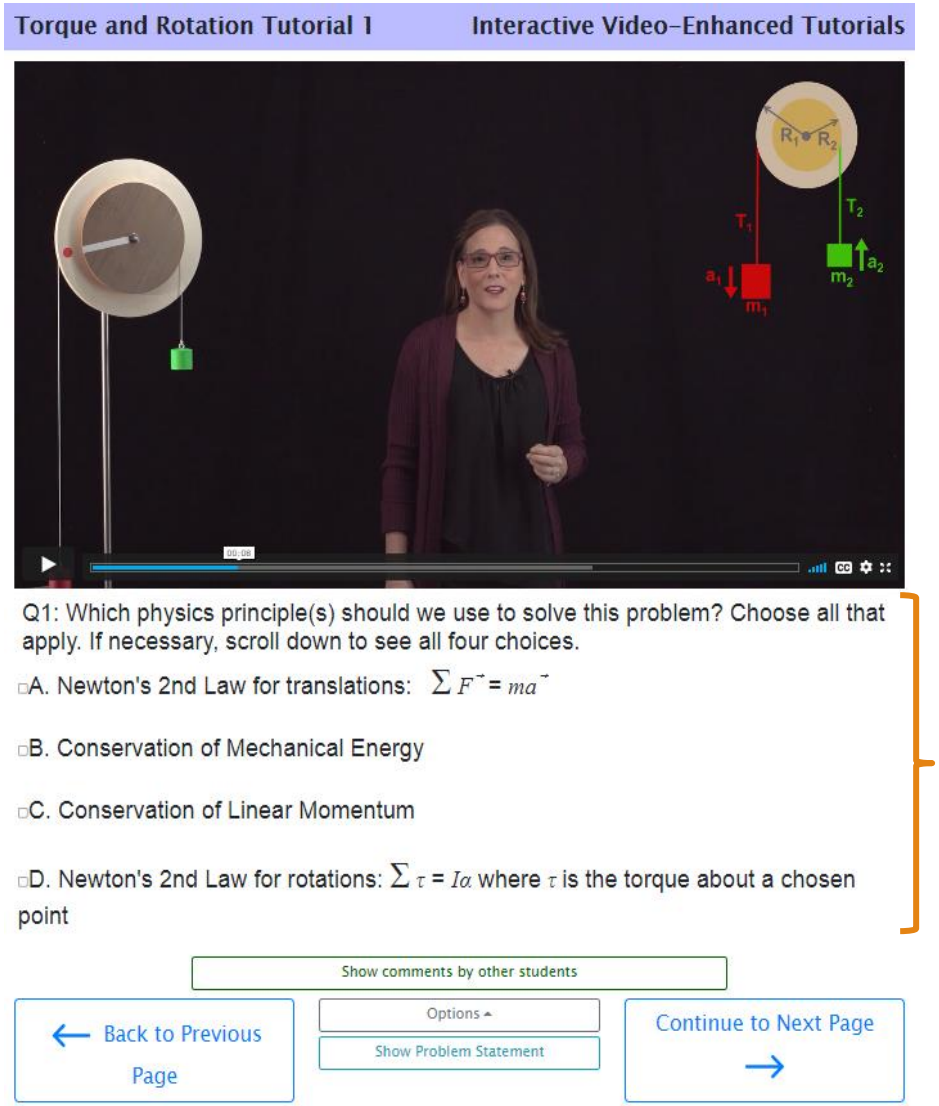
- primarily engineering majors
- 16 sections of 135 each/yr (~2000 students)
- Lab and recitation taught by graduate TAs

Supplement with online resources to personalize instruction and attempt to level the playing field.

Wide variation in students' academic preparation

Wide variation in approaches to teaching

Interactive Video-Enhanced Tutorials (IVETs)



Videos interspersed with multiple choice questions to teach **expert-like problem solving strategies** for specific problem types; i.e.Newton's Laws, conservation of energy, etc.

Short (7-10 min), self-paced

Questions branch based on student responses, providing relevant feedback for incorrect (and correct) answers

IVETs are based on the work of Singh & DeVore (Univ of Pittsburgh).

IVETs Designed with Affect/emotion in mind

Research on advanced learning technologies indicate that various emotional experiences are triggered in specific situations (e.g., engagement, boredom, frustration, confusion, worry).

These emotions can facilitate or inhibit student learning, suggesting that emotional experiences should not be overlooked in the design of online learning environments.

