University of Arkansas, College of Education and Health Professions
Department of Curriculum and Instruction

1. Program Affiliation: Career and Technical Education: Technology and Engineering Education

1.1 Course Number and Title: TEED 3103: Frameworks for Resolving Technological Challenges

Prerequisites: None

Meets: T/TH 9:30-10:50am
Peabody Hall 317

1.2 Instructor: Vinson Carter
vcarter@uark.edu
575-3076
314 Peabody Hall

Office Hours:
Monday/Wednesday - 9:30-11:30am
Tuesday/Thursday - 1:30-3:30pm
Friday - By Appointment

1.3 Textbooks and/or Supplementary Materials

Required Text:

Anderson, C. (2012). *Makers: The new industrial revolution*. New York: Crown Publishing.

International Technology and Engineering Education Association. (2000). *Standards for technological literacy: Content for the study of technology*. Reston, VA: Author.

Can be downloaded for free at: http://www.iteaconnect.org/TAA/PDFs/xstnd.pdf

***Students will be required to purchase the project materials required for the course. These materials can be obtained at the bookstore, local hardware store, or ordered online.**

In addition to the University library, guest speakers, and journal articles distributed by the professor, the following reference materials will be used extensively:

Davis, M. (1998). *Thinking like an engineer.* New York: Oxford University Press.

National Academy of Engineering. (2002). *Technically speaking: Why all Americans need to know more about technology*. Washington, DC: Author.

2. Course Description/Justification

2.1 Catalog Description: This advanced course in technology and engineering education focuses on concepts of engineering & design including analysis and use of technology problem solving tools of research, experimentation and trouble-shooting in the classroom.

2.2 Relationship to Knowledge Base: This course supports the "Specialty Studies" component of the Scholar-Practitioner model by providing the teacher education candidate with a set of technological problem solving tools that can be used to develop curricula, deliver instruction, and guide learning in the technology and engineering education classroom. The course will model the methods expected in a contemporary technology and engineering education facility and expose the candidate to instructional strategies utilized throughout exemplary programs in the field.

3. Goals and Objectives

3.1 Goals

This course is designed to provide the candidate with the knowledge and methods for solving technological problems and teaching engineering design. Elements of design and theory will be applied through design problems, research problems, experimentation, and trouble-shooting activities. Software, design, and problem solving techniques from the fields of science, technology, engineering, and mathematics will be utilized.

All candidates pursuing degrees in the College of Education and Health Professions are expected to apply the principles of the conceptual framework as *Scholar Practitioners.* The scholar practitioner reflects a professional who is knowledgeable about subject matter and pedagogy; skillful in teaching and managing classrooms and schools; caring about students, families, school staff and the community; and constantly inquiring to better the profession and increase the success of students, schools and the community. The scholar practitioner is **knowledgeable, skillful, caring and inquiring** and is defined by the following tenets:

1. One who accesses, uses, or generates knowledge
2. One who plans, implements, and models best practices
3. One who understands, respects, and values diversity
4. One who is a developing professional and a lifelong learner
5. One who communicates, cooperates, and collaborates with others
6. One who makes decisions based upon ethical standards and professional criteria
7. One who is knowledgeable about teachers and teaching, learners and learning, and schools and schooling

Technology: As with all teacher preparation coursework, students are expected to demonstrate technological competence in this course. This technological competence will be demonstrated through the use of the appropriate technological hardware and software as well as other web-based applications. Scholar-practitioners will utilize technology that enhances the instructional process during the completion on this course.

