MASE 6390-14685–Fall 2014
"Foundations in Engineering Education"

Course Syllabus

Welcome to our class! Engineering education prepares students to change the world. The emphasis has traditionally been on hands-on experiences; what today we sometimes call *experiential learning*. Traditionally it is the activity of becoming learned in engineering principles and practices, ultimately related to the fields of professional practice of engineering. So how does the education of engineers proceed in the 21st century, as we participate in a learning revolution? Engineering education is an on an old branch of learning. It is not a new endeavor. It is as old as Engineering. How we transpose practice and advance learning of new generations of engineers is key to the success of our US' and global future' society. In this doctoral-level class we begin a fascinating adventure of studying an age-old profession and how we learn it and teach about it in the modern era.

Course Description This course is designed to introduce doctoral students to fundamental issues, questions and approaches to education of engineers and engineering education practices. It includes delving into past efforts to advance engineering education and current initiatives and endeavors. You will be exposed to a range of literature pertaining to engineering education research, development and practice. Engineering education is a multi/interdisciplinary field and scholars in this field draw on work in diverse academic traditions. Therefore, in addition to the primary journal of the field, *Journal of Engineering Education*, we will be reading and reviewing articles from several different fields such as learning sciences, organizational studies, communication, science and technology studies, psychology, anthropology, management, and sociology. We will cover a range of topics including learning theories, collaboration, designing learning environments, institutional issues in education, the use of technology in learning, identity, and current topical issues in engineering education.
This course is designed with the following graduate students in mind:

- Engineering education doctoral graduate students
- Engineering students who want to teach/academia
- Doctoral students in non-engineering departments who want to learn about engineering education
- Graduate students who are or will be writing grants that require a significant educational component, and those who will do so as post-doctoral students.

The course is modeled after the Virginia Tech engineering education doctoral fundamentals course, the first such course to be taught in the US. The pedagogical aim of the course is to contribute to your development as a scholar and to get you to start thinking critically about engineering, education, and learning. For instance, although we will discuss engineering curriculum design, we will also focus on how to go beyond that and think in terms of designing a learning environment of which curriculum is just one component. We hope you will be able to use the knowledge from this course in your future teaching and research – as a student and as a professional

Our Course Objectives The overarching goal of the course is for you to come to know and understand the fundamentals of the discipline and field of engineering education. Through so doing you will be able to: articulate, contemplate, converse, explore, discuss and share communications in the field of engineering education.
The specific course objectives are to: (A) Develop as scholars of learning, and specifically of the pedagogies of engineering learning; (B) Advance our understanding of the field of engineering education research so we can (C) Use the knowledge in our teaching and research as graduate students, education professionals, professional engineers, managers and in education leadership, now and in the future.

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Our Course Outcomes Through completing the course we will become: (A) Able to help advance the public interest in engineering education, and practice the liberal arts of rhetoric and elocution, key to educating others who are new to the concepts and practice of engineering education (on the "teaching side" of the engineering profession), (B) Share our knowledge and understanding so as to help others to learn about the art, business and science of engineering educational processes and pedagogies. Finally, (C) We will have experienced an opportunity to actually learn in cooperation with one another, with helpful classroom practices, and investigative critiques from engaged engineering education faculty and practitioners.

As A Result Together we will: (1) **reflect** upon the experiences we bring to the table from our own education experiences, including our engineering educational history, with our diverse backgrounds, and to share lessons learned in making the transition, (2) **introduce** a number of creative and effective experiential approaches, from a variety of sources, for enhancing engineering education learning, (3) **apply** a simple but powerful framework for organizing and achieving deep learning in engineering, (4) **demonstrate** effective teaching approaches so that you can become the teacher and instigator of your own efforts to help others and the community we live in and are part of! (5) **share** ideas on key current topics in engineering education, such as creative mentoring programs, what's happening in entrepreneurship education, strategic planning, research programs, K-12 and 12-14 engineering, diversity issues, internships and much more! And (6) **expose** our minds to a rich resource base helping us all to join in a network of engineers who regularly share ideas, insights and experiences on engineering education approaches, methods and the results of using them, the failures and successes!

Enrollment MASE Program Secretary: Beatriz Tarango at MME *Office location*: ENG M 201, Bea's phone: (915) 747-8002. *Office hours*: UTEP regular office hours.

