A Bridge too Far: on the Nature of Teacher Training

JOHN E. OWENS

Beginning teachers' salaries are often compared to those of other college graduates but the nature of their preparation and of the character of the new employee's experiences are not. This article presents a fictional look at engineering curricula and hiring practices in terms of teaching preparation and beginning teachers' experiences, suggesting ways teacher educators can learn from the experiences of other professions.

On my way to the University each morning I cross a bridge. Approximately one-half mile in length, the four-lane concrete span rises about two hundred feet above the river and seems solidly built. Normally, I would give no thought to the possibility of imminent disaster but I had recently read of the collapse of a similar span and on this particular morning the barge nearing my bridge seemed menacingly close to the support structure.

As I sped from the bridge I looked back to see two young fishermen on the river's bank. One covered his head while the other held up his palms like a referee at a football signaling the play had fallen an inch short. After minor repainting of the barge and support, all should return to normal along the river.

When my pulse returned to normal, my thoughts turned to the qualifications of two people: the pilot of the barge that had caused my consternation and the engineer in charge of constructing the bridge. As my musings alternated between the two and the student teachers I was scheduled to observe later that day, I began to envision the formers' training in terms of that my own students were receiving. The following scenarios came to mind.

George P. Burdell, certified bridge builder

The engineer in charge of building my bridge—one George P. Burdell—had attended a well-respected engineering school, majoring in civil engineering. After a solid three and one-half year academic program covering topics from surveying to cost-estimates to the psychology of bricklaying, he was assigned a one-semester internship (for which he paid out-of-state tuition of $653.00).

For fifteen weeks the student engineer assisted the supervisor on the construction of a steel-frame railroad bridge over a dry creek bed. Beginning with the unloading crew (the project had actually begun three weeks earlier and the foundation was already in place) he gradually assumed responsibility for each aspect of the bridge, his tenure culminating in a two-week stint as general foreman.

Finishing his term, he left with the superstructure half in place. Upon graduation, George took and passed the state bridge-building competency test; the newly-certified engineer than spent three months painting houses while waiting for bridge-construction season to begin.

When September came he was given three thousand tons of concrete, a state bridge-building guideline, and full authority (with the exception of hiring—the crews were filled by lot from all who applied) to build the concrete span I had just survived.

The administrator of the project, a former football stadium architect, visited the bridge twice during the nine months it took to construct—on each visit assessing the discipline of the crews. George's requests to visit other bridges and work with other engineers were viewed by the administrator as mere attempts to avoid the serious and solitary job of bridge building. Completing the bridge, George returned to home painting for the summer and the next fall decided on a career selling real estate.

Cap'n Eddie on the river

The barge captain, "Cap'n Eddie" Smith, had similarly attended a first-rate school, spending the final one-eighth of his tenure training at the hand of a certified barge pilot. The school, however, offered only one course in actual barge-piloting (BP 301, Methods of Barge Piloting). Cap'n Eddie's coursework included studies in River Management, Coastal Surveying, and Theory of Sediment Flow—each taught in the School of Water Resources.

In the College of Driving he took, in addition to the Methods course, classes in Foundations of Driving, Psychology of Driving, Driving for the Handicapped, and so on. Each was a generic driving course covering a range of vehicles from motorcycles to space shuttles since the Foundations instructor had once been in a rowboat and the Psychology professor swam, validity was assured.

The two departments rarely communicated about the nature of Eddie's preparation; the School of Water Resources considered the College of Driving a haven for those incapable of understanding advanced theories of particular matter, while the College of Driving faculty considered Water Resources' courses unduly technical and generally missing the essence of driving. The methods class instructor, the only faculty member trained in both fields (and a certified barge pilot) was looked upon with suspicion by both departments.

Completing his academic training, Eddie began his student piloting. His cooperating pilot, Captain Jim "Whiskey Fitz" Fitzsimmons, had learned his trade in the days of mule-powered barges along the Erie Canal and taught young Eddie all he knew about steamboating down the Mississippi.

Forsaking the river for the next twenty years to pan for gold in the Sierras, Cap'n Eddie attended two classes at the Nevada School of Barge Piloting and received a renewed license. As a certified barge pilot he was assumed fully trained for the job and thus began his first assign-

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ment—piloting a 35-barge load beneath the bridge over which I had driven.

The Twain Group

In due course, the number of accidents and near misses led to the formation of commissions and numerous reports (you might remember "A Bridge at Risk"), followed by the Secretary of Transportation's vehement denunciation of the educational preparation of barge pilots

In Washington the Administration responded with proposals for increased academic and moral rigor, while cutting the educational budget. Leaks from the White House suggested a Central American drug ring was to blame for decreasing standards. The president checked his horoscope and recalled several anecdotes from his days as a SeaBee (or was that in a movie?).

The major research universities—fearful of losing their role as arbiters of piloting standards and ever vigilant for new funding—reacted to the clamor by forming The Twain Group. Membership in The Group was restricted to those universities renowned for their research efforts; a proposal for revamping barge piloting education, based on their best instincts, soon followed.

