

MEET YOUR STUDENTS. 3. MICHELLE, ROB, AND ART*

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The scene is the student lounge at a large university. Three juniors—Michelle, Rob, and Art—are studying for the second quiz in the introductory fluid dynamics course. Art got the high grade in the class on the first quiz, Michelle was close behind him, and Rob got 15 points below class average. They've been at it for over an hour.

Michelle: “What about this stuff on non-Newtonian flow—I don't think I really get it.”

Art: “I think we can forget it—I've got copies of Snavely's tests for the last five years and he's never asked about it.”

M: “Maybe, but it's the real stuff...you want to analyze blood flow, for instance, Newtonian won't work.”

A: “So what...the only blood flow we're going to have to worry about is ours on this test if we don't stick to the stuff Snavely *is* going to ask.”

M: “Yeah, but if we don't...”

Rob: “Hey Art, is there going to be any of that Navier-Stokes trash on the quiz?”

A: “Yeah, there usually is, but no derivations—you just have to know how to simplify the equation.”

R: “Rats—I hate that garbage.”

M: “I've been looking through the text...there are all sorts of Navier-Stokes problems in there—we could try to set some of them up.”

R: “Nah, too much grind—I just need to do enough to get my C, my degree, and my MG...Art my man, why don't you haul out those old tests and let's just memorize the solutions.”

A: “Okay, but that may not...hey, look at this question—he's used it for three years in a row...Parts (a) and (b) are just plug-and-chug, but he throws a real curve ball here in Part (c)—I don't know how to do it.”

R: “How much is Part (c) worth?”

M: “Never mind that—let me see it...okay, he's asking about velocity profile development—you just need to use the correlation for entrance length.”

A: “What are you talking about—I never heard of that stuff.”

M: “He never talked about it in class but it's in the reading—you need to calculate the Reynolds number and then substitute it in this dimensionless correlation, and that gives you...”

R: “I'm gonna grab a Coke from the machine, guys—when you get it all straight just tell me what formula I plug into, okay?”

A: “Yeah, sure. So it's just this correlation, huh Michelle—do I need to dig into where it comes from?”

* *Chem. Engr. Education*, 24(3), 130-131 (Summer 1990).

M: “Probably not for the test, but I was trying to think why you would want to know the entrance length, and it seems to me that if you're designing a piping system that has a lot of short pipe segments it would be important to know how well your pressure drop formulas will work...blood flow again, in capillaries, or maybe lubricating oil in a car engine, or...”

A: “Forget it—that stuff's not going to be on this test...even Snavelly wouldn't be that tricky...now look at this problem here...”

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These three students illustrate three different *approaches to learning*.¹

- Michelle tends to take a *deep approach*, meaning that she tries not just to learn facts but to understand what they mean, how they are related, and what they have to do with her experience.
- Rob almost always takes a *surface approach*, following routine solution procedures but not trying to understand where they come from, memorizing facts but not trying to fit them into a coherent body of knowledge.
- Art's primary goal is to get the highest grade in the class, whatever it takes. He takes a *strategic approach*, which involves finding out what the instructor wants and delivering it—digging deep when he has to, staying superficial when he can get away with it.

Engineering faculty members often complain that most of their students are Robs and pitifully few are Michelles. Unfortunately, few of us do anything in class to stimulate our students to take a deep approach: we just give them tricky tests to see if they can “do more than plug in,” and then gripe that they're apathetic and incompetent when they can't. Fortunately, there's something more productive we can do. The following conditions increase the likelihood that students will adopt a deep approach to learning.¹

- *Student-perceived relevance of the subject matter.* Students will not struggle to achieve a deep understanding of material that seems pointless to them, any more than we would. To motivate them to do it, let them know up front what the material has to do with their everyday lives (e.g. fluid flow in their cars and circulatory systems, heat and mass transfer and reaction in the atmosphere and their homes and respiratory and digestive systems) and with significant problems they may eventually be called on to solve (e.g. fabricating improved semiconductors, developing alternative energy sources, avoiding future environmental catastrophes).
- *Clearly stated instructional objectives, practice, and feedback.* Students are not born knowing how to analyze deeply, and little in their precollege experience is likely to have fostered that ability. To get them to pull meaning out of lecture material and solve problems that go beyond those in the text, spell these objectives out and give concrete examples of the kind of reasoning desired. Then explicitly ask the students to carry out deep analysis in class activities and on homework and give them constructive feedback on their attempts.
- *Appropriate tests.* *Provided the preceding conditions have been met*, include questions that call for deep analysis on all tests. If the students know they will only get surface questions (closed-

¹ R.M. Felder & R. Brent. (2005). Understanding student differences. *J. Engr. Education*, 94(1), 57–72.
<www.ncsu.edu/felder-public/Papers/Understanding_Differences.pdf>.

ended exercises that require only standard solution procedures), most will likely take a surface approach to learning the material. If they expect some deep questions (more open-ended questions that require greater understanding), most Michelles and Arts and perhaps even some Robs will be motivated to take a deep approach.

- *Choice over learning tasks.* Provide bonus problems and/or optional projects and/or alternatives to quizzes and/or optional self-paced study and/or choices between group and individual efforts.
- *Reasonable workload.* If students have to spend all their time and energy just keeping up, they'll fall back on a surface approach.

The research indicates that by establishing these conditions we may substantially increase the number of our students who think critically about the material we are presenting, try to discover its meaning and its relationship with other material they have previously learned, and routinely question the inferences and conclusions that we present in class. Whether or not we'll know what to do with these people once we have them is a question for another occasion.