

Targeting Learning Barriers in Introductory Physics: Enhancing the First-Year Experience

E H Kim*, T L Spanjers*, C Rangan* and E Kustra †

*Department of Physics and †Centre for Teaching and Learning, University of Windsor

Remember when **you** were in first year physics...

What do you think the **central obstacles** in first year physics are?

As an **educator**, how would you address these obstacles?

Offer Tutorials
More Office Hours
Have Q&A in Class
Assign Practice Problems
Provide Online Resources
Other:

If you were a **student** today, how would you address these obstacles?

Attend Tutorials
Go to Office Hours
Ask in Class
Do Practice Problems
Ask the Internet
Other:

Perceived Obstacles:

- Students come to the University from diverse backgrounds, and their preparation is heterogeneous.
- With the loss of grade-13, students' background in mathematics is less comprehensive.

Consequences for course structure and delivery:

- First-year physics courses must fill in gaps from the provincial high-school curriculum, making these courses overtaxing and, at times, even boring.

Consequences for students:

- First-year courses do not cover the curriculum needed to keep upper-level courses on track; concomitantly, there is inadequate preparation for the second year.
- Students are frustrated by the density of the first-year physics courses; consequently, student retention is compromised.

- Proposal for Strategic Priority Fund

Proposed Solution:

Supplementary modules and **specialized tutorials** will be designed and offered to address individual weaknesses in student background knowledge in first year physics, with a particular focus on **math skills**.

However, initial results showed...

Method of delivery needs to change!

Math skills are not the primary problem!

'Math Tutorials for Physics':

Students were offered voluntary tutorials in Winter 2011; the resources from these tutorials were posted online.

Student Participation:

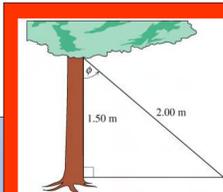
- Attendance at Tutorials: <20/504
- Accessed Online Resources: 462/504

Next Step...

A series of online 'Math Tutorials for Physics' were designed/offered through the Mastering Physics Software.

This mode of delivery was adopted to increase/improve

- 1) **Student Accessibility**
- 2) **Active Feedback**



Example: A support wire is attached to a recently transplanted tree to be sure that it stays vertical. The wire is attached to the tree at a point 1.50 m from the ground, and the wire is 2.00 m long.

What is the angle between the tree and the support wire?

Diagnostic Math Test:

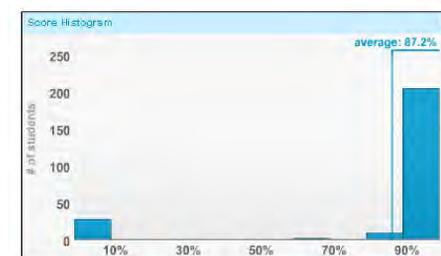
- Issued at the start of Fall 2012

Questions:

- Representative of the mathematics necessary for first year physics

Result: (Surprisingly)

- **Most students scored very high!!!**



Focus on Problem Solving:

If math skills are **not** lacking, then why do students have difficulty in first-year physics?

Problem solving skills are the likely culprit, along with the ability to identify which math skills to employ.

Problem Solving in Lecture:

A framework for problem solving was introduced in lecture, providing scaffolding when students move from simple to complex multi-level problems.

Optimizing In-Person Instruction:

The lab-tutorial system was re-designed to support the development of problem solving skills and re-enforce conceptual knowledge taught in lecture.

Each lab session now consists of:

Tutorial (1hr) – Practice problems are assigned for students to solve in small groups, to employ techniques discussed in class (with GAs/TAs present to assist).

Lab (2hr) – Physical experiments are conducted using a 'check point' system designed to check understanding at each key stage, allowing students to get feedback throughout the session.

Example Check Point –

Question 2

If your mass is set into motion, it will eventually come to rest if you wait long enough. Explain why this happens.

STOP CHECKPOINT 3
Mark: _____

Get your TA's initials before proceeding onto the next part. _____

Acknowledgments – The authors would like to thank the University of Windsor's Strategic Priority Fund for supporting this project.