TEACHING STATEMENT
ANDREW J. GUSWA

I. DECLARATION OF EDUCATIONAL PHILOSOPHY

As a civil and environmental engineer, I view my teaching as an opportunity to pass on my enthusiasm for and knowledge of the built and natural environment and to guide my students to acquire the skills necessary to evaluate, assimilate, apply, and communicate new concepts and information. While each class is unique, with its own strengths, needs, and personality, I have a few tenets that underlie all my teaching in order to achieve these goals. I focus on having each student develop a strong intuition for the fundamental concepts of the course, so the students will have a deep understanding of the primary principles in addition to the ability to apply specific methodologies. I relate new material to problems, applications, and experiences outside of the classroom to establish its relevance and help students recall their learning long after they have taken my courses. I structure my coursework to instill a sense of self-reliance in each student, so each will have the confidence to work independently and learn continuously throughout her career. I am open and honest with my students to promote trust and effective communication so the students see me as an ally in the learning process and are willing to provide me with critical feedback to improve my teaching.

II. EDUCATION STRATEGIES

DEVELOPING A CONCEPTUAL INTUITION

In the engineering disciplines, one can often become mired in the complicated methods employed to solve or analyze problems. My goal is to enable my students to develop a conceptual intuition, so that these methodologies are seen as sophisticated ways of accomplishing common sense or intuitive tasks. To do this, I combine precise mathematical representations of concepts, qualitative intuition built on common experiences, varying degrees of complexity, and physical demonstrations.

I teach my students to interpret new equations not as black-box formulas into which one plugs data and from which the answer appears. Rather I strive to present math as a language, as a formal way to describe and quantify relationships. Comparing a relationship indicated by an equation with common sense helps one internalize the information. For example, the equation for the horizontal tension in a cable of a uniformly loaded suspension bridge is

$$H = \frac{ql^2}{8d} = \frac{1}{8} \cdot ql \cdot \frac{l}{d}$$

where q is the load per unit length, l is the length of the span, and d is the depth of the cable sag. By using the right-most expression, students quickly see that the tension increases with the size of the total load (ql) and the shape of the cable (l/d). Deeper sag in the cable leads to lower horizontal tension for the same loading and span.

I also encourage an intuitive understanding by starting with a conceptual reasoning. By talking through the qualitative character of a physical system, equations often seem familiar when finally presented. On the first day of EGR 271, I talk with my students about prototypical fluid flows. Even at that early stage, students are able to articulate that flow in a pipe will depend on fluid properties, pipe geometry, and changes in elevation and fluid pressure. During

the semester, we build on these initial insights as we more formally describe the mechanics of fluids.

A third way of achieving this conceptual intuition is to start with a simple system and work to the more complex. For example, when discussing how to estimate average rainfall over an area, I start by asking the students where in a field they would install a single rain gauge if they wanted the best estimate; then, what if they had four? By having the students articulate the principle underlying their responses, I can directly introduce the complexities of spatial averaging and the formalism of methods such as Thiessen polygons. By starting with a concept that is already intuitive, I can build on it and introduce more complex pieces, while staying focused on the fundamental premise.

Physical demonstrations provide another mechanism to impart an intuition regarding new concepts. In EGR 101, I have the students hang various combinations of weights on a chain to show that the shape of a suspension cable under a uniform load is parabolic. Their play with the physical artifact helps them understand the concept. The notion of steady flow is one that is challenging at first in EGR 271; however, by using the faucet in the classroom, I am able to demonstrate steady versus unsteady flows in a simple way so that the concept becomes intuitive.

This goal of developing a conceptual intuition guides all aspects of my teaching, not just my work with students in the classroom and during office hours. When designing a course syllabus, I develop an intuitive procession of topics. On exams, tests, and homework assignments I incorporate quantitative problems, as well as questions requiring short answers that focus on concepts and relationships. With these strategies, students emerge from my courses not with a laundry list of techniques and equations, but with a deep understanding of the fundamental principles and an intuition about how to make use of them.

