THE UNIVERSITY OF TEXAS AT AUSTIN

Student Course Syllabus

STM 390T: Development of Instructional Materials in STEM Education
Unique #73604

3 credit hours

Course Meeting Times, Location, and Instructor

Day and Time	Location	Course Website
MTW 9:00 – 12:00	Online (Zoom Meetings)	http://canvas.utexas.edu

Instructor

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Course Description and Objectives

Course Description. This course examines ways to design learning experiences that highlight the social injustices in our communities and gives people an opportunity to learn how to use the core ideas and practices of science, mathematics, and engineering to make sense of them or to develop a solution to help address them. It focuses on three major questions that are associated with current research on the development of instructional materials: (1) what are the types of interactions that take place between people, ideas, and materials that foster learning in a way that is equitable and inclusive? (2) How can instructional materials be designed to promote and support these types of interactions? And, (3) What criteria should be used to determine if instructional materials are of high-quality? Students in this course will be expected to read and discuss articles about the design of the instructional materials in STEM education and complete several projects. The projects include creating a mathematics investigation, an engineering design challenge, and science unit.

Course Objectives. After participating in class activities and completing the assignments, you will be able to:

1. Describe the nature of the interactions that take place between people, ideas, and materials that foster learning in a way that is equitable and inclusive;
2. Describe design principles and instructional models than can be used to guide the development of new instructional materials;
3. Create an Argument-Driven Mathematics investigation that examine a social injustice;
4. Create an Argument-Driven Engineering STEM design challenge that will help make the world a better place;
5. Create a Model-Driven Inquiry unit that examines a social injustice in a community; and,
6. Evaluate and critique the design of instructional materials used in mathematics, engineering, and science.

Class Requirements

Attendance and Participation. Attendance and participation are important in this class. If you need to miss a class please provide, when possible, advance notice of the absence. You will need to make up all work that is missed.

Texts, Readings, and/or other Resources

There is no textbook for this course. Instead, you will be reading journal articles, books, and book chapters as part of the systemic quantitative literature review that you will do over the course of the semester. You will be able to access these materials through the UT Library. The materials you will must be used in compliance with U.S. Copyright Law. Under that law, you may view these materials on your computer but these materials may not be saved to your computer, revised, copied, or distributed without permission. They are to be used in support of the instructional activities required by this course only and shall be limited to the duration of the course, unless otherwise specified by the instructor or owner of the material. For more information, see UT Copyright Guidelines.

Tentative Schedule

Session	Date	Topic(s)	Activities	Milestone Due
1	6/8	Design of math investigations	• Overview of the Argument-Driven Mathematics instructional model and nature of the instructional materials • Design Step 1: Choose a topic • Design Step 2: Identify target standards	
2	6/9	Design of math investigations	• Design Step 3: Decide on the investigation phenomenon • Design Step 4: Determine the question • Design Step 5: Create an ideal argument	Math 1 (Steps 1 and 2 for math investigation)
3	6/10	Design of math investigations	• Design Step 6: Decide materials and resources • Design Step 7: Create needed materials and resources • Design Step 8: Create the handout and teacher notes	Math 2 (Steps 3-5 for math investigation)
4	6/15	Design of math investigations	• Discuss Reading Set A • Design Step 9: Review of materials • Design Step 10: Revise the materials	Math 3 (Steps 6-8 for math investigation)
5	6/16	Design of STEM design challenges	• Overview of the Argument-Driven Engineering instructional model and nature of the instructional materials • Design Step 1: Choose a topic • Design Step 2: Identify target standards	Math 4 (Final math investigation)
6	6/17	Design of STEM design challenges	• Design Step 3: Decide on the problem to solve • Design Step 4: Determine the criteria and constraints • Design Step 5: Create an ideal solution and argument	Engineering 1 (Steps 1 and 2 for STEM Design Challenge)
7	6/22	Design of STEM design challenges	• Discuss Reading Set B • Design Step 6: Decide materials and resources • Design Step 7: Create needed materials and resources • Design Step 8: Create the handout and teacher notes	Engineering 2 (Steps 3-5 for STEM Design Challenge)
8	6/23	Design of STEM design challenges	• Design Step 9: Review of materials • Design Step 10: Revise the materials	Engineering 3 (Steps 6 and 8 for STEM Design Challenge)
9	6/24	Design of science units	• Overview of Model-Driven Inquiry and nature of the instructional materials	Engineering 4 (Final STEM Design Challenge)
10	6/29	Design of science units	• Discuss Reading Set C • Design Step 1: Choose a topic • Design Step 2: Identify target standards • Design Step 3: Choose the phenomenon	
11	6/30	Design of science units	• Design Step 4: Create a target model and explanation	Science 1 (Steps 1-3 for the unit)
12	7/1	Design of science units	• Design Step 5: Create the summary table	Science 2 (Step 4 for the unit)
13	7/6	Design of science units	• Discuss Reading Set D • Design Step 6: Create the tasks and teacher note	Science 3 (Step 5 for the unit)

