Simulation Apps for Teaching Engineering Delivered via COMSOL Server™

William M. Clark

Chemical Engineering Department, Worcester Polytechnic Institute, Worcester, MA, USA

INTRODUCTION: Apps were developed and delivered via COMSOL Server™ for use in an undergraduate chemical engineering laboratory class. Before experimental runs, 66 students used the apps to review heat transfer fundamentals and used pre-built COMSOL® models and detailed tutorials to review fluid flow fundamentals.
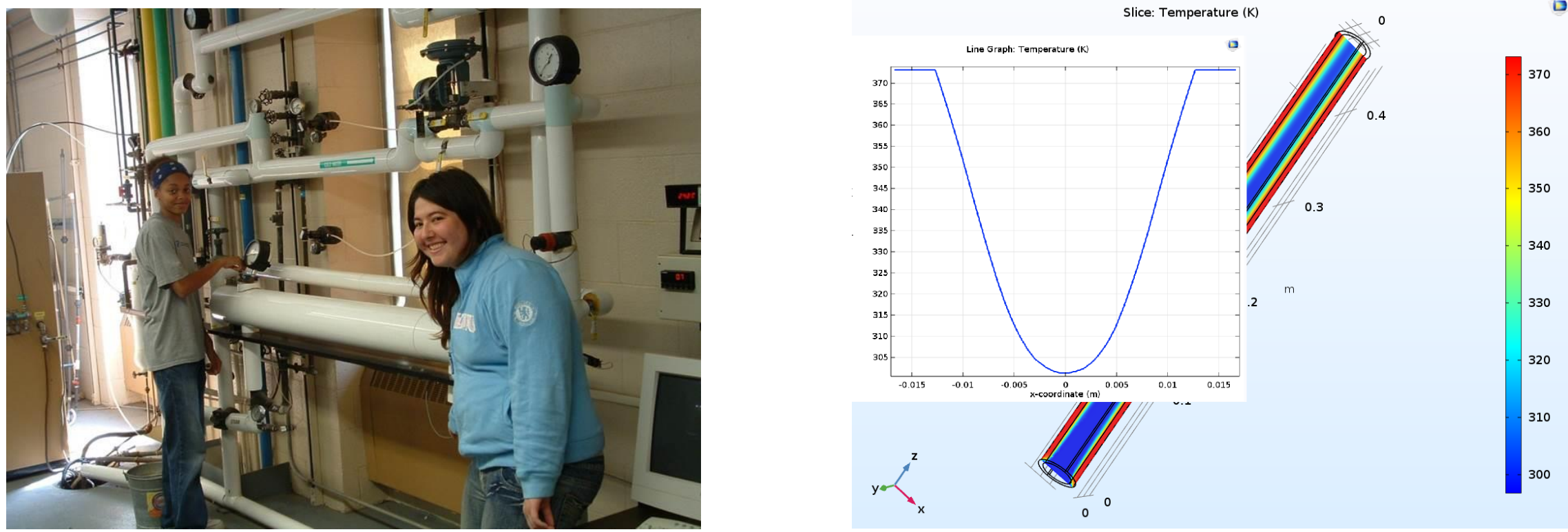

(a)   (b)

Figure 1. Heat exchanger: (a) experiment, (b) simulation.