CONNECTIONS BEYOND THE CLASSROOM

I make connections between the material in my courses and everyday life, content in other classes, and professional practice. Making these connections provides motivation and improves retention of the material. Because I have a different set of objectives for each class, the connections on which I focus vary from course to course.

EGR 100 is the first course for students who are considering engineering as a major. Consequently, the material is related to personal and professional values, perceptions, and aspirations. Prof. Borjana Mikic introduced the idea of book-ending the course by two essays that address the questions of “What is engineering?” and “How does engineering fit in with my plans for the future?” In 2003, Prof. Judith Cardell and I expanded this concept by having the students reflect regularly on new material and write about how the new thoughts and ideas affected their view of engineering. Having students reflect in this way extends the learning beyond the classroom and connects the material with their personal experiences.

EGR 270, 271, and 272 form a coherent mechanics sequence that is required of all engineering majors. Consequently, Professors Mikic, Ellis and I work to connect fundamental concepts across these courses. Prof. Ellis includes example problems in 270 that we revisit in 271, and I regularly tie the concepts in 271 back to those from 270 and across to those being learned in EGR 272. In addition, the students in EGR 271 measure discharge on the Mill River, which cuts through the Smith campus. Wading in this waterway that they see everyday and responding to questions from passers-by makes this a memorable experience for my students. Applying their new-found knowledge to their immediate environment helps them internalize and retain the concepts.

EGR 315, Ecohydrology, is an upper-level elective that is aligned with my scholarly interests. As such, I relate the course material to some of my current research questions. For

example, when the students learn about averaging precipitation in space, I relate this to questions from my project in Costa Rica. When learning about mathematical representations of evapotranspiration, we investigate the utility of a range of models that I use in my ecohydrology work. Through these connections, the students better understand the motivation for and applicability of what they are learning.

Structures and the Built Environment, adapted from David Billington's "Structures and the Urban Environment" at Princeton University, is a course that integrates the humanities, social sciences, and natural sciences within the context of engineering. Given the broad audience, I tie the material to real-world examples in a variety of ways that connect to common experiences. I frequently present current newspaper articles at the start of class that deal with structures. I invite a number of speakers to discuss their work in class; individuals include representatives from architecture, construction, engineering, and academia. The homework assignments are created as case studies that include the Washington Monument, the George Washington Bridge, and the Hancock Tower in Chicago. Additionally, I will bring an exhibit entitled "The Art of Structural Design: A Swiss Legacy" to the Smith College Museum of Art in the fall of 2006. Through these efforts, students gain a broader perspective on what they were learning in the class. As one student put it, "This was by far my favorite class! I genuinely looked forward to it each and every time. I feel like I've learned a lot from this course – I look at structures in a different way as a result of this class!"

PROMOTING SELF-RELIANCE

Beyond the classroom, engineers take on higher levels of independence, greater uncertainty, and increased stakes. The confidence and ability to check one's work, to appropriately simplify a problem, to use sound engineering judgment, and to ably communicate one's thoughts are essential for an engineer. By emphasizing these skills in my teaching, I promote independent thinking and self-reliance.

My office hours have provided one opportunity to work toward this goal. When students are unsure of a procedure or result, I guide them to find ways to validate each step of the process. I encourage them to ask questions such as, "Are the units correct?", "Is the result the right order of magnitude?", "Does it have the right sign?", "Does my answer fit with my conceptual understanding?", and "Are there other ways of solving the same problem?" Working with the students to develop these techniques helps them build the confidence to work independently.

When designing assignments, I have additional ways to incorporate this emphasis on self-reliance. In EGR 101, I require the students to write a term paper that constitutes a substantial portion of their grade. Because many of the students are at the beginning of their academic careers, I provide structure around this project, including requiring an annotated bibliography and a first draft of their paper. I also require the students to present their findings to the class and to write a critique of a classmate's paper. These efforts help to strengthen their oral and written communication skills. The opportunity to take responsibility for reapplying the concepts and ideas presented in class gives the students a sense of independence. In EGR 271, weekly problem sets create challenging opportunities for the students to build on concepts learned in class. On exams, I ask questions that are similar to those on problem sets, which emphasizes the importance of reflecting on and reviewing previous work.