Session	Date	Topic(s)	Activities	Milestone Due
14	7/7	Design of science units	• Design Step 6 (continued): Create the tasks and teacher note	Science 4 (50% of step 6 for the unit)
15	7/8	Design of science units	• Design Step 7: Review of materials • Design Step 8: Revise the materials	Science 5 (100% of step 6 for the unit)

Evaluation and Grades

Course Project (140 points possible). You will create three different types of instructional materials for the course project. You must complete 14 milestones to finish this project by the end of the semester. These milestones are included in the table below.

Number	Milestone	What to Submit
1	Math 1	Topic of the investigation, target standards, concepts and practices students will use
2	Math 2	The investigation phenomenon, the guiding question, and an ideal argument
3	Math 3	Draft of investigation handout, teacher notes, and any supplemental materials
4	Math 4	Final version of investigation handout, teacher notes, and any supplemental materials
5	Engineering 1	Topic of the challenge, target standards, concepts and practices students will use
6	Engineering 2	The problem to solve, the criteria and constraints, and an ideal solution and argument
7	Engineering 3	Draft of design challenge handout, teacher notes, and any supplemental materials
8	Engineering 4	Final version design challenge handout, teacher notes, and any supplemental materials
9	Science 1	Topic of the unit, target standards, DCIs, CCs and SEPs will use, and the phenomenon
10	Science 2	Target model and full explanation of the phenomenon
11	Science 3	Summary table
12	Science 4	Draft of 50% of tasks and teacher notes
13	Science 5	Draft of remaining 50% of tasks and teach notes
14	Science 6	Final version of the unit (due July 13th)

Each milestone is worth ten points. Five points will be deducted from the points awarded for that milestone if the milestone is not completed on time. Please note that a degree in education is not only about learning the content involved in the discipline (such as learning theories or means of assessment). It is also about learning how to think and write in an academic fashion. Your manuscript will be evaluated, not only in terms of content and the soundness of one's ideas, but also in terms of clarity of expression, conformity to academic styles of writing (such as APA format), and in terms of acknowledging the origin of ideas (through use of appropriate citations). *Please take this into account as you complete this project.*

Reading Discussion Leader (10 points). You will lead the discussion of a set of readings during the semester. You will be responsible for helping your team identify the big "takeaways" from the articles or chapters and your biggest "concern" that will require more discussion. You will then prepare a summary of the big takeaways from the reading after class and then share them with the rest of your team.

Grading Scale. The grading scale for this class is as follows:

Letter Grade	Percentage	Letter Grade	Percentage	Letter Grade	Percentage
A	≥ 91%	B-	< 83% and ≥ 80%	D+	< 70% and ≥ 67%
A-	< 91% and ≥ 89%	C+	< 80% and ≥ 77%	D	< 67% and ≥ 63%
B+	< 89% and ≥ 87%	C	< 77% and ≥ 73%	D-	< 63% and ≥ 60%
B	< 87% and ≥ 83%	C-	< 73% and ≥ 70%	F	< 60%

Special Notices and Policies

Accessible and Inclusive Learning Environment. The university is committed to creating an accessible and inclusive learning environment consistent with university policy and federal and state law. Please let me know if you experience any barriers to learning so I can work with you to ensure you have equal opportunity to participate fully in this course. If you are a student with a disability, or think you may have a disability, and need accommodations please contact Services for

Students with Disabilities (SSD). Please refer to SSD's website for contact and more information: http://diversity.utexas.edu/disability/. If you are already registered with SSD, please deliver your Accommodation Letter to me as early as possible in the semester so we can discuss your approved accommodations and needs in this course.