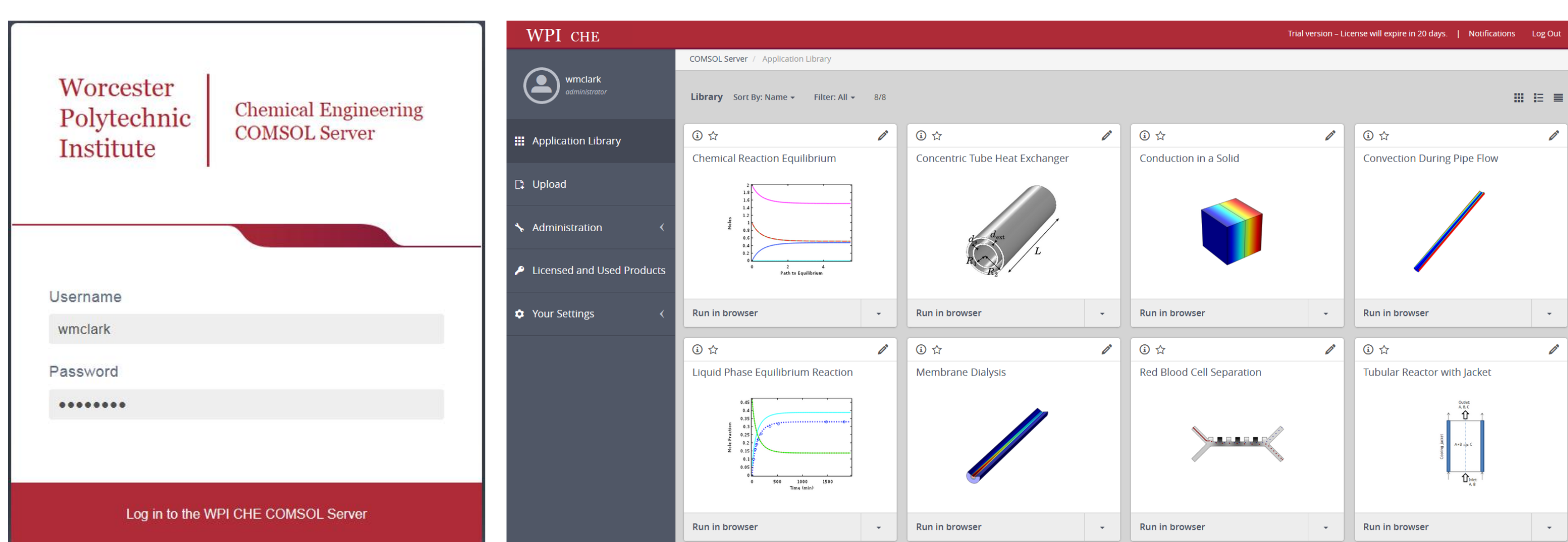**COMSOL SERVER™ AND APPS**: Screenshots below show some of the features of our app implementation.

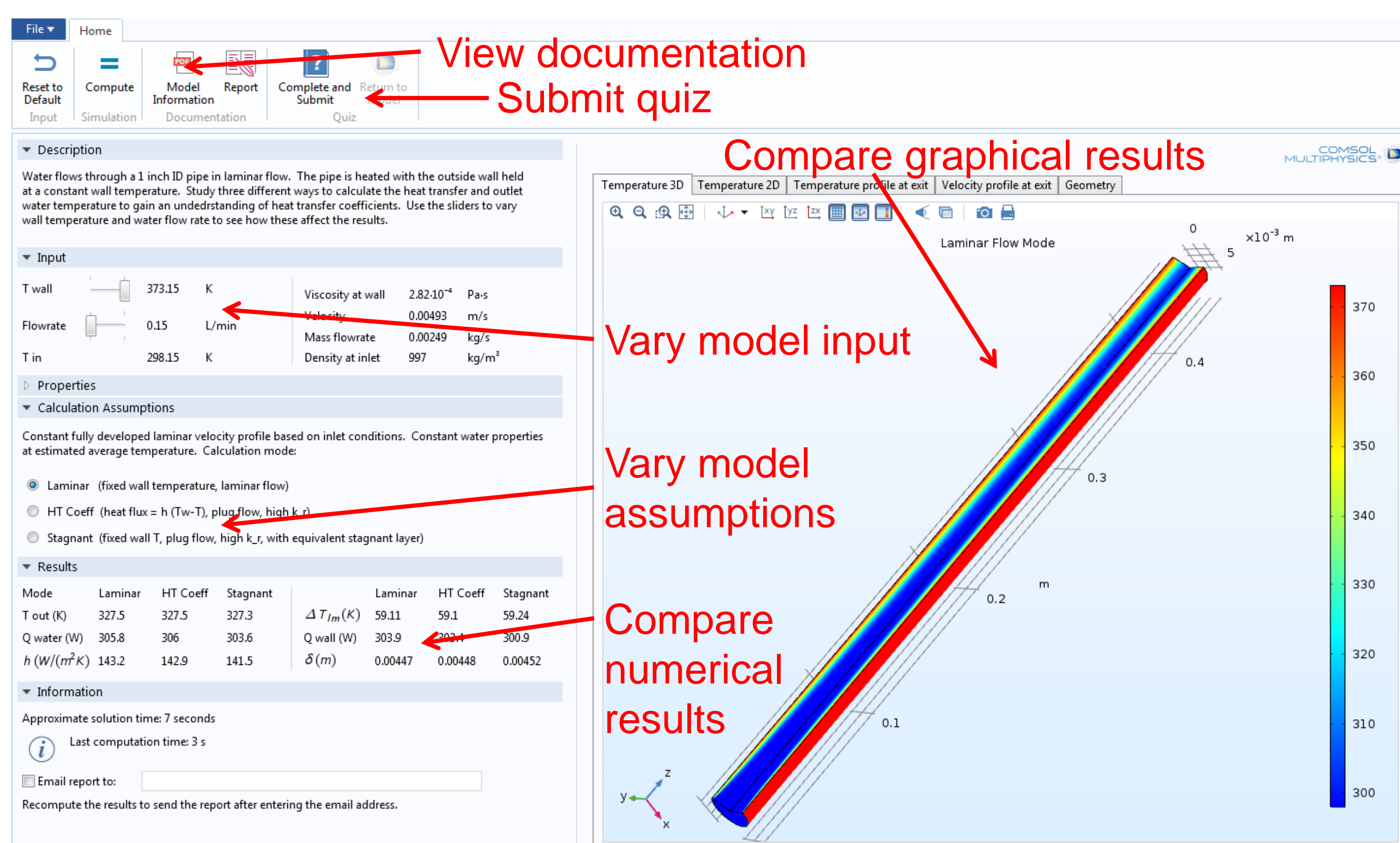**Figure 2**. Customized login page and application library.