The Fifth Year at Nevada Barge

Nevada School of Barge Piloting was the first school of its kind to institute the recommendations of The Twain Group Prospective barge pilots were required to earn an undergraduate degree in Water Resources All Driving courses were relegated to the "fifth year."

The immediate response was impressive Enrollment at Nevada barge surged (from 4 to 6 students) with the new interest and funding—the old Latin saying, bragum, payum, winum, getum (publicity, funding, and a winning football season increases enrollment), was again verified Articles were written, a newsletter published, meetings covering such topics as Minorities in Barge Piloting and Barge-University Cooperation were held at resorts around the country.

At Nevada Barge there was an initial flurry of activity devoted to identifying "master teachers" in Water Resources. These paragons of epistemology would, by their very presence in the classroom, inundate their charges with good barge piloting technique. Soon, however, the initial funding waned and the master teachers opted for promotion and tenure, returning to their studies of sediment flow.

In the fifth year the Driving School faculty, now assured of the subject-matter competence of their charges, fired the Barge Piloting Educator and only taught generic Driving courses. Barge piloting instruction was left to internship programs in cooperation with the local barge company. Much was made of field experiences—cooperating with the local barge company, a section of river with the potential for a variety of piloting experiences was created.

In true democratic fashion each prospective pilot, whether intending to ply a trade on the Mississippi or the Yukon, in a steam-powered antique or a high-tec wonder, experienced over a nine-month period all the possible carefully selected, carefully controlled, carefully supervised piloting episodes available. The man-made river section, known affectionately (with apologies to J. Abner Peddiwell) as the "Real Creek School of Barge Piloting" was the envy of every university in the land.

The barge companies, previously convinced that mere four-year graduates were prepared to immediately begin piloting, were now (in light of their new candidates' degrees in Water Resources and Master's in Barge Piloting) even more ready to turn over their barges on the first day of employment. Pilots, graduating with or near completion of a Master's Degree, were freed from returning to Nevada Barge after experiencing barge piloting—where they might suffer the consequences of reflecting on their profession.

In the meantime initial funding sources dried up and the number of minority barge pilots (who had considerable difficulty affording four years at a major University and were now faced with five) declined. Most pilots were, of course, still prepared by small piloting schools not aligned with The Twain Group. Many others, holding degrees in Water Resources, were certified under the new "strength-in-field" certification guidelines—some never having been on a barge.

I heard that last Thursday one of Nevada Barge's first graduates rammed his ship into a bridge across the Missouri. As they fished the pilot from the wreckage, he was reported to murmur with his dying breath: "Sediment flow, hell, there's a bridge up there!"

The engineering curriculum

I won't malign the engineering curriculum here. You see, in the 70's they underwent their own upheaval over five-year undergraduate programs. And in the process they learned a valuable lesson: Education and training are both critical to the practice of engineering but they are not the same thing.

Proponents of the fifth year believed that just one more group of courses and experiences (and, naturally, higher standards) would produce engineers ready for the challenges of the workplace. Fortunately, cooler heads prevailed. In effect, the decision not to elongate the undergraduate curriculum delineated the responsibilities of the university and the workplace in the development of professional staff.

The undergraduate program

Walk through a university bookstore's engineering department and you are likely to see several mathematics texts. This is not a stocking error and these are not texts for courses taught by mathematicians. Engineering schools learned long ago that, beyond general introductory course, mathematics for engineering is best taught in the context of engineering and by faculty whose expertise and interest is in the engineering.

Look further and you will notice these texts are for courses in mechanical engineering, or chemical engineering, or industrial engineering. Engineering schools seem to have avoided developing courses in general engineering practices, farming their "content courses" out to the physics, chemistry and mathematics departments, and tying these together with perhaps one course in "Mechanical

Engineering Methods" or "Methods of Civil Engineering."

Walk on through the bookstore and you will see titles including "Engineering Economics," "Technical Writing," and "Engineering Statistics." Think of these as the engineering equivalent to courses in pedagogy. Notice, again, that they are context-sensitive.

Now consider the prospective mathematics teacher. Upper level courses in the teaching field are designed and taught by mathematicians—those trained and interested in mathematical research. The result?

> Educational programmes and methods are influenced by a belief which is natural for every mathematician, that mathematical education is education to become a mathematician. [Freudenthal, 1972; p.73]

Teachers understandably come to believe that the curriculum is not under their control—that they serve merely to prepare students for the "real" mathematics of the college world.

Educational theorists (Piagetians, at least) swear by the belief that learning proceeds from the concrete to the abstract, with transfer of learning a difficult task at best. But for their own charges, they seem to prefer general courses in psychology, classroom management, and teaching methodology—from which undergraduates are to transfer abstract concepts and skills relevant to their field.

I can understand some of the reasons behind this. Other than momentum (hasn't it always been this way?) and vested interests, there is a tendency for states that would never consider establishing more than one or two engineering schools to certify thirty or more teacher preparation programs. Admittedly, we tend to need more teachers than engineers (or do we?), but the result is undergraduate programs that train few students in many areas on the basis of what is available, not what is appropriate.