3.2. Objectives

Upon the completion of this course, students will be able to:

3.2.1. Understand the historical background and development of the fields of design and engineering;

3.2.2. Describe the goals, objectives and organization of the Standards for Technological Literacy (National Standards);

3.2.3. Apply technical tools and resources toward solving human and environmental problems;

3.2.4. Develop confidence in the use and development of design models and engineering constraints;

3.2.5. Develop the ability to work in collaborative design teams to meet given criteria and solve engineering-related problems;

3.2.6. Utilize the fundamentals of design and engineering in the development and delivery of curriculum;

3.2.7. Develop innovative and alternative teaching methods and learning activities that promote the teaching of engineering, design and the national standards for technology; and

3.2.8. Develop and deliver curriculum units of instruction related to the content of this course while paying special attention to standards, behavioral or performance objectives, lesson content, teaching strategies, lesson activities, diversity, and assessment strategies.

4. Student Activities and Experiences

4.1. Assignments/Tasks

Grades for each student will be based on the following assignments:

4.1.1. Professionalism (attendance and participation) (20 points)
Students are expected to attend all classes and participate in all activities. Students are required to maintain professional decorum during class.

4.1.2. Daily and weekly assignments (30 points)
Students will participate in ongoing daily and in-class design and engineering activities, assignments, readings, and discussion.

4.1.3. Course Practicum Experiences (40 points)
Each student will develop and deliver (4) design-based instructional activities on a given topic. These instructional activities (and classroom examples) will be constructed and delivered in accordance with guidelines established throughout the course.

4.1.4. Engineering Journal (10 points)
Each student will keep an engineering notebook throughout the course. This notebook will document class notes, design and engineering activities, assignments, readings, and outlines of discussions during the semester. This portfolio will be assessed throughout the course.

5. Content Outline

5.1. Introduction to engineering and design

a. The history of design
b. The history of the engineering profession
c. The vocabulary of engineering and design
d. Engineering & design as a tool for teaching technology
e. The relationship between adjoining disciplines (technology education/engineering)

5.2. The Standards for Technological Literacy

a. The role of the standards
b. The relationship between the standards and engineering
c. Delivering the standards through engineering and design
d. Using standards to develop curriculum

5.3. Solving human and environmental problems

a. Surviving nature
b. A search for a more comfortable life
c. Technology solving and creating problems
d. Unexpected results/unintended consequences

5.4. Fundamentals of engineering and design

a. Foundational concepts
b. Form, function, balance, texture, etc.
c. Computer and quantitative modeling
d. Adhering to design parameters and constraints
e. Risk/benefit analysis
f. Technological assessment

5.5 Tools of engineering and design

a. Questioning/clarifying the problem
b. Identifying constraints/limitations
c. Gathering research
d. Quantifying/mental modeling
e. Visioning and graphic representation
f. Drawing and modeling (including software usage)
g. Prototyping and assessment
h. Artifact development
i. Communicating the results of engineering/design

5.6 Fundamental techniques

a. Engineering design (innovation)
b. Experimentation
c. Research and development
d. Troubleshooting
e. Invention

5.7 Teaching with engineering and design

a. Teaching with the end in mind
b. The role of design and engineering in the secondary classroom
c. Curricular assessment procedures, tools, and techniques
d. Developing curriculum and activities
e. Instructional methods for teaching engineering and design
f. Collaboration strategies

5.8 Course practicum

a. Practicum experience
b. Teaching technological understanding with engineering and design tools

6. Evaluation Policies

6.1. The following scale will be used to determine the final grade in the course:

A = 92% - 100%
B = 82% - 91%
C = 72% - 81%
D = 60% - 71%
F = Below 60%

7. Syllabus Change

The Instructor reserves the right to make changes as necessary to this syllabus. If changes are made, advance notification will be given to the class.

8. Academic Policies

8.1 Accommodations

Students with disabilities requesting reasonable accommodations must first register with the Center for Students with Disabilities. The CSD is located in the Arkansas Union, Room 104, and on the web at http://www.uark.edu/ua/csd/applications.htm. The CSD provides documentation to students with disabilities who must then provide this documentation to their course instructors. Students with disabilities should notify their course instructors of their need for reasonable accommodations in a timely manner to ensure sufficient time to arrange reasonable accommodation implementation and effectiveness. A typical time frame for arranging reasonable accommodations for students who are registered with the CSD is approximately one to two weeks.

