How to Prepare Effective Teachers, Especially for STEM / STEAM Disciplines

"By almost any standard, many if not most of the nation's 1,450 schools, colleges, and departments of education are doing a mediocre job of preparing teachers for the realities of the 21st century classroom. America's university-based teacher preparation programs need revolutionary change—not evolutionary tinkering." So said Arne Duncan, U.S. Department of Education Secretary, on October 22, 2009 at Columbia Teacher's College ***(http://www.ed.gov/news/speeches/2009/10/10222009.html)***.

Frances Fuller, in the late 1960s, discovered that no student teachers, while teaching entire classes on a practicum, were able to identify and respond appropriately to individual learners so as to maximize learning for each learner. She discovered this while investigating the sequential concerns of student teachers as well as for beginning in-service teachers:

- At Stage 1, there is a Concern for **Self** – "Do I know my subject well enough so I can teach it? Can I control my class so I can teach?"

- At Stage 2, there is a Concern for **Them** – whether this is a small group or the entire class.

- At Stage 3, the Concern is for **Individuals** – "What must be done differently so each student learns?"

Fuller found that student teachers (and most year one teachers) got stuck on "Them." In contrast, I discovered that my pre-service teachers, who earned course credit for being effective mentors while carrying out a Mentor-Assisted Enrichment Project (MAEP) with small groups of interested student-proteges, reached Stage 3 by the third meeting.

These mentors skipped Stage 1 Concern for Self because each MAEP involved sharing an existing expertise with a small group of interested proteges. So, mentors started with a Stage 2 Concern for Them (their small group), but quickly ensured Individuals were learning and using higher-level thinking skills (based on Bloom's famous Taxonomy) while carrying out their project.

Most MAEPs focused on Science, Technology, Engineering, Mathematics (STEM). Such as: building a robot, designing a model for a light rapid transportation system, growing cells in the biochemical lab, developing software for a computer game, building a wind tunnel to explore the aerodynamics of airplane wings, doing rat learning studies in the psychology lab, discovering how different arches throughout the history of architecture enabled construction of different kinds of buildings, comparing horses throughout history and their impact (e.g., race vs. farm vs. hauling horses).

I trained mentors to employ ***Situational Mentoring*™** where they used **four Mentoring Styles** to provide assistance proteges would accept and utilize. To facilitate this, I developed a *Mentoring Style Indicator* that identifies the types of assistance a mentor prefers to provide and a protege prefers to receive. Mentors used the Mentoring Styles to equip proteges with what they knew and empower what proteges wanted to do. (You can preview my eBook on ***Situational Mentoring*** at http://www.smashwords.com/books/view/125079 .)

Situational Mentoring involved using both didactic instruction and open inquiry to ensure individuals connect "learning about" STEM concepts with "learning how" they are applied in real world situations. To facilitate this connection even more, mentors involved STEM professionals (who were too busy to be mentors). This created a **STEM Pipeline** of Motivated Youth, who wanted to become STEM majors in college, who wanted to become STEM professionals as an occupation.

For example, Arthur Erikson, Canada's foremost architect, gave proteges extra time because they had so thoroughly prepared interview questions based on visits to and photos of his major works: "What problems did you have to solve when you decided to let large trees grow through the roof of the underground library at the University of British Columbia? What challenges did you have to resolve when you designed Simon Fraser University as a single structure on top of Burnaby Mountain?") No wonder, these proteges decided they wanted to become architects.

In contrast, two female proteges thought they wanted to become fashion models and chose to do a MAEP that focused on what modeling agencies do, until they realized how "sex" was being used to sell products, then their project changed to critiquing the advertising industry.

This involvement of youth, undergrads and professionals is important because it enables young proteges to learn about "best-fit" careers and reject unsuitable ones. Proteges also overcome their fear of science and math, and gain exposure to the possibilities and realities of STEM careers they might pursue.

My wife (Marilynne) and I did R&D over 16 semesters, on some 300 MAEPs involving some 1,000 proteges, and discovered how to provide appropriate incentives, structures and training so effective mentoring occurs for different kinds of proteges (gifted/talented/creative; ESL; at-risk; Native) in different grades (4-12).

Two examples: (1) Proteges in grades 4-7 eagerly showed up to give a final presentation of what they had done and learned, whereas proteges in middle school were too self-conscious to present to their classmates, so we had to develop a less ego-centric method so classmates could also benefit from what was done and learned. (2) Teachers of G/T/C students wanted them to develop and use higher-level thinking skills, whereas ESL teachers wanted their students to develop and use English language more competently.

Mentors earned course credit for helping their proteges carry out, complete and present each MAEP over a 10-week period (semester). Earning course is the best "quality control" over mentoring I know, because requirements will be fulfilled to earn full credit. Comparable "quality control" is not possible when teachers, professionals, retirees, or even paid mentors spend a semester mentoring small groups of proteges.

My undergrads, who served as mentors, reported that they learned more about working effectively with individual learners while carrying out a MAEP than they had learned through coursework or student teaching during a 4-year Elementary or a 5-year Secondary B.Ed. Program. Future elementary teachers (who tend to be student-oriented) became more subject-oriented. Future secondary teachers (who tend to be subject-oriented) became more student-oriented. This and many other benefits motivated my 300 undergrads to stay in university during the semester they carried out a MAEP.

When the Student Teaching Office learned what we had discovered, we were asked to replace the initial practicum for future secondary teachers with our MAEP concept. For several years the dropout rate had increased, until it reached 40%, because these beginning student teachers observed the regular teacher for several hours and were then introduced as "student teachers" to teach the entire class or smaller groups. They lacked expertise in classroom management and instructional methods, were just starting their academic major, and typically with no prior experience speaking in front of any group. It's a tribute to these idealistic student teachers that more did not drop out.

My wife and I did more R&D on this new application of MAEPs and found the same thing: all beginning student teachers reached the Stage 3 Concern for Individuals by the third meeting. Perhaps even more importantly, when these student teachers taught entire classes on their next practicum, we found that 50% to 70% reached Stage 3 (depending on the particular semester we investigated).

Over 16 semesters of doing R&D, we discovered that neither simplistic "Announcements" encouraging mentors to "do your own thing" nor partially planned "Initiatives" will produce intended outcomes, because essential components have not been defined, designed and delivered. Only a thoughtfully planned "Program" does this. This includes training everyone to fulfill essential roles and responsibilities so everyone benefits: faculty who supply mentors, undergrads who receive course credit for effective mentoring, young proteges who are prepared for each meeting, their teachers and parents, participating schools and universities.

In sum, Mentor-Assisted Enrichment Projects – as a course assignment or as the initial practicum – enable future teachers to learn how to work effectively with groups and with individuals – to become effective teachers, who can maximize learning for everyone.