EDUCATIONAL DEVELOPMENT AND SERVICES
in partnership with

DOMINICAN UNIVERSITY of CALIFORNIA
School of Liberal Arts and Education

# EDUO 9572
# Advanced Modeling Instruction:
# Cognition & Instruction in STEM
# (15 Week AMTA Workshop)
# 1 – 3 Graduate-Level Credits

## Course Prerequisites:

Participants must be currently using the Modeling technique and ready to take the process to the next level.

## Course Overview:

This course will focus on the study of human thinking and learning as it relates to Modeling Instruction and the Modeling Theory of cognition. The fundamental theoretical underpinnings of Modeling Instruction will be reviewed, and theoretical trends in cognitive science will be examined.

## Course Description:

Teachers already using the Modeling technique will participate in 15 weeks of training in Advanced Modeling Instruction that will focus on cognition and instruction in STEM. Instruction will be seminar, online synchronous and asynchronous formats. This synchronous distance learning course will meet online from 7 PM to 10 PM weekly on Thursdays from 1/17/2019 to 5/2/2019. All course materials will be distributed electronically.

Participants will discuss major trends in our understanding of thinking and learning as it relates to STEM instructional settings, design instructional sequences based on learning theories addressing fundamental concepts and skills in their chosen content area, and examine technology as a cognitive tool to support teaching and learning. Instruction is organized into modeling cycles rather than traditional content units. This promotes an integrated understanding of modeling

processes and the acquisition of coordinated modeling skills. The two main stages of this process are model development and model deployment. The modeling cycle addresses the deficiencies of traditional instruction by assisting students to construct understanding from observations, by confronting student preconceptions, by examining student thought processes through the process of "whiteboarding" and Socratic dialoguing. Participants will receive both printed and electronically stored versions of the course manual, as well as ancillary materials.

The goal of this Modeling Method course is to provide a meaningful form of professional development for pre-service or in-service teachers using student-centered, inquiry-based, constructivist practices. Participants will frequently be asked to play two roles. First, they will be asked to take the role of a novice student in chemistry (similar to their actual students) as they perform all the laboratory investigations and problem solving that such students will be asked to do. Armed with a taxonomy of common preconceptions and misconceptions students hold will give participants a useful perspective from which they will be better able to address their own student's learning obstacles. Second, they will be asked to play the role of the classroom chemistry teacher where they will be able to practice the techniques of managing student discourse, using Socratic dialogue, and general classroom management in an inquiry-based classroom. Throughout the course, teachers are asked to reflect on their practice and how they might apply the techniques they have learned in the course to their own classes. The principles learned here can be readily transferred to any other sort of classroom instruction.

## Course Objectives:\NGSS Content & Teaching Standards Addressed

Through successful completion of this course, teachers will

- Students will be able to discuss major trends in our understanding of thinking and learning as it relates to STEM instructional settings;
- Students will be able to design instructional sequences based on learning theory, addressing fundamental concepts and skills in their chosen content area.
- Students will be able to conduct empirical evaluations of student learning and instructional practices.
- Improve their instructional pedagogy by incorporating the modeling cycle, inquiry methods, critical and creative thinking, cooperative learning, and effective use of classroom technology,
- Experience and practice instructional strategies of model-centered discourse, Socratic questioning/whiteboarding, and coherent content organization,
- Strengthen local institutional support as school leaders in disseminating standards-based reform in science education,
- Increase their skill in all eight scientific practices recommended by the National Research Council in "A Framework for K-12 Science Education."
- The development and use of models are at the core of the NGSS Science and Engineering Practices.

## Course Relation to NGSS Content & Teaching Standards:

The NGSS standards addressed in this course are:
1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

## Course Assignments & Required Content:

**Read weekly readings and participate meaningfully in in-class discussions** (40% of your final grade)
**Lead a class discussion** (30% of your final grade-chose this by the end of class in week 2) Choose a topic of interest from the weekly schedule. Go beyond the assigned reading to flesh out the topic in a brief introduction; lead the discussion; summarize the discussion within 48 hours of the class meeting; respond to classmates' questions in online discussion forum. No more than two individuals may choose a single week's topic.
**Classroom observation** (20% of your final grade-due by the end of week 13) Document an instance of the manifestation of some theory we have explored in class and describe how it emerged and how it maps onto the theory you choose.
**Participate in online discussion forum** outside class time (10% of your final grade-do this weekly). Each week you will have 48 hours after the end of class to post an (intelligent) question that remains unresolved in your mind following class discussion of the week's articles. The class leader(s) for that week's discussion will respond to each question posted.

## Tentative Course Reading Calendar

This synchronous distance learning course will meet online from 7 PM to 10 PM weekly on Thursdays from 1/17/2019 to 5/2/2019. Some readings will be altered based on how the discussions unfold.