D'Mello and Graesser (2012); Xing et al. (2019); O'Regan, K. (2003); Dillon et al. (2016)

Design Features – Built into Scripts*

- Personalized instruction (ex. imagine student in office hours)
- Use of short videos (text) interspersed with interactivity; gesturing
- Scaffolding
  - Provide add'l *information* for better understanding problem solving process
  - Immediate, direct, discriminating feedback (e.g. resolve confusion)
  - Hints and just-in-time explanations
- Narrator's demeanor and language - "Yes! That is correct!" or "Almost!...."
- Reflection problem at end (build confidence, make more self-reliant)

Emotions:
*engagement
boredom
frustration
confusion
worry

* Informed by research literature, our own experiences, student interviews

Implementation Features to Promote Positive Experience

- Reduce issues with technology, layout of the learning space
- Low stakes (completion score only)
- Control-Value Theory
  - Content has high appeal (value), aligned with coursework (intrinsic value)
  - Cognitively demanding activities with appropriate balance between skill and challenge, so feel some control over the outcome of the activity
  - Student control of learning space

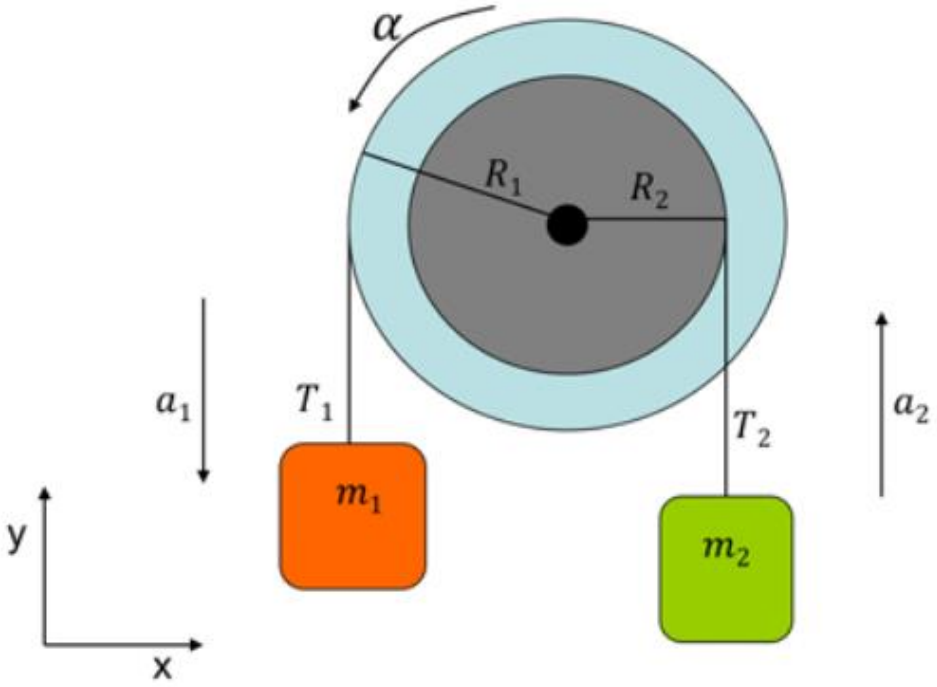
Mayer, 2009; Pekrun, 2006

Choose a problem that is challenging to most students

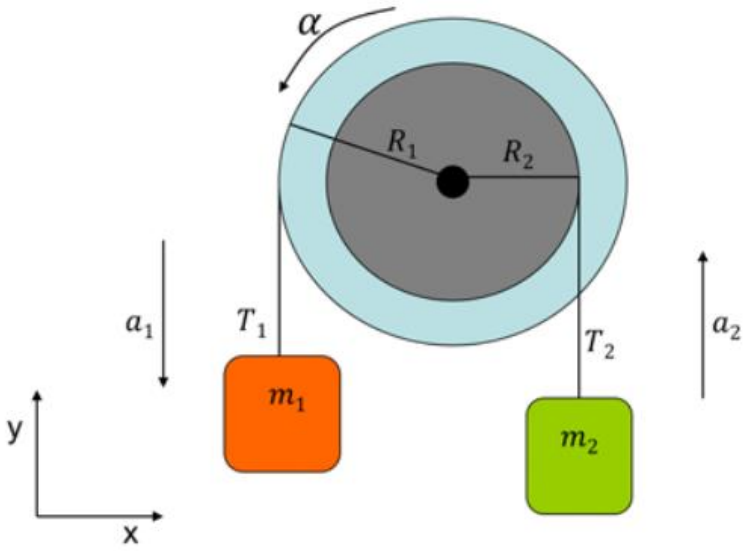
Problem Statement

Two blocks ($m_1 = 1.0\ kg, m_2 = 0.6\ kg$) are hanging from a pulley as shown in the figure below. The moment of inertia through the axis of rotation passing through the center of the pulley is $I = 1.70\ kgm^2$. The ropes are attached at two different distances from the center of the pulley ($R_1 = 30cm$ and $R_2 = 20cm$).

