Helping Students Learn Problem Solving – Forming An Initial Model of Instructors’ Beliefs*

Vince H. Kuo

Kenneth Heller, Patricia Heller
University of Minnesota
Charles Henderson
Western Michigan University
Edit Yerushalmi
Weizmann Institute

http://www.physics.umn.edu/groups/phyled

*Supported in part by NSF grant #DUE-9972470
Motivation

Instructors’ beliefs about teaching influence their use (or non-use) of curricular materials

Knowing these beliefs could help curriculum developers make these materials more acceptable

Everything in this talk is about the instructors’ beliefs about their own teaching, not about what they actually do!
Learning Activities Cluster

Some College Students can help learn how to Solve Physics Problems while they engage in Learning Activities of using Working while/after of Feedback can be of Appropriate Problems Individualized Responses to (Path B) can be Appropriate Example Solutions to (Path C) get the Appropriate Knowledge Looking/Listening can be Lectures
Managing Cluster
Managing students working on problems

- Appropriate Knowledge
  - Get the
    - (Path A)

- Working
  - on the
    - Appropriate Problems
  - While
    - after
      - can be
        - of
          - of using
            - Individualized Responses
              - to
                - (Path B)

- Feedback
  - While
    - of
      - of using
        - Setting Constraints
          - Making Suggestions
            - Providing Resources

- Engage in Learning Activities
  - by
    - Providing Resources

- Solve Physics Problems
  - Some College Students
    - can help

- Teacher
  - Engage in Learning Activities
    - while they
      - Looking/Listening
        - Lectures
          - Setting Constraints
            - Making Suggestions
              - Providing Resources

- Managing students working on problems
  - Some College Students
    - can help
      - Solve Physics Problems
        - while they
          - Looking/Listening
            - Lectures
              - Setting Constraints
                - Making Suggestions
                  - Providing Resources
A. Providing Resources

- Choose appropriate problems
  
  i. Requires consideration of physics principles behind the problem
  
  ii. Conveys the message that physics is related to reality by posing problems in realistic or semi-realistic context
  
  iii. Is based on the current state of the students’ knowledge
B. Making Suggestions

- Practice working on a lot of appropriate problems
- Particular techniques to enhance student learning
  - e.g. students should first guess at the answer, and after having worked through the problem, compare their guess to the calculated answer

There was no justification on why they believe these suggestions enhance student learning
Working

C. Setting Constraints

- Collecting homework
- Giving tests

Only situation where students work seriously on a problem without prematurely looking for help

Most instructors do not view the act of taking tests to be beneficial to learning

They believe that students can learn from the feedback after taking the test
Managing students working on problems
Managing students using feedback
Using Feedback

There are 2 opportunities to provide useful feedback

1. While student is solving a problem
   - i.e. Coaching

2. After student has solved a problem
   - e.g. Providing example problem solutions or Grading

Instructors believe both are equally effective
Using Feedback

A. Providing Resources (time)

i. Written example problem solutions

ii. Personal Coaching (feedback while students work)
   • Peer Coaching
   • Instructor Coaching

   Advantage of Peer Coaching: requires considerably less instructor time (almost as helpful as Instructor Coaching)

iii. Grading on tests

   Unfortunately, instructors’ grading often countered the values that they wish to communicate (Kuo, et. al., PERC Proceedings, Rochester, NY, 2001)
Using Feedback

B. Making Suggestions

- Students should first work on problems, and then come to office hours when having difficulties.

Even though they believe that very few students do this.

- Instructors placed a high value on their coaching.

Student surveys rated instructor office hours as one of the least valuable resources.
Using Feedback

C. Setting Constraints

- Instructors did not express the belief that they should set constraints to influence feedback usage
Managing students using feedback
Managing students looking / listening
Instructors did not express the belief that they should either make suggestions on how students should use this information or influence students to use the information by setting constraints
A. **Providing Resources**

i. Posting example problem solutions  

ii. Solving problems during lecture  

iii. Lecturing about specific problem-solving techniques  

iv. Presenting interesting example problems
Summary of Management

Statements

- Setting Constraints: 23%
- Making Suggestions: 62%
- Providing Resources: 15%
Caution!

Hypothesis was developed with a sample of 6 research university faculty

Will be tested using a broader sample
Implications

Instructors spent the most time discussing management of feedback

They do not spend significantly more time preparing feedback than on other teaching activities

✅ Curriculum developers could promote alternative instructional approaches by highlighting this conflict

✅ e.g. more advanced class response systems that allow instructors to provide immediate feedback for problem solving during lecture
It is important to know how instructors perceive constraints.

- Many curricular material are designed to promote problem solving by constraining students to use a problem-solving framework (e.g. Van Heuvelen, 1991; Heller, Keith, & Anderson, 1992; Heller & Hollabaugh, 1992; Leonard, Dufresne, & Mestre, 1996; Reif & Scott, 1999).
Implications

- **If instructors**
  - *in principle, oppose constraining students*
    - • Students should take responsibility for their own learning
      • Curricula need to be revised to soften the importance of the constraints
  - lack specific knowledge to appreciate the value of constraints
    • Appropriate professional development could be designed to make this type of material more acceptable
  - Students should take responsibility for their own learning
In Conclusion

1. Instructors believe their teaching consists of managing 3 distinct ways by which students learn to solve physics problems!

2. Knowledge about these beliefs could help guide curriculum developers!
To be continued …
Thank you!

For more information, please visit our website at:

http://www.physics.umn.edu/groups/physed