Class Time and Location 3.00 pm to 5.50 pm C203 (Classroom Building)

Instructor Peter/"Pedro" Golding, Metallurgical & Materials Engineering.
Contact info: pgolding@utep.edu, Office phone direct: (915) 747-8125, or via CREaTE Program Manager: Joe Ramos, josepra@utep.edu, Office phone direct: (915) 747-7999.

Working Assumptions for the Course We want to share this time and place in our formal learning lives, have fun doing it together, learning from one another to advance mastery. Following Dave Ellis ("Becoming a Master Student," Cengage, 2014): "Mastery cannot be captured with words. It defies analysis. Mastery cannot be taught, only learned and experienced." We will act purposefully to grow our master student traits, in the light of our own experience, and expand on the opportunity to advance our own in light of our understanding.

Assignments Since this is a graduate class, we expect significant participation from all involved. You will be expected to read all assigned materials and come prepared to discuss in class and raise questions. Class participation is mandatory.

Grades Students will be graded based on these main activities:
Research of Readings, Joint Discussion and Class Participation *(30%):*
Students will be asked to lead the discussion at least twice during the semester. This entails providing the class with a short overview of the readings (typically, 30-45 min) and leading a discussion of the readings. Students will be graded on their grasp of the material as well as display of teaching/facilitating abilities. Please keep PowerPoint presentations to a minimum, if for some reason you decide to use them. We will either start or end the day's discussion with a review of our progress and next steps. Discussion assignments will be made during classes, at least one week in advance.

A good seminar should have active dialogue and debate and be productive, provocative and challenging (without being obnoxious). Here are some guidelines:
• *Outstanding Contributor*: Contributions in class reflect exceptional preparation. Ideas offered are always substantive; provides insights and direction for the class. Challenges are well substantiated and persuasively presented. If this person were not a member of this class, the quality of discussion would be diminished significantly.
• *Good Contributor*: Contributions in class reflect thorough preparation. Ideas offered are usually substantive; provides insights and sometimes direction for the class. Challenges are well substantiated and often persuasively presented. If this person were not a member of this class, the quality of discussion would be diminished considerably.
• *Adequate Contributor*: Contributions in class reflect satisfactory preparation. Ideas offered are sometimes substantive; provides generally useful insights, but seldom offers new direction for discussion. Challenges are well presented, fairly well substantiated and sometimes persuasively presented. If this person were not a member of this class, the quality of discussion would be diminished somewhat.
• *Non-Participant*: This person says little or nothing in class. Therefore, there is not adequate basis for evaluation. If this person were not a member of this class, the quality of discussion would not be changed.
• *Unsatisfactory Contributor*: Contributions in class reflect inadequate preparation. Ideas offered are seldom substantive; provide little insight, and never a constructive direction for the class. Effective challenges are absent and contributions are isolated or presented in a disorganized manner.
Research Project Proposal (30%): The basic idea of this project, due at the end of the semester, is for students to prepare a preliminary research proposal. We will follow the NSF guidelines (15 pages, Times Roman font size 12 pt). This is a formal writing assignment wherein you will be asked to conceptualize, apply and expand the ideas introduced in the readings and discussed in class. The goal of this proposal is for you to formulate your own research emphasis, and demonstrate that you are advancing your own contributions.
Reflective Examinations (30%):
These can be formal and Socratic in form and function. We will undertake two mid-term (each *10%*) and one final *(10%)* examination. Our examinations and discussions are meant to provide experiences that challenge us to evaluate our critical thinking in relation to the readings. We should aim to include ideas, concepts or arguments we find interesting; questions or concerns we have with the readings and connections and links that we see between ideas. Over the course of the semester we will be expected to contribute each time class meets, and beyond in our discussions online.

Readings In addition to the required readings, there are several recommended readings offered during each week. These are works that provide insight and context for our studies. Note the listing is subject to change, as we will share and suggest other relevant readings as they become relevant to us during the semester. We will encourage and support one another to share relevant articles/news with the class.

Key Readings

1. Educating the Engineer of 2020: Adapting Engineering Education to the New Century, National Academies Press (2005) (available online for free)
2. How People Learn (Expanded Ed.), National Research Council (also available online)
3. Learning Theory and Epistemology, also available online at (http://www.hss.cmu.edu/philosophy/kelly/papers/learnreview.pdf)
4. A University for the 21st Century, J. J. Duderstadt (excerpts TBA)
5. Higher Education in the Digital Age, Duderstadt et. al. (excerpts TBA)
6. Friedman, T. 2005. *The World is Flat*. Farrar, Straus and Giroux. (Paperback/Revised Edition).