Find the angular acceleration α of the pulley system and the tensions T_1 and T_2.



Identify Essential Steps (decision points)



1. Identify principles that will be used.
2. Draw force diagrams of each hanging mass.
3. Choose coordinate system.
4. Apply Newton's second law to each mass.
5. Draw extended FBD for pulley.
6. Apply Newton's second law of rotation to pulley.
7. Recognize that have 3 equations and 4 unknowns, but can relate linear and angular acceleration through $a = r\alpha$.
8. Solve 3 equations with 3 unknowns to get numerical value for α.
9. Use calculated α to calculate T_1 and T_2.

How are you feeling right now?

What is this? Why should I answer?

- I feel fine.
- I feel confused.
- I feel frustrated.
- I feel bored.
- I feel worried.
- None of the choices apply to me.
- I prefer not to answer.

We do not have ability to measure emotions during the IVET, with exception of the affect question placed about halfway through IVET.

I feel fine. **(81.1%)**

Please choose the most appropriate response from this list.

12.0% I feel confident. I already knew how to do the problem so I find this easy.

34.4% I feel confident. This tutorial has been easy to follow and understand.

17.0% I'm engaged with the problem and feeling good.

17.7% I'm feeling OK.

From ~1000 student responses.

Not Applicable (7.5%)

3.0% None of the choices apply to me.

4.5% I prefer not to answer.

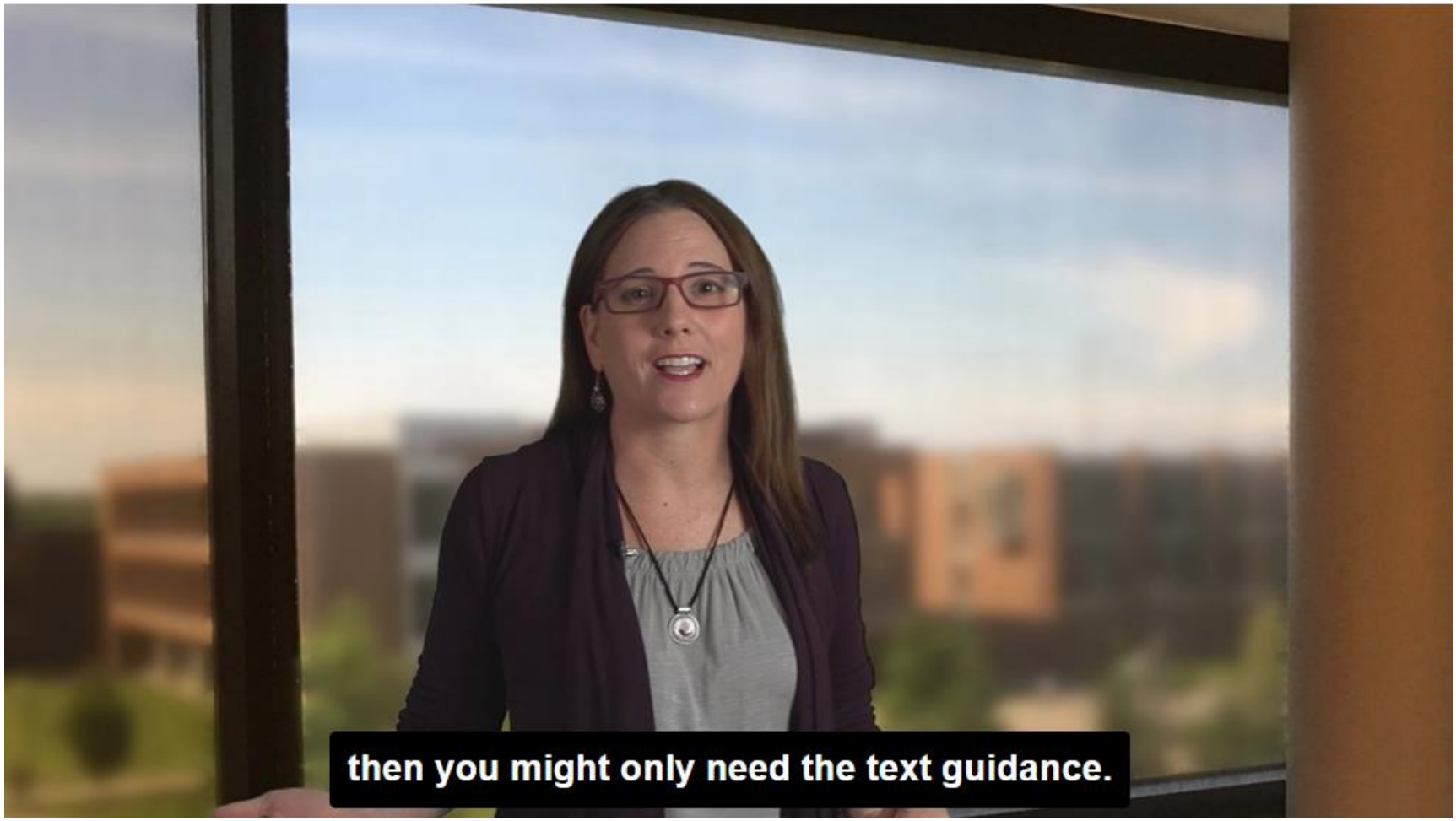
Other responses

I feel bored. (4.4%)

