Using Modeling Software for Environmental Engineering Technology

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ABSTRACT

An environmental modeling course allows students to develop software utilization capability through three stages. In the primary phase students become accustomed to the capabilities of spreadsheet and statistical packages. In the intermediate phase students create personal models using mathematical and analytical programs. Finally, students are exposed to industry modeling packages. Each phase is dedicated toward utilizing the models to depict instantaneous conditions and as indicators of future environmental impact.

TEXT

Comprehension of environmental modeling is a reasonable expectation stemming from a university education in engineering or technology. And though neither employers nor graduate schools anticipate specific software expertise, confidence toward skillful utilization of company-wide programs, whatever the source, whatever the operating system, will enhance a graduate's prospects. Therefore, the task facing educators, usually within the context of one semester, encompasses three phases. These are; first: the ability to foster maximum impact from the most ubiquitous software; second: the ability to derive and program models based upon mathematical tenet. In environmental technology phase two includes laboratory exercises to compare models with reality. The third phase requires students become acquainted with industrial and agency modeling programs.

In order to foster the most beneficial learning environment an instructor must budget time allocated to each phase based upon overall program expectation; engineering grounded in theory; technology grounded in theory and practice. Also, the nature of computer utilization eschews individualism in favor of the collective. The instructor need construct an environment that separates group effort from individual effort lest one student solve all problems and simply pass mechanics on to his/her peers. But group effort is necessary, particularly in the beginning of each phase. Damon and Phelps determined problem solving is enhanced when carried out in a social setting[1], and Roschelle determined collaboration participants converge toward the common solution[2]. The key becomes timely divergence from the one or two accelerated individuals toward the capability of each to personally understand and use the tools.

For modeling under the auspices of environmental engineering technology the class occurs in the senior year (concurrently for first year graduate students). Phase one consists of extensive use of data based spreadsheet programs. Students are provided data regarding an environmental issue (e.g. atmospheric carbon dioxide concentrations at several reporting stations or comparative storm water flowrates at one location) and challenged to develop plausible regressional analyses and effective graphic presentations.

With one data set students are encouraged to freely exchange information; none are admonished for remitting duplicate solutions. Subsequently, the data are complex and individualized. Classroom demonstrations explore the limits of the program and assignment #3 (end of week #2) necessitates professional quality.

Use of the course text (presently, Surface Water-Quality Modeling, Steven C. Chapra (1997)) heralds the onset of phase two. A universal environmental focus (e.g., gas dynamics and atmospheric chemistry) could occur. However, students are comfortable regarding water modeling since simplistic outcomes are observable and surface water is neither ephemeral nor buried. The course progresses through one-dimensional modeling utilizing software that requires students to develop mathematical solutions prior to developing an accompanying model. At this juncture students are encouraged to collaborate thus promoting cognitive growth [3]. The Chapra text promotes this phase via presentation of several modeling techniques, many applicable, however arduously, to the same problems. Additionally, in technology the one-dimensional Bernoulli solution can be modeled and subsequently compared with visual and quantitative laboratory data. Every student, whether part of the collective or flying solo, that succeeds in comparatively approaching wet reality with a mathematical model has overcome the greatest hurdle. Subsequent Chapra chapters allow complexities and multiple variable approaches to be included. The inclusion of additional variables complicates derivations but guides the overall education toward reality. Once the students succeed in developing the models despite a dearth of data, therefore, requiring a wealth of assumption, the technical educational process nears apogee. This phase lasts ten weeks. By the end the students have been given assignments with individualized data sets which encourage individualized solutions. Through the ten-week period six assignments occur, the last a compilation of data from a journal. Additionally, students are required to present their final problem solution for peer review.

During phase three students are allowed to experience professional software. Problems are constructed to test the credibility of the programs and the gullibility of the students. Commercial programs and most downloads (DOE/EPA) are available with minimum documentation. Users input prescribed variables and accept outcomes without the capability to include contingency influences. Operating these programs comprises a skill, at best, though an intrepid student will compare the commercial solution with a personally derived solution. The class is grouped in two’s or three’s for solution and presentation of a contemporary dilemma (e.g., flooding in a Mississippi River tributary or non-point source impact due to excessive fertilization prior to a historic rainfall).

Finally, the course is paperless. All submissions occur via diskette or as an email attachment. There are no examinations; only results.

References:

1. Roschelle, J. (1992). Learning by collaborating: Convergent conceptual change. *Journal of Learning Sciences*, 2, 236-276.

2. Damon, W., & Phelps, E. (1989), Critical distinctions among three methods of peer education. *International Journal of Education Research*, 13, 9-19.

3. Shunk, D.H. (1987), Peer models and children's behavioral change. *Review of Educational Research*, 57, 149-174.

Course Text: Chapra, Steven C. Surface Water-Quality Modeling, McGraw-Hill, 1997, ISBN 0-07-011364-5

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