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A Note on Reading What should we look for when we are reading an article? There are certain elements of an article and paper that we will probably want to focus on. Why is this paper important? How can/does it contribute/contributes to engineering education? What are the limitations of this piece (let's not be too nit-picking)? Most importantly, what future research is suggested by this work? Try not to focus solely on the limitations – all studies are flawed – as they distract you from uncovering more important issues. Although this is not a research methods class, theory and methods are interrelated and you will be exposed to a range of research methodologies over the course of the class. Therefore, look for theories and methods and the alignment of theories and methods. Make a note of methods and theories you like or do not like and why. Keep an eye out for relevant/interesting citations. Some of the readings are from traditions that are often orthogonal to engineering and assume significant background in other literatures. We do not expect you to completely understand or absorb such readings but by engaging with the material we hope that you will gain important and diverse insights.

Other Recommended Texts (1) Lave & Wenger – Situated Learning, (2) Wenger – Communities of Practice, (3) Zuboff – In the Age of the Smart Machine, (4) Wankat, Phil and Oreovicz, Frank, "Teaching Engineering." (available online at: https://engineering.purdue.edu/ChE/AboutUs/Publications/TeachingEng/index.html)

A Note on Writing Writing is an integral part of scholarship. Through the writing assignments in the course we want you to start developing your own style and become a critical and reflective writer. Quality writing does not come easy to most engineers; therefore, consider the assignments as an opportunity to get constructive feedback and improve as you advance.

Students Requiring Accommodations Any student who feels that he or she may need an accommodation because of a disability (learning disability, attention deficit disorder, psychological, physical, etc.), please make an appointment to see the instructors.

Class Logistics We have high expectations of your working as a professional. Graduate students are already trained as engineers. We anticipate that there will be a strong level of motivation, and that you will be able to engage fully in the course and the learning experiences it provides.

Our class will meet on time and after sharing news and stories we will focus on the day's work. We will have short breaks to enable us to re-focus, especially after intense and lengthy engagement.

Note that mobile phone use is allowed (yes!) with the proviso that we first discuss why this policy is presented to you.

Students Auditing the Course Students auditing the course will be expected to attend class, participate in group discussions, and complete all of the elements of the class except the teaching case project.

Academic Honesty Please refer to the UTEP's Policy outlined in the Graduate Catalog. http://www.utep.edu/catalogs/2006/2006-2008GRAD.pdf#index.

Again, we **welcome** you to our course this semester and hope that it supports your overall efforts to advance, and complete your graduate studies.

COURSE OUTLINE
Calendar of Activities
(NB: always subject to updates)

Week 1 (August 26): **Introduction/Perspectives on Engineering Education**
Introduction to the class, discussion of the syllabus, assignments, and projects.Student introduction, Connections and Careers
Required Readings: Seely, B. (1999). The Other Re-engineering of Engineering Education, 1900-1965. *Journal of Engineering Education*, July, 285-294.
Also, or optionally, Seely, B. in Educating the Engineering of 2020: p. 114-130. http://www.nap.edu/download.php?record_id=11338
Recommended Readings: Cuban, L. (1999). *How Scholars Trumped Teachers: Change without Reform in University Curriculum, Teaching and Research, 1890-1990*. New York: Teachers College Press. Chap 1, 6 & 7.

Week 2 (Sept 2 – following Labor Day): **Reading Across the Curriculum**
Journal of Engineering Education Special Issue, January, 2005
Required Reading(s): Selected articles from the *Journal of Engineering Education*, Special Issue, January '05. Available online at: http://www.asee.org/publications/jee/2005jee_sample.htm Especially articles starting on page: 1, 11, 13, 27, 41, 103. This is Volume 94.