To provide insight into how to simplify a problem and the tradeoffs associated with doing so, I ask students to work through a problem with different levels of solution sophistication. In many of the assignments for Ecohydrology, I leave it up to the students to decide on the particular methodology to use and to communicate and support their decision. While students

are sometimes frustrated by the lack of guidance as to the "right" way to proceed, these strategies help my students develop confidence and independence.

In each class, I spend time discussing approaches and strategies for learning. By doing so, I emphasize learning as a skill that can be improved. For example, beyond the curricular content in EGR 271, the students struggle with multi-stage problem solving. I have worked with Prof. Al Rudnitsky in the Education Department to develop meta-cognitive exercises to help my students improve in this regard. As another example, I ask each student in EGR 271 to reflect on her performance on each midterm exam and to write down one sentence of advice to herself for the next exam; I then share and discuss all of these statements with the class. These discussions and activities foster responsibility and independence and provide the students with the tools to improve and continue their learning beyond the classroom.

ESTABLISHING TRUST AND COMMUNICATION

I recognize how influential the classroom environment and the professor's teaching style can be on one's ability and motivation to learn. As a teacher, I commit to respect the priorities of my students and to continually improve my teaching, using the quality of my students' learning as the measuring stick. I aim to establish myself as an ally in the students' learning process. Specifically, I seek, review, and address comments from my students about their learning, and I commit to make my expectations clear and to respect the demands on my students' lives. For example, in addition to informal discussions with students, I conduct mid-semester reviews to obtain feedback on what activities and approaches are working and which are less effective. In my syllabi, I explicitly state the learning objectives, means of assessment, and rules of conduct for each course. I make clear that each student is responsible for her learning, and that my value of each of them as a person is not dependent on their success in my class. I take time to explain not only what I expect of each student, but also why and how it facilitates her learning. In these ways, I build an open and honest, two-way interaction with my students, founded on mutual respect.

III. ASSESSMENT AND IMPROVEMENT OF TEACHING EFFECTIVENESS

I have a strong commitment to teaching, and I continually work to evaluate and improve my methods and approaches. I gather formal and informal feedback from my classes; I solicit advice and guidance from my peers; I regularly participate in teaching workshops and seminars; and I use my teaching portfolio and reflective post-mortems to guide my development as an instructor.

STUDENT FEEDBACK

Feedback from my students is my primary tool for assessment of my teaching, and I rely on their performance on exams, formal evaluations, and the insights I gain from informal discussions with them. In the classes I teach, I take time to establish a rapport with the students and to ask them about their learning. This close contact with the students allows me to inquire about what are and are not effective ways of presenting material. My efforts to improve my teaching are guided largely by my personal reflections on these conversations and student performance.

PEER FEEDBACK

In addition to feedback from my students, I also solicit advice from my colleagues. Early in the development of the Picker Engineering Program, we established an effective process of curricular review. By presenting my courses and hearing the presentations of my colleagues, I obtained insight to alternative pedagogical approaches that have enhanced and improved my classes. In addition, I have worked with Prof. Glenn Ellis and Prof. Al Rudnitsky to establish effective strategies for teaching problem-solving and instilling metacognitive reflection in our students. These discussions are complemented by classroom visits and feedback from senior colleagues as part of the regular review process.