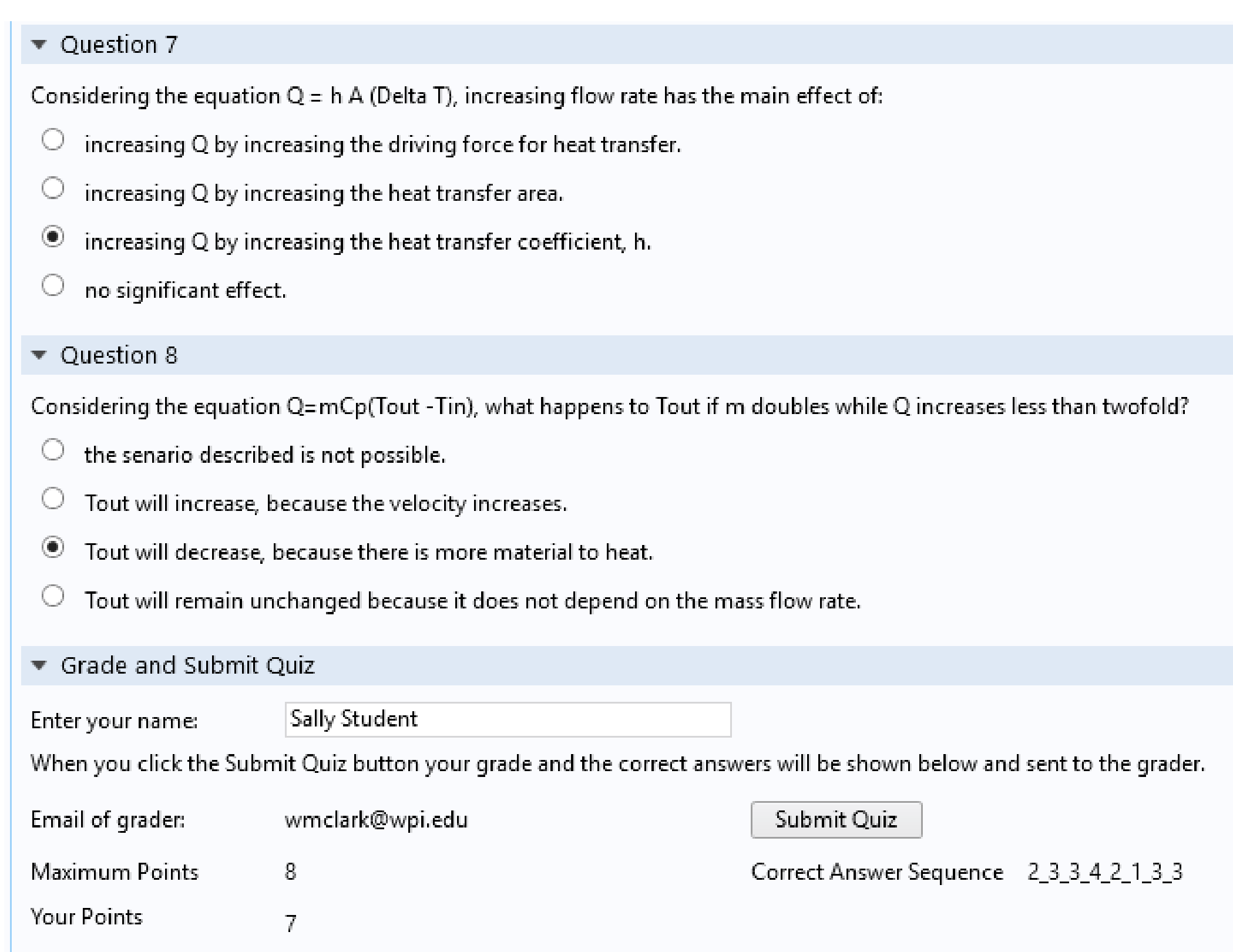**Figure 3**. Convection during pipe flow application.

Figure 4. Students see their grade and the correct answers after they submit the quiz via email directly from the app.