Week 3 (Sept 9): **Engineering at the Start of the 21st Century**
Required Reading: Educating the Engineer of 2020: A Report by NAE*Educating the Engineer of 2020: Adapting Engineering Education to the New Century*, National Academies Press (2005)
Recommended Readings: *The Engineer of 2020: Visions of Engineering in the New Century*, National Academies Press (2004) *Engineering for a Changing World: A Roadmap to the Future of Engineering, Practice and Research* (2008). The Millennium Project, University of Michigan. http://milproj.dc.umich.edu/

Week 4 (Sept 16): **How People Learn/Formal & Informal Settings for Learning**
Required Readings: Chapters from "How People Learn", National Research Council.
Greeno, J., Collins, A., & Resnick, L. (1996). Cognition and Learning. In D. C. Berliner & R.C. Calfee (Eds.), *Handbook of Educational Psychology*, pp. 15-46. New York: Macmillan.
Recommended Readings: Rogoff, B., Paradies, R., Arauz, R., Correa-Chavez, M. & Angelillo, C., (2003). Firsthand Learning Through Intent Participation. *Annual Review of Psychology*, 54:175-203.
Sawyer, R. (2005). *The Cambridge Handbook of the Learning Sciences*. Cambridge University Press.

Week 5 (Sept 23): **Learning in Groups & Teams**
Required Readings: Cohen, S. & Bailey, D. E. (1997). What Makes Teams Work: Group Effectiveness Research from the Shop Floor to the Executive Suite. *Journal of Management, 23*: 239-290.
Cohen, E. (1994). Restructuring the Classroom: Conditions for Productive Small Groups. *Review of Educational Research*, Vol. 64, No. 1, pp. 1-35.
Roschelle, J. (1992). Learning by Collaborating: Convergent Conceptual Change. *The Journal of the Learning Sciences*, 2(3), 235-276.
Recommended Readings: Salomon, G. (1992). What Does the Design of Effective CSCL Require and How Do We Study Its Effects? *SIGCUE Outlook*, Vol. 21, No. 3.
Newstetter,W. (1988). Of green monkeys and failed affordances: A case study of a mechanical engineering design course, *Research in Engineering Design*, **10**, 118-128.
Gersick, C. (1988). Time and transition in work teams: Toward a new model of group development. *Academy of Management Journal*, 31: 9-41.

Week 6 (Sept 30): **Engineering Design: How, what, why, who and where?**

Required Readings: Simon, H. (1996). *The Sciences of the Artificial*. MIT Press. Chaps 1, & 5. DBRC (2003). Design-Based Research: An Emerging Paradigm for Educational Inquiry. *Educational Researcher*, Vol. 32, No. 1, pp.5-8. Pea, R. (2005): You, the Designer. *The Philadelphia Inquirer*, Dec. 11 (Op-ed)

Recommended Readings: Henderson, K. (1998). *On line and on paper: visual representations, visual culture and computer graphics in design engineering*. MIT Press, Cambridge, Mass. and London.

Bucciarelli, L. (1996). *Designing Engineers*. MIT Press.

Week 7 (Oct 7): **Education, Technology & Society**

Required Readings: Selections from Diamond, J. (1997) *Guns, Germs and Steel: The Fate of Human Societies*. Chap 13 & Afterword.

Mayer, R. (2001). *Multimedia Learning*. Cambridge University Press. Chap 1 & 11. Selections from New Media Reader (Fruin, 2003). Bush, V. (1945). As We May Think. *Atlantic Monthly*.

http://www.theatlantic.com/doc/194507/bush

Sproull, L. & Kiesler, S. (1991). *Connections: New Ways of Working in the Networked Organization*. MIT Press. Chapter 1 & 8.

Recommended Readings: Powell, W. (1987). Explaining Technological Change. *The American Journal of Sociology*, Vol. 93, No. 1, pp. 185-197.

Week 8 (Oct 14): **Review & Study / Socratic Re Examinations**

Week 9 (Oct 21): **Learning in Engineering Work Settings**

Required Readings: Brown, J. S. and Duguid, P. (1991). Organizational Learning and Communities of Practice: Towards a Unified View of Working, Learning & Innovation. *Organization Science* 2(1): 40–57.

Stevens, R. (2000). Divisions of Labor in School and in the Workplace: Comparing Computer and Paper-Supported Activities Across Settings. *The Journal of the Learning Sciences*, 9(4), 373-401.

Add Zuboff here

Recommended Readings: Orlikowski, W. (2002). Knowing in Practice: Enacting a Collective Capability in Dispersed Organizing. *Organization Science, 13*, 249-273.

Barley, S. & Orr, J. (Eds.) (1996). *Between Craft and Science: Technical Work in U.S. Settings*. Ithaca, NY: ILR Press.