8.2 Academic Integrity

The application of the University of Arkansas Academic Integrity Policy will be fully adhered to in this course. Grades and degrees earned by dishonest means devalue those earned by all students; therefore, it is important that students are aware of the University of Arkansas Academic Integrity Policy. Academic dishonesty involves acts, which may subvert or compromise the integrity of the educational process.

"As a core part of its mission, the University of Arkansas provides students with the opportunity to further their educational goals though programs of student and research in an environment that promotes freedom of inquiry and academic responsibility. Accomplishing this mission is only possible when intellectual honesty and individual integrity prevail."

"Each University of Arkansas student is required to be familiar with and abide by the university's Academic Integrity Policy' which may be found one the UA website. Students with questions about how these policies apply to a particular course or assignment should immediately contact their instructor."

The description of the Academic Integrity Policy is located at:
http://provost.uark.edu/245.php

The Academic Integrity Sanction Rubric is located at:
http://provost.uark.edu/246.php

All students are to complete their own work during the semester. Although students are allowed to share ideas and learn from one another throughout the semester, students are not allowed to copy another person's work. All assignments must be original and completed individually. All citations must be documented using the 6th edition of the APA manual (http://www.apastyle.org/, http://psychology.vanguard.edu/faculty/douglas-degelman/apa-style/)

8.3 Inclement Weather

For information regarding whether the university is closed or an inclement weather day is declared, use the following sources:

- See the inclement weather web site at: http://emergency.uark.edu/11272.php
- Call 479-575-7000 or the university switchboard at 575-2000 for recorded announcements about closings.
- Listen to KUAF Radio, 91.3 FM, or other local radio and television stations for announcements.
- Check your e-mail.

8.4 Instructor Policies

Attendance

Students are expected to attend all classes and participate in all activities.

Professionalism

Students are required to maintain professional decorum during class. Cell phones and other electronic devices must be turned off and out of sight during class. Inappropriate and disruptive classroom behavior (including the use of cell phones, iPads, laptops, and other electronic devices) will not be tolerated.

Framework for Engineering and Design Problem Solving

The problem solving approach is one that has many possibilities for creative teaching. This approach can clearly be used in many circumstances and is probably one of the most exciting teaching techniques that can be used in integrated STEM education. Technological problem solving is also one of the most often misused teaching techniques in the profession. Classroom research indicates that some students find the prescribed design problem solving methods cumbersome to use, and if held accountable, merely retrofit methods to meet the results of their actual experience. For this reason, the following section has been developed to help the perspective teachers gain a better understanding of the impacts of using the problem solving method.

The term "problem solving" has become very popular in educational settings in recent years. One of the key skills that employers want their employees to possess is the ability to critically analyze situations and solve problems. The difficulty is that the term "problem-solving" (and the behavior and thinking associated with it) is complex and refers to different things in various contexts. Technological problems are distinct from other types of problems (e.g., social, environmental, interpersonal, economic, international, puzzles, etc.). For example, a family with an alcoholic son or daughter has a problem, but it is not technological (MacPherson, 1998). Although there are numerous methods that can be used to categorize technological problems, these are the categories that we will use:

- *Engineering Design*: Design is a classification of problem solving. Unlike some other methods of problem solving, design problems frequently are less well defined and often can be solved in a number of different ways within a set of constraints. Also in contrast to trouble shooting, design solutions often reflect the unique knowledge and experience the designer brings to the situation. Engineering design problems always begin with a statement of what should be designed to solve the problem.
- *Invention and Innovation*: Are among the most open-ended and creative approaches to problem solving. Unlike other forms of problem solving that deal with things already in existence, invention launches into the unknown and the untried. Invention is the process of coming up with new ideas, while engineering design is concerned with applying those ideas. Invention tends to require considerable creativity, and an ability to visualize, model, and create. On the other hand, an innovation is an improvement of an existing product, system, or method of doing something. Invention and innovation problems are always stated as a problem that must be solved—but not how the problem will be solved as is the case with *engineering design* (above).
- *Trouble shooting*: Trouble shooting is a classification of technological problem solving where problems tend to be well defined and the activity is directed at finding a single solution to a problem (e.g., locating a fault in an electronic circuit, finding out why an engine won't start, trying to determine why the curling iron won't work, etc.). Trouble shooting problems typically require specific knowledge in order to solve. Troubleshooting always start with a flaw or fault in a system that must be identified and resolved by the student.

- *Technical/Procedural:* Following and/or writing technical directions is an essential skill for the technologically literate person. To be technologically literate, one must be capable of assembling, disassembling, and creating technological devices and apparatus. As technology becomes more pervasive in our society, the need for citizens capable of following/understanding technical directions will continue to grow. This type of problem is designed to allow students the opportunity to practice using their problem solving skills to successfully solve a technical problem.

- *Research & Development*: After something has been conceived, it can take considerable time for teams of people to work the bugs out and prepare the product for the market. *Research and development* is a problem solving method that attempts to address a wide range of issues concurrently. The product must work. It must be reliable, safe, and have market appeal. Sometimes, questions about its value to society or potential harm to the environment must be addressed.

- *Experimentation*: Is the form of technological problem solving that resembles most closely the methods that scientists use. Using methods that are similar to the scientific approach, problem solvers apply iterative processes to experiment on technological products and systems. For example, performing timed tests on fingernail polish to determine which formula results in the fastest dry-time while maintaining the desired luster.

The Role of Creativity

Create: (kre at')To bring into existence out of nothing; to originate; to make. The act of creating. Any original production of the human mind. The components of a lesson that has *creativity* as a foundation: A chance to:

  - View problems from many angles
  - Hear differing points of view
  - Take things apart and see how things operate
  - Reason, analyze, and brainstorm
  - Adapt ideas of others and self
  - Add a new twist to an old idea
  - Find new uses for old ideas
  - Simplify the solutions to old problems/ideas
  - Rearrange the components of an old solution to create a new one
  - Combine previous technologies to create a new one
  - Use the non-rational portions of our brains
  - Explore "gut feelings"
  - Visualize and use mental imagery
  - Collaborate and learn from others
  - Apply basic ideas and concepts
  - Practice discovery techniques
  - Take risks and build self-confidence
  - Become more tolerant of the unknown
  - Become more open to new experiences

The Maker Movement

- http://www.pbs.org/newshour/video/2011/06/29/20110629_4_makerfaire.mp4

- As many of you know, the Maker Movement is expanding (rapidly!).
    - There have been Maker Faires in NY, Oakland CA, and Detroit, and they're talking about "franchising" the Maker Faire concept. So, it may soon come to your town.

- Description from a friend who attended:

  “The Maker Faire at the NY Hall of Science 2 weeks ago was a remarkable event. They were anticipating as many as 50,000 attendees. LOTS of energy from Makers of all sorts. Some of the makers are trying to commercialize their inventions...but many were intentionally constructing relatively useless Rube Goldberg-like things (e.g., the HUGE roller-coaster-like device, with the maker using a mike to explain to the zillion people watching how it was intended to work, followed by a 10 minute demonstration of the working contraption, which resulted in the dropping of a huge safe (I initially thought Houdini was inside) on a car... for the intended purpose of crushing the car. They use "whimsy" to describe the maker stuff of that sort.

    - The "MakerSpace Project" will soon be distributing applications to teachers, as the first step in their goal of putting "makerspaces in 1000 high schools across the US this year.

- What are the implications of the MakerMovement for Integrated STEM Education?

- How can this be used in technology and engineering classes?

- How should we get involved?