0.7% The problem is too easy.
1.0% The problem is not very interesting to me.
2.5% The tutorial is taking too long.
0.2% I don't understand this, and the tutorial is not helping.
0% Technical issues keep getting in the way.

I feel worried. (3.9%)

0.2% I feel that I don't have enough background to follow the tutorial.
0.7% I worry that I will never understand the material it's too difficult.
1.7% I worry that I will not do well in this course.
1.3% I am just feeling kind of stressed today.



Narrator suggests that that student switch over to the text mode to move through tutorial more quickly.

Other responses

I feel confused. (1.6%)

0% The tutorial is moving too quickly.
1.3% I am having trouble staying focused…not getting most out of tutorial.
0.2% This tutorial uses terms that I do not understand.
0.1% The problem-solving approach is different from what I learned in class.

I feel frustrated. (1.6%)

1.0% I keep getting the questions wrong, but I understand the concepts.
0.2% Sometimes the answer I would give…is not among the answer choices.
0% The problem-solving approach…is different from what I learned in my class.
0.4% Technical issues keep getting in the way.

General Findings from Student Interviews

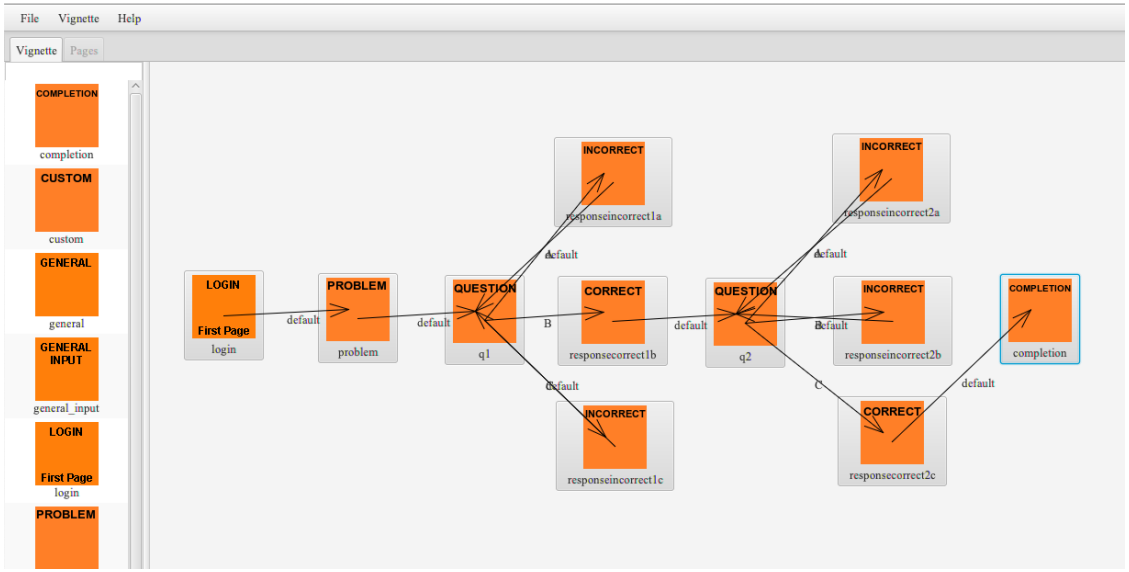
Students reacted positively to narrator

- Nodded head or made remarks during feedback (ex. “got it”, “ah”)
- Appreciated “gentle” feedback when incorrect
- Students cheered/commented when correct
- Enthusiasm and support motivated students to keep going

- More likely to do something when asked by narrator
- Didn’t fast forward videos

Students indicated affect question was appropriately placed and that guidance was useful.

Vignette Studio II –
Make your own IVETs!



- A free desktop application for authoring IVETs and similar online activities
- Easy to use if you know a little about HTML
- Activities can be uploaded to most LMS (Blackboard, Canvas, Moodle…)
- Download any of our 30 IVETs for student use and Java app at:

ivet.rit.edu/IVET

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Koenig, K., Maries, A., Teese, R., & Chabot, M. (2022). Promoting Problem Solving through Interactive Video-Enhanced Tutorials. *The Physics Teacher*, *60*(5), 331-334.