Education is a delicate balance; it must at once be broadly based and specific, walking a delicate line between developing students' reasoning abilities and providing specific skills for employment. In this process, the fields of mathematics education, science education, and so on, have been the neglected stepchildren of the university, pulled apart by school administrators wanting fully-trained beginning teachers, subject matter specialists pushing their own interests, educational psychologists or historians with their own agenda to share, and state certification systems listening to all or none of these.

Perhaps the solution is to rename mathematics education as Quantitative Enlightenment—then the research mathematicians can return to their research and the generic educators can continue their search for generics to educate. Failing this, we might begin to recognize mathematics education (and science and language arts and the others) as legitimate fields of study—each with its own content, pedagogy, history, and research base.

Shulman [1985] stresses the need for the preservice teacher's conception of her subject to be "a central construct (rather than a control variable) in the teaching of mathematics." From this perspective a mathematics teacher's development centers around *mathematics teaching and learning,* which forms the base around which specific learning theory, methodology, and curriculum development can develop into broader perspectives on the role of education and the role of mathematics within education.

Hiring and training

Engineering companies have long known that even the brightest new engineer needs extensive training in the specifics of both the company and the job for which the graduate is hired. Schools intuitively know this is true of beginning teachers, too; they just don't do much about it.

Imagine the look on the chief engineer of General Motor's face if you told him engineering schools would reduce their academic programs to three and one-half years with a 15 week internship in the local manufacturing facility; and that he could then hire the graduates as fully-trained engineers.

Engineers are hired not to build a bridge, but to be a trainee. There is nothing derogatory about this term, everyone goes through such a stage—the difference being that nearly every profession except teaching seems to understand the nature of the learning process of their members (isn't that a kick?).

What would be the educational equivalent of engineering training? Perhaps something like this: During her first semester the new teacher team-teaches three classes with an experienced trainer-teacher, assuming full responsibility for these three classes for the remainder of the year. In her second year she teaches four classes (no more than two lesson plans and no courses not taught the previous year). Routine supervision by the teacher-trainer and the assignment of a cooperating teacher for each plan are included. Finally, in the third year the teacher assumes a full five-class load (with no more than one new plan) and, while continuing to receive training, is evaluated for tenure.

Obviously, a full-fledged training program would be much more elaborate than this brief outline suggests. Planned seminars in handling assorted paperwork and maintaining student records are needed, along with workshops in disciplinary procedures and standardized testing but these are job-specific skills, not the stuff of which masters' degrees are made; although many current fifth-year programs tend to offer credit or degrees for what is essentially on-the-job training.

Is every school capable of such a system? No; but many schools are, and the possibility of establishing a training school in each school district emulates the corporate idea of a training plant—one that trains engineers in techniques and procedures used throughout the division or company.

Training and education

My essential points are these: First, teacher *training* is inherently job-specific. Teaching Algebra I in a suburban high school in a university town is not preparation for teaching eighth-grade general mathematics in an urban setting. Student teaching and its fifth-year internship equivalents are artificial substitutes for on-site instruction.

Schools have abrogated their roles in developing their professional staff in a manner no other profession or industry could conceive; universities have leaped into this vacuum with an array of "Real Creek" programs that are likely to have little effect.

Second, the role of the university has become a fragmented medley of special interests. Preservice teachers learn a combination of abstruse subject matter and generic educational terminology, practicing their skills in artificial settings. Teacher education must focus around the subject matter, but the subject matter of the secondary teacher is not the subject matter of the university specialist.

The areas of teaching deserve their stature as much as the areas of engineering. They serve as the focus around which a curriculum is built rather than a name for a piecemeal program.

It almost sounds as if I am calling for a return of the Normal School. If these schools could take on the stature of major engineering schools, then the idea has merit (imagine the Massachusetts Institute of Teaching, Georgia Teach, Rensselaer Polyteaching Institute, and CalTeach). Teaching has too long been the bastard child of the mathematician (and chemist and historian) and the child psychologist, god-parented by administrators following a nineteenth century industrial model. Give teachers their due, and their profession.

References

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Profound differences in theory are never gratuitous or invented. They grow out of conflicting elements in a genuine problem – a problem which is genuine just because the elements taken as they stand are conflicting. Any significant problem involves conditions that for the moment contradict each other. Solution comes only by getting away from the meaning of terms that is already fixed upon and coming to see the conditions from another point of view, and hence in a fresh light. But this reconstruction means travail of thought. Easier than thinking with surrender of already formed ideas and detachment from facts already learned is just to stick by what is already said, looking about for something with which to buttress it against attack. [.] The easy thing is to seize upon something in the nature of the child, or upon something in the developed consciousness of the adult, and insist upon *that* as the key to the whole problem. When this happens a really serious practical problem – that of interaction – is transformed into an unreal, and hence insoluble, theoretic problem. Instead of seeing the educative steadily and as a whole, we see conflicting terms. We get the case of the child vs. the curriculum, of the individual nature vs. social culture. Below all other divisions in pedagogic opinion lies this opposition.

John Dewey