Week 10 (Oct 28): **Globalization – Beyond a Flat World** NB: *Study Day for Next Week*

Required Readings:

Appadurai, A. (1996). Disjuncture and Difference in the Global Cultural Economy. In *Modernity at Large: Cultural Dimensions of Globalization*, pp. 27-47. Minneapolis: University of Minnesota Press.

O'Leary, M. (2002). Chapter 2: The Hudson Bay Company 1670-1950. *Dissertation Submitted to MIT*.

Friedman, T. 2005. *The World is Flat*. Farrar, Straus and Giroux. Chaps 1 & 2.

Recommended Readings: Cramton, C. D. (2001). The mutual knowledge problem and its consequences in geographically dispersed teams. *Organization Science, 12*(3), 346-371.

Week 11 (Nov 4): **Mid-Semester Re View / Examination** *NB: Virtual if Appropriate*

Week 12 (Nov 11) **Interdisciplinary & Liberal Education**

Required Readings: Bauer, H. H. (1990). Barriers against interdisciplinarity: Implications for study of science, technology, and society (STS). *Science Technology and Human Science, 15*(1), 105-119.

Lattuca, L.R., L.J. Voigt, and K.Q. Fath. 2004. Does Interdisciplinarity Promote Learning? Theoretical Support and Researchable Questions. *The Review of Higher Education*, Vol. 28, No. 1, 23-48.
Mansilla, V.B., Assessing Student Work at Disciplinary Crossroads. Change, 2005. 37(1): p. 14(8).
Recommended Readings: Lave, J. Missionaries and Cannibals (Indoors). 1997, orig. 1988. In *Cognition in Practice,* pp. 23-44*.* Cambridge: Cambridge UP.
Rhoten, D. (2004). Risks and Rewards of an Interdisciplinary Research Path. *Science* (December 17), 2046.

Week 13 (Nov 18): **Persistence in Engineering**

Required Readings: Dryburgh, H. (1999). "Work Hard, Play Hard: Women and Professionalization in Engineering—Adapting to the Culture." *Gender & Society* 13 (5): 664-682.
Ohland, M., S.D. Sheppard, G. Lichtenstein, O. Eris, D. Chachra, and R.A. Layton (2008). "Persistence, Engagement, and Migration in Engineering Programs." *Journal of Engineering Education* 97 (3): 259-278.
Recommended Readings: Faulkner, W. (2000). "Dualisms, Hierarchies and Gender in Engineering." *Social Studies of Science.* 30, Part 5: 759-792.
Marra, R. and B. Bogue (2007). Self Efficacy in Women Engineering Students: Three Years of Data at U.S. Institutions. *American Society for Engineering Education.* Honolulu, HI: 15 pp.

Week 14 (Nov 25): **Review and THANKSGIVING WEEK**

Week 15 – (Dec 2): **Organization of Education: Formal and Informal Learning Environments and Impact on Engineering Education**

Required Readings: Becker, H. (1972). School is a Lousy Place to Learn Anything In. *American Behavioral Scientist*, 85-105. Also Callahan, R. (1962). *Education and the Cult of Efficiency*. University of Chicago Press. Chap 1.
Meyer, J. & Rowan, B. (1978). The Structure of Educational Organizations. In Meyer et al., *Environments and Organizations*, 78-109. San Francisco: Jossey-Bass.
Recommended Readings: Pope, D. (2001). *Doing School: How We Are Creating a Generation of Stressed Out, Materialistic, and Miseducated Students*. Yale University Press: New Haven. Chaps 1 & 7.
Also: **Presentations drafts for review.** Planning for next semester.

(NB DEAD DAY is December 5)

Week 16 (Dec 9): **Class has ended – no class. Optional Study Day.**

NOTE: (Dec 11): **Final Examination** (NB: 4.00 to 6.45 PM). Final Paper Submissions. Final Paper Due**.** Final Socratic Examinations Review.

Optional Extra (1 or 2) Week(s) of Class: (Dec 18 and Dec 25):

Design of Life Beyond Doctoral Program Learning Environments

Required Readings: Chapters from How People Learn.
Barab, S. A., & Plucker, J. A. (2002). Smart people or smart contexts? Cognition, ability, and talent development in an age of situated approaches to knowing and learning. *Educational Psychologist, 37* (3), 165-182.
or
End of Class.