Scaffolding Student Success – Application to Fluid Mechanics

Michael N. Gooseff
Pennsylvania State University

Abstract

Scaffolding and fading is an approach that is designed to provide students with learning support as they encounter new concepts and then progressively remove that support as students increase their learning and expertise. We have applied this to Fluid Mechanics with the goal of enhancing student learning of difficult concepts and improving their problem solving ability in an efficient manner for fairly large classes. We have developed: 10-15 minute video explanation of the topic and think-aloud demonstration solution, and problems of increasing difficulty with faded learning support.

Introduction and Objectives

Original: provide static learning support to students outside of class hours

Revised: 1) Provide parallel lessons; 2) Enhance learning through scaffold and fade techniques (integrated into HW assignments)

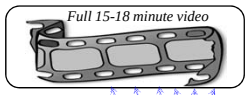
Developmental History of Innovation

We have developed 5 scaffold & fade modules and incorporated them in CE 360 Fluid Mechanics in the fall of 2009 (1 section, ~60 students) and we are currently using them in 2 sections of the same course (~140 students total).

Learning Activities and Materials

Our 'modules' are made up of:

1 instructor video

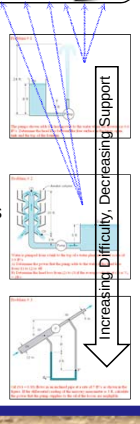


Problem set:

Problem #1 is similar to the problem solved in the video, and each question contains links to snip-its of the video that directly address the question.

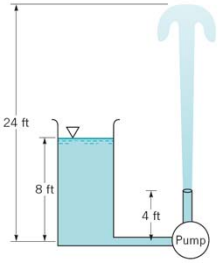
Problem #2 is slightly more difficult than #1 and also contains the support of video links to support the student.

Problem #3 is more difficult than #2 and has *no support* for the student (i.e., support is faded).

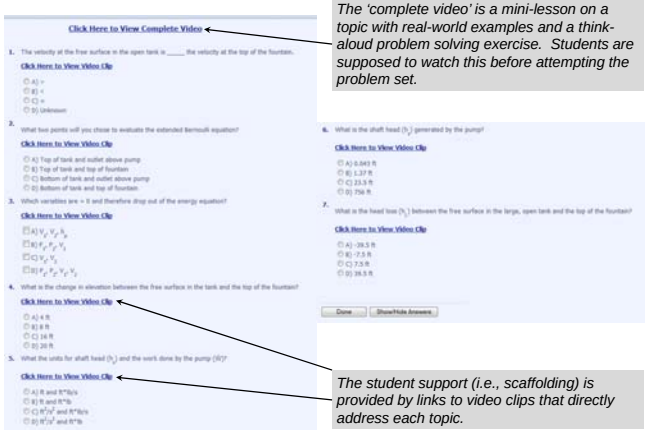


Learning Activities and Materials

Problem # 1 for *Pumps and Turbines*



The pumps shown adds 1.6 horsepower to the water when the flowrate is 0.6 ft^3/s. Determine the head loss between the free surface in the large, open tank and the top of the fountain.



The 'complete video' is a mini-lesson on a topic with real-world examples and a think-aloud problem solving exercise. Students are supposed to watch this before attempting the problem set.

The student support (i.e., scaffolding) is provided by links to video clips that directly address each topic.

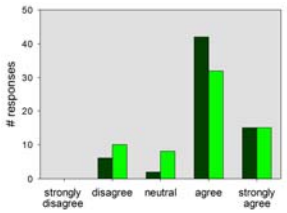
Execution

We have deployed our scaffold & fade modules online using our course management system (ANGEL). The challenge is to have the students complete problems by asking for more than just a simple answer and at the same time not walk them through the entire problem solving process.

We asked 65 students to evaluate their experiences using these problem sets (likert scale statements):

Having the video clips made doing the problems easier

Doing the 1st and 2nd problems helped me solve the 3rd problem in the set

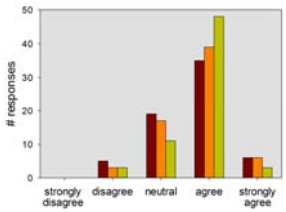


After finishing the scaffold & fade problems, I am confident that I can…

… explain the problem concept and solution to my friends and classmates

…make assumptions about new problems and successfully solve them

…use and adapt the problem solving strategy I have learned for other problems



Conclusion: *Students are finding these to be valuable in their learning.*

Major Issues to Resolve

Can students learn engineering concepts via the web? Original goal was to provide learning materials to students outside of class and office hour times. We have created modules that go beyond simple podcasts. Is that too much?

How well do these work? We are assessing the performance of the two current sections of the class on both homework assignments (comparing 'regular' delivery and these modules) and subsequent quizzes.

Are databases of conceptual questions related to fluid mechanics concepts available? I have found that reinforcement and/or assessment of learning in simple formats is to use multiple choice conceptual questions.

Discussion

Engineering students are busy. Furthermore, within a single classroom there are as many different learning styles required for class success as there are students. To address these challenges we have been developing resources that are available to students beyond the schedules of the class, instructor and teaching assistant (i.e., office hours). Our modules have been well-received by students, but we have not yet evaluated the impact of the modules on student learning.

Ultimately, scaffold & fade techniques should be transferrable. This application is not the first. We seek to document our lessons, challenges, and successes to others so that they might develop their own modules. We are developing guidance (i.e., recipes) documents for those interested in transferring these techniques to their classes.

Within a year, we do intend to submit a proposal to NSF to focus on the development and implementation of scaffold & fade techniques across engineering departments.

Acknowledgments

The author gratefully acknowledges the support and collaboration of the experts in the Leonhard Center, within the College of Engineering, Penn State University, and the Civil & Environmental Engineering Department.

2011 Frontiers of Engineering Education Symposium

Irvine, California
November13 - 16

Sponsored by:
The National Academy of Engineering
and
The O'Donnell Foundation

PENNSTATE 1855

NATIONAL ACADEMY OF ENGINEERING OF THE NATIONAL ACADEMIES