WORKSHOPS AND SEMINARS

I also seek out teaching workshops and seminars as another way to improve my effectiveness as an instructor. These include the regular seminars at Smith, such as the Teaching Arts lunches, as well as opportunities outside of my college. In July of 2002, I was selected to participate in the New Century Scholars program sponsored by the National Science Foundation. This week-long workshop was designed to help new engineering faculty from around the country understand learning and teaching practices which support effective learning for all students. Workshop activities also addressed the integration of pedagogical knowledge with other forms of scholarship, recognizing the multiple demands for faculty productivity. In May of 2003, I participated in a two-day symposium at Princeton University, titled "Teaching and Scholarship in the Grand Tradition of Modern Engineering." The symposium was in honor of Prof. David Billington and his role in pioneering the integration of the liberal arts with the technical aspects engineering, and the presentations and discussions centered on that topic. This symposium sparked an annual workshop sponsored by the National Science Foundation, and I presented papers in 2004 and 2005:

Guswa, Andrew J., 2005. Implementation of "Structures and the Urban Environment" at Smith College: Doing Design, *Proceedings of the Summer Symposium on Teaching and Scholarship in the Grand Tradition of Modern Engineering*, Princeton University, NJ, August 7-10, 2005.

Guswa, Andrew J., 2004. Implementation of "Structures and the Urban Environment" at Smith College: Development of a Digital Image Database, *Proceedings of the Summer Symposium on Teaching and Scholarship in the Grand Tradition of Modern Engineering*, Princeton, NJ, August 8-13, 2004.

These workshops have provided an opportunity for me to discuss pedagogy and teaching with engineering faculty from around the country and from a range of institutions.

SELF ASSESSMENT

To effectively integrate the lessons gleaned from the above sources, I incorporate regular reflection into my efforts to improve as a teacher. At the end of a semester, I take time to gather all materials (exams, notes, student comments, etc.) related to each course that I taught. I go through these materials and determine what worked well and what needs to be improved. These reflective post-mortems provide me with guidance on how to modify my courses for subsequent years, and I find this process to be very effective.

IV. TEACHING EXPERIENCE

I have had a variety of teaching experiences throughout my career. I have taught undergraduates and graduate students, courses for majors and those designed for broader audiences, in lecture, laboratory, and discussion group settings. Below is a summary of my teaching experience. Detailed objectives, outcomes, and reflections on my teaching can be found in supplementary material. Table 1 presents a summary of the courses I have taught while at Smith College.

Table 1: Summary of courses taught by Andrew J. Guswa at Smith College

Academic Year	Fall Semester	Spring Semester
2001-2002	EGR 101	EGR 271 lecture, EGR 271 lab
2002-2003	EGR 100, EGR 101, EGR 315	EGR 271 lecture, EGR 271 lab
2003-2004	EGR 100	EGR 271 lecture, Picker fellowship
2004-2005	EGR 100, EGR 315	EGR 271 lecture, EGR 271 lab
2005-2006	EGR 101, Kahn Project	Sabbatical Leave

SMITH COLLEGE

EGR 100 – DESIGNING THE FUTURE: INTRODUCTION TO ENGINEERING

This course presents an introduction to engineering practice through participation in a semester-long team-based design project. Students will develop a sound understanding of the engineering design process, including problem definition, background research, identification of design criteria, development of metrics and methods for evaluating alternative designs, prototype development, and proof-of-concept testing. Working in teams, students present their ideas frequently through oral and written reports. Reading assignments, in-class discussions, and written reflections challenge students to critically analyze contemporary issues related to the interaction of technology and society.

EGR 101 – STRUCTURES AND THE BUILT ENVIRONMENT

This course examines the development of large structures (towers, bridges, and domes) throughout history with emphasis on the past 200 years. Following the evolution of ideas and materials, it introduces students to the interpretation of significant works from the scientific, social, and symbolic perspectives. Examples include the Brooklyn Bridge, the Eiffel Tower, and the Big Dig.

EGR 271 – CONTINUUM MECHANICS II

This is the second course in a two-semester sequence designed to introduce students to fundamental theoretical principles and analysis of mechanics of continuous media, including solids and fluids. Concepts and topics to be covered in this course include intensive and extensive thermophysical properties of fluids, control-volume and differential expressions for conservation of mass, momentum, and energy, dimensional analysis, and external, internal, and open-channel flows.

