MEET YOUR STUDENTS
7. DAVE, MARTHA, AND ROBERTO*

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Three engineering classmates are heading for lunch after a heat transfer test. Martha and Roberto are discussing the test and Dave is listening silently and looking grim.

Martha: "OK, so Problems 1 and 2 were pretty much out of the book, but Problem 3 was typical Brenner—he gives us a heat exchanger design and asks us to criticize it. I said the design might be too expensive, but we could say *anything* and he couldn't tell us we're wrong."

Roberto: "Sure he could—it was a lousy design. They were putting a viscous solution through the tube side so you'd have a big pressure drop to overcome, the flow was laminar so you'd have a low heat transfer rate, the salt would probably corrode those carbon steel tubes, the…"

M: "Maybe, but it's just a matter of opinion in questions like that—it's like my English teacher taking off points because of *awkward expression* or something when anyone with half a brain would know exactly what I was saying."

R: "Come on, Martha—most real problems don't have just one solution, and he's trying to…"

M: "Yeah,yeah—he's just trying to get us to think and I'm okay with that game as long as I don't lose points if my opinion isn't the same as his. What do you think, Dave?

Dave: "I think that problem sucks! Which formula are you supposed to use for it?"

M: "It's not that kind of question—not everything has a formula you can…"

D: "OK, so when did he tell us the answer? I memorized every lousy word he said after I bombed that last test and not one had anything to do with…"

R: "It's a thinking question—you have to try to come up with as many…"

D: "That's bull, man! I already know how to think—I'm here to learn how to be an engineer."

M: "Dave, not everything in the world is black and white—some things are fuzzy."

D: "Yeah, in those airhead humanities courses and those science courses where they spout all those theories but not in engineering—*those* questions have answers, and Brenner's job is to teach them to me, not to play guessing games or put us in those dumb groups and ask us to…"

M: "Yeah, I'm not too crazy about those groups either, but…"

D: "…and that's not all—Monday Roberto asked him that question about the best exchanger tube material and he starts out by saying 'it depends'…I'm paying tuition for the *answers*, and if this bozo doesn't know them he shouldn't be up there."

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R: "Look, the teachers don't know everything…you have to get information wherever you can—like in those groups you two were trashing—and then evaluate it and decide for yourself, and then you can..."

D: "That's a crock of…"

M: "Um, what did you guys get for Problem 2? I used the Dittus-Boelter formula and got 4.3 square meters for the heat transfer area. How does that sound?"

R: "I don't think it's right. I did the same thing at first, but then I started to think about it some more and I remembered that you have to be in turbulent flow to use Dittus-Boelter and the Reynolds number was only 550, so I redid it with the laminar flow correlation and got…"

M: "*Whoa*—he never did anything like that in class."

D: "I say we go straight to the Dean!"

These three students illustrate three levels of the **Perry Model of Intellectual Development**.[1–3] The model was developed in the 1960's by William Perry, an educational psychologist at Harvard, who observed that students varied considerably in their attitudes toward courses and instructors and their own roles in the learning process. The Perry model is a hierarchy of nine levels grouped into four categories:

Dualism (Levels 1 and 2). Knowledge is black and white, every problem has one and only one correct solution, the authority (in school, the teacher) has all the solutions, and the job of the student is to memorize and repeat them. Dualists want facts and formulas and don't like theories or abstract models, open-ended questions, or active or cooperative learning ("I'm paying tuition for *him* to teach me, not to teach myself.") At Level 2, students begin to see that some questions may seem to have multiple answers but they still believe that one of them must be right. Like many entering college students, Dave is at Level 2.

Multiplicity (Levels 3 and 4). Some questions may not have answers now but the answers will eventually be known (Level 3) or responses to some (or most) questions may always remain matters of opinion (Level 4). Open-ended questions and cooperative learning are tolerated, but not if they have too much of an effect on grades. Students start using supporting evidence to resolve issues rather than relying completely on what authorities say, but they count preconceptions and prejudices as acceptable evidence and once they have reached a solution they have little inclination to examine alternatives. Many entering college students are at Level 3, and most college graduates are at Level 3 or 4. Martha is at Level 4.

Relativism (Levels 5 and 6). Students in relativism see that knowledge and values depend on context and individual perspective rather than being externally and objectively based, as Level 1–4 students believe them to be. Using real evidence to reach and support conclusions becomes habitual and not just something professors want them to do. At Level 6, they begin to see the need for commitment to a course of action even in the absence of certainty, basing the

commitment on critical evaluation rather than on external authority. A few college graduates like Roberto attain Level 5.[**]

The key to helping students move up this developmental scale is to provide an appropriate balance of challenge and support, occasionally posing problems one or two levels above the students' current position.[1,2] (They are unlikely to comprehend wider gaps than that.) If teaching is confined to single-answer problems, students will never be impelled to move beyond dualist thinking; on the other hand, expecting most freshmen to think critically when solving problems and to appreciate multiple viewpoints is a sure recipe for frustration. Instructors should assign open-ended real-world problems throughout the curriculum but should not make course grades heavily dependent on the outcomes, especially in the freshman and sophomore years. They should have students work in small groups (automatically exposing them to multiplicity), model the type of thinking being sought, and provide supportive feedback on the students' initial attempts to achieve it. While doing those things won't guarantee that all of our students will reach Level 5 or higher by the time they graduate, the more we move them in that direction the better we will be doing our job.

References

1. R.S. Culver and J.T. Hackos, "Perry's Model of Intellectual Development," *Engr. Education, 72*, 221–226 (1982).
2. M.J. Pavelich and W.S. Moore, "Measuring the Effect of Experiential Education Using the Perry Model," *J. Engr. Education, 85*(4), 287–292 (1996).
3. W.G. Perry, *Forms of Intellectual and Ethical Development in the College Years*, New York, Holt, Rinehart and Winston, Inc., 1970.

[**] At the highest category of the Perry model, *commitment within relativism*, individuals start to make actual commitments in personal direction and values (Level 7), evaluate the consequences and implications of their commitments and attempt to resolve conflicts (Level 8), and finally acknowledge that the conflicts may never be fully resolved and come to terms with the continuing struggle (Level 9). These levels are rarely reached by college students.