Science, Technology, Engineering and Mathematics disciplines require comprehension of complex interactions of a system. Experts in these disciplines continually invent new devices for managing this complexity which they use to support their inquiring into new discoveries and innovations. These tools are underutilized in our educational learning environments, and more can be done to systematically integrate them into our PreK – 16 educational processes. We invite scholars from all disciplines to investigate the multiple perspectives of the design of effective devices for thinking and learning in STEM learning environments.

**COURSE DESCRIPTION**

Cognitive devices provide the ability to extend and amplify our abilities to accomplish physical and intellectual activities. In some cases these devices help us develop abilities we can perform later without the use of the device. Other tools become integral parts of our process of thinking and doing. This course explores the nature of technologies we use to assist in our thinking, learning and teaching. We will specifically focus on cognitive tools associated with engineering activities and how to blend them with science and mathematical contexts. These will range from representational tools, computational tools and cognitive tools for supporting individual and group thinking and learning.

**OBJECTIVES**

The participants in this course will be able to evaluate various learning technologies relative to specific learning goals and outcomes and will design a technological tool to support thinking, learning and/or teaching about concepts in science, engineering, mathematics and technology. Participants will also be able to identify assessment methods that indicate cognitive change in learners as a measure of the effectiveness of a device/tool in context of an activity. Participants will propose a research study to explore the hypothesis of a cognitive device they will design as part of a course. And/or a study an existing cognitive device to investigate a new research question.

**REQUIREMENTS**

The following summarize the major requirements for the course. Details for the assignments will be provided as handouts later in the semester.
**CLASS PARTICIPATION (15%)**

1. Keeping up with selected readings. Students will be expected to read extensively from a collection of readings relevant to the topics in the course.

2. Engage in dialogue and discussion - Students are expected to come to class prepared to discuss the assigned readings relative to the general questions stated above. In addition, students will participate in a number of small group activities designed to explore subtle issues related to the specific topics being studied.

3. Contribute examples to a class database of examples of cognitive artifacts (devices). Research popular news and literature for examples of cognitive devices and tools and bring examples for class discussion.

4. Thought papers – Each week students will be expected to write a short (one page maximum) thought paper about the specific readings and about their examples of cognitive devices and tools. The paper will be posted on Blackboard by noon on the Tuesday before our Wednesday class session. The student leading that week’s discussion may use these “thought papers” as artifacts for a learning activity conducted during class.

5. Provide weekly progress reports on status of term project.

**Lead Class Discussion (15%)**

6. Lead classroom discussion on designated topic- Each week a student (or pair of students) will be responsible for leading a class session around a set of readings or around an example of a “cognitive device/tool”. The students can use a range of instructional methods necessary to increase their peer’s comprehension of the big ideas related to the topic and the relevance of the article to how engineers learn.

**TERM PROJECT (70%)**

7. Design and potentially develop a cognitive device to support a STEM related cognitive activity. Each learner in this class will construct at least a conceptual design of a cognitive device to a cognitive activity they have observed in their domain area. The device can target any of the categories we will discuss in class and for any age learner. The term project is divided up into three milestones. The first is a short description of your project idea in a two slide powerpoint presentation to the class (week 3). The second milestone is a formal proposal (5 page maximum) describing the rational for the cognitive device, how it works, the cognitive processes it is intended to support and an outline of the development plan (week 7). Students will share their proposal during a 5 minute presentation of their proposal to the class. A final report will describe the current literature related to research conducted on this area, a justification for how and why this device will support cognition. The final project will include either a functional prototype of the tool, or a detailed development plan for how to construct the tool. The last week of class will consist of 15 minute presentation of the final project.
8. Make a formal presentation of their work - Students will share the results of their Conceptual design as part of the last week of the course.

**MAJOR DRIVING QUESTION**

- What is the relationship between science, technology, education and mathematics?
- How can cognition be supported and what is the direct and indirect affects?
- What is the “role” of technology in an environment?
  - What do we mean by environment?
  - What do we mean by learning environments?
- What are the limits?
- What are the pros and cons?

**MAJOR COURSE ACTIVITIES**

Identify, Categorizing and Evaluate Cognitive Devices
Identifying methods for Assessing Cognitive Tasks
Evaluate the pros and cons of cognitive devices/tools
Identify and explore technology tools at Purdue
  - Devices for data perceptualization (e.g. virtual reality and haptic devices)
  - Simulation tools (e.g. nanoHub.org)
  - Robotics
  - Experimental Systems (e.g. Fluid Dynamics)
  - Manipulative
  - Modeling tools

**Major Topics of Exploration**

Support of Engineering Expertise
Learning with Cognitive Devices
Individual and Social Interaction
The role of Play – learning with games and other informal situations
Teachable Agents
Representations
Visualization
Simulations
Models
Multimedia