EGR 315 – ECOHYDROLOGY

This upper-level course focuses on the study of hydrology and its interplay with ecosystems. Material includes the conceptual understanding of hydrologic processes and their statistical and mathematical representation. Topics for the latter portion of the semester are driven by student

interest and include nutrient transport, biogeochemical cycles, cloud-forest hydrology, and evaluation of evapotranspiration models.

EGR 346 – HYDROSYSTEMS ENGINEERING
Through systems analysis and design projects, this course introduces students to the field of water resources engineering. Topics include data collection and analysis, decision-making under uncertainty, the hydrologic cycle, hydropower, irrigation, flood control, water supply, engineering economics, and water law.

PRINCETON UNIVERSITY
ENV 201 – FUNDAMENTALS OF ENVIRONMENTAL SCIENCE, FALL 2000
ENV 201 and 202 together examine the causes and consequences of global or regional environmental perturbations, and analyze strategies for mitigating these perturbations and managing global resources. ENV 201 concentrates on some of the anthropogenic causes of environmental perturbations. Topics covered include population, land-use, water, and energy.
My role as instructor: With another post-doctoral researcher, I developed a laboratory component for this class. I also led two discussion sections each week, integrating scientific concepts with issues related to policy and decision-making.

STANFORD UNIVERSITY
CEE 162 - HYDROLOGY AND WATER RESOURCES, WINTER 1999
This is a senior-level course that focuses on the concepts and methodologies in hydrology and water resources. Topics include precipitation, infiltration, evaporation, runoff, watershed delineation, unit hydrographs, channel and reservoir routing, reservoir yield analysis, hydroelectric power generation, urban water systems, flooding, and analysis of hydroclimatological data.
My role as instructor: During my Ph.D. advisor's sabbatical, I was responsible for all elements of this course. I designed the syllabus, lectured three times per week, prepared and graded all assignments and exams, and held office hours. Because I handled all aspects of the course, I was able to get a good sense of the students learning, which helped me to pace the course appropriately and to spend more time on those areas with which the students were having difficulty.

CEE 169 - ENVIRONMENTAL AND WATER STUDIES: DESIGN, SPRING 1997 AND 1998
A senior-level class centered around a quarter-long design project, introducing the students to elements of design and extending their quantitative skills in environmental and water resources engineering.
My role as TA: I worked closely with the professor to develop the course structure, discussing issues such as how best to give feedback to the students, how to arrange the students into teams, what to include in the scope of the design project, and how to balance active teaching with letting the students learn on their own. My office hours were spent primarily advising students on how to approach problems, rather than imparting specific knowledge. Topics included how to simplify complex problems, where to look for information, how to identify and prioritize tasks, and how to distribute the workload among team members. I also provided extensive feedback on their written and oral assignments, and I performed general administrative tasks as needed.

CEE 162 – HYDROLOGY AND WATER RESOURCES, WINTER 2000
An undergraduate course focused on the movement of water through the natural environment and the management of water as a resource (see description above)
My role as TA: I assisted students in class and during office hours, helped prepare and evaluate homework assignments, and worked with Professor Freyberg to grade the midterm and final exams.

CEE 268 – MATHEMATICAL METHODS IN GROUNDWATER MECHANICS, WINTER 1997
A graduate course focused on analytical solution methods for groundwater flow
My role as a TA: For this class I was responsible for preparing and presenting a one-hour class each week, during which I reviewed and extended the homework and lecture material. I also held regular office hours and graded and commented the students' problem sets.

CEE 106 – INTRODUCTION TO WATER RESOURCES, WINTER 1996
A sophomore-level class introducing students to hydrology and water resources (note: this course has since become CEE 162, Hydrology and Water Resources)
My role as a TA: I held office hours to help elucidate concepts presented in class and assist with homework problems, prepared the solutions for the homework sets, and performed general administrative tasks. I also had the opportunity to give two lectures in the professor's absence.