**Week 1: What is cognition?**

- Cognition and learning (Greeno, Collins and Resnick)
- Modeling theory of cognition (Hestenes)

**Weeks 2-3 : What is model? (schemas, prototypes, metaphors, analogies)**

- Excerpts from A theory of remembering (F.C. Bartlett)
- Principles of categorization (E. Rosch)
- Excerpts from Where mathematics comes from: how the embodied mind brings mathematics into being (Lakoff and Nunez)

**Weeks 4-6: How do we model? (Situated Cognition, Distributed Cognition, Cognitive Linguistics, Inscriptions, P-Prims, mental models)**

- Situated cognition and the culture of schooling (Brown, Collins and Duguid)
- Distributed cognition: toward a new foundation for human-computer interaction research (Hollan, Hutchins & Kirsch)
- The relationship of grammar to cognition (Talmy)
- Toward a theory of inscriptions (Roth and McGinn)
- Knowledge in pieces (diSessa)
- Mental models in cognitive science (Johnson-Laird)

**Weeks 7-9: Why do we model? (Goal theory, expectancy value theory, relevance theory, motivation theory)**

- Multiple goals, multiple pathways: The role of goal orientation in learning and achievement. (Pintrich)
- Expectancy–value theory of achievement motivation (Wigfield and Eccles)
- Excerpts from Relevance theory (Wilson and Sperber)
- Adaptive Motivation (Middleton)
- A study of intrinsic motivation in the mathematics classroom: A personal constructs approach (Middleton)

**Weeks 10-13: Constraints and affordances (Cognitive Load Theory, Chunking, Story Analogs, Conceptual Blending, embodied cognition)**

- Cognitive load theory and instructional design: Recent developments (Paas, Sweller and Renkl)
- The magical number seven: Still magic after all these years? (Baddeley)
- The effects of surface and structural feature matches on the access of story analogs.
- The way we think: Conceptual blending and the mind's hidden complexities (Fauconnier & Turner)
- From the revolution to embodiment: 25 years of cognitive psychology (Glenberg, Witt & Metcalf)

**Week 14: Modeling Theory of Cognition**

- Modeling Theory of Cognition (Hestenes) revisited

**Week 15: leftovers and bonus topics**

- Learning environments?
- Equity?
- Suggestions??

## Course Assessment Rubrics

**Final grades will be based on the following point totals and percentages: A: 90-100% B: 80-89% C: 70-79%**

**Readings ( 40% of course grade)**

| 108-120 points | 96-107 points | 84-106 points | 0-83 points |
|---|---|---|---|
| Participant reads all articles and adds meaningful comments to the discussion | Participant reads 90% if the articles and adds meaningful comments to the discussion | Participant reads 80% articles and adds general comments to the discussion | Participant reads less than 80% of the articles and does not add meaningful comments to the discussion. |

**Lead Discussion (30% of course grade)**

| 81-90 points | 72-80 points | 61-71 points | 0-60 points |
|---|---|---|---|
| Participant chooses topic, thoroughly researches beyond articles, provides scholarly introduction, successfully leads & summarizes discussion, facilitates online discussion forum. | Participant chooses topic, researches beyond articles, provides introduction, leads & summarizes discussion, facilitates online discussion forum. | Participant chooses topic, provides basic research beyond articles, provides introduction, leads & summarizes discussion, facilitates online discussion forum. | Participant chooses topic, provides minimal research, provides general introduction & summary, leads discussion, facilitates online discussion forum. |

**Classroom Observation (20% of course grade)**

| 54-60 points | 48-53 points | 41-47 points | 0-40 points |
|---|---|---|---|
| Thoroughly documented an instance of the manifestation of a theory explored in class and clearly described how it emerged and how it maps onto the chosen theory | Documented an instance of manifestation of a theory explored in class and described how it emerged and how it maps onto the chosen theory. | Briefly documented an instance of manifestation of a theory explored in class and briefly described how it emerged and how it maps onto the chosen theory. | Failed to completely document an instance of manifestation of a theory explored in class and failed to completely describe how it emerged and how it maps onto the chosen theory. |

**Forum (60 points: 10% of course grade)**

| 24-30 points | 18-23 points | 11-17 points | 0-10 points |
|---|---|---|---|
| Well written; no grammatical Post related to discussion topic and cites additional references. Expresses opinion and idea in a clear and concise manner with obvious connection to topic. . Frequently attempts to motivate group discussion and presents creative approaches to topic. | Well written, no grammatical errors. Topic related to discussion topic and prompts further discussion. Opinion or idea clearly stated. Frequently attempts to direct the discussion and present relevant viewpoints for consideration by the group. Interacts freely. | Some errors in grammar. Post is short in length and offers no further insight into the topic. occasionally makes meaningful reflection on groups efforts and marginal effort to add value to the discussion. | Uses poor grammar & post appears 'hasty". Topics do not relate to the discussion or include relevant remarks. Does not express opinion and does not make effort to participate in learning community. |