ASSESSMENT: Students completed:
- pre and post diagnostic tests on knowledge of fluid flow and heat transfer
- survey on satisfaction with using COMSOL® for reviewing fundamentals
- survey on preference for using apps compared with manipulating .mph files following tutorials

RESULTS: Instructor observations:
- apps took slightly longer to produce than the original models with associated detailed tutorials
- apps with built-in quizzes were convenient self-contained learning modules deliverable to any browser
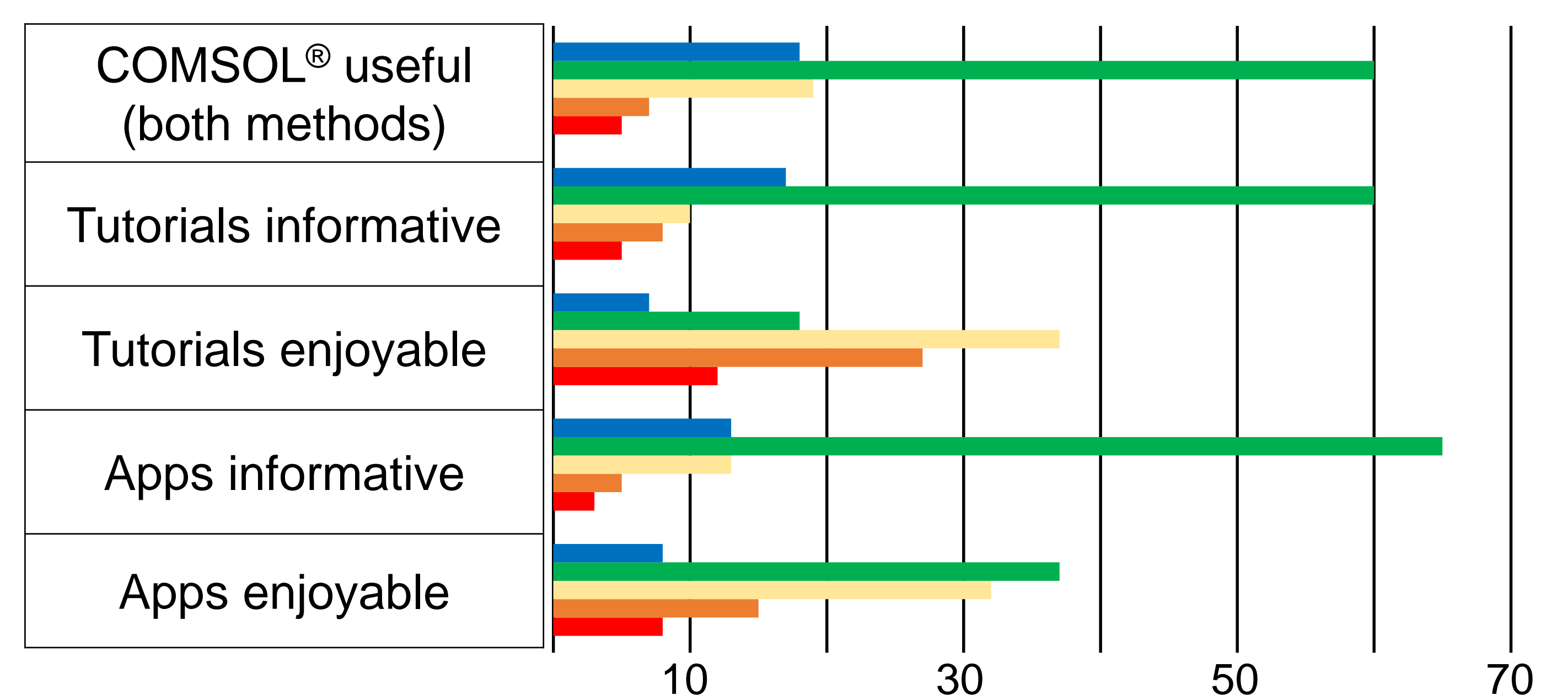
Student learning:

Table 1. Class average on diagnostic tests.

Test	Pre	Post
Fluids (tutorials)	74	100
Heatx (apps)	66	98

Student satisfaction:

Table 2. Student satisfaction survey response (%).

Student preference:

Table 3. Student preference survey response (%).

CONCLUSIONS: COMSOL Server™ is a convenient way to deliver interactive online learning materials. Apps are time consuming to build, but only slightly more so than models plus detailed tutorials. Both the tutorial and app delivery methods were very effective with regard to student learning. Student satisfaction and preferences varied. Most students believed that both learning methods were useful. Most students preferred apps, but others preferred working directly with .mph files while following tutorials. Very few students preferred neither.