Religious Holy Days. Religious holy days sometimes conflict with class and examination schedules. If you miss an examination, work assignment, or other project due to the observance of a religious holy day you will be given an opportunity to complete the work missed within a reasonable amount of time after the absence. It is the policy of the University of Texas at Austin that you must notify the instructor at least fourteen days prior to the classes scheduled on the days you will be absent to observe a religious holy day.

University of Texas Honor Code. The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the university is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community. Students are expected to abide by the University of Texas Honor Code. Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and/or dismissal from The University. Since such dishonesty harms the individual, all students, and the integrity of The University, policies on scholastic dishonesty will be strictly enforced. All work on papers should be done individually. Any material that you include that is not in your own words must be cited clearly as to its source. Likewise, you should give credit for ideas that originate from another source. Using another person's words or ideas (including words and ideas from the Internet!) without due credit is plagiarism and is a violation of University rules.

Writing Center. The Undergraduate Writing Center (FAC 211, 471-6222) offers free, individualized, expert help with writing for any UT undergraduate, by appointment or on a drop-in basis. Consultants can help you develop strategies to improve your writing, or simply provide feedback (this is a normal part of the writing process). See http://www.uwc.utexas.edu for more information.

Use of E-mail for Official Correspondence to Students. All students should become familiar with the University's official e-mail student notification policy. It is the student's responsibility to keep the University informed as to changes in his or her e-mail address. Students are expected to check e-mail on a frequent and regular basis in order to stay current with University-related communications, recognizing that certain communications may be time-critical. It is recommended that e-mail be checked daily. The complete policy is available at: http://www.utexas.edu/its/policies/emailnotify.html.

Behavior Concerns Advice Line (BCAL). If you are worried about someone who is acting differently, you may use the Behavior Concerns Advice Line to discuss by phone your concerns about another individual's behavior. This service is provided through a partnership among the Office of the Dean of Students, the Counseling and Mental Health Center (CMHC), the Employee Assistance Program (EAP), and The University of Texas Police Department (UTPD). Call 512-232-5050 or visit http://www.utexas.edu/safety/bcal. Please sign up for text alerts at http://www.utexas.edu/emergency/.

Emergency Evacuation Policy. Occupants of buildings on the UT Austin campus are required to evacuate and assemble outside when a fire alarm is activated or an announcement is made. Take valuables with you if you can gather them quickly. Please be aware of the following policies regarding evacuation:

- Familiarize yourself with all exit doors of the classroom and the building.
- If you require assistance to evacuate, inform the instructor in writing during the first week of class.
- In the event of an evacuation, follow the instructor's instructions.
- Do not re-enter a building unless the Austin Fire Department, the UT Austin Police Department, or the Fire Prevention Services office gives you instructions to do so.
- Please familiarize yourself with procedures in case of an active shooter: http://www.utexas.edu/police/videos/

Q drop Policy. The State of Texas has enacted a law that limits the number of course drops for academic reasons to six (6). As stated in Senate Bill 1231: "Beginning with the fall 2007 academic term, an institution of higher education may not permit an undergraduate student a total of more than six dropped courses, including any course a transfer student has dropped at another institution of higher education, unless the student shows good cause for dropping more than that number."

Syllabus Change Policy. Except for changes that substantially affect implementation of the evaluation (grading) statement, this syllabus is a guide for the course and is subject to change with advance notice.

Bibliography

Reading Set A: What are the types of interactions that take place between people, ideas, and materials that foster learning in a way that is equitable and inclusive?

- Schoenfeld, Alan H. "Video Analyses for Research and Professional Development: The Teaching for Robust Understanding (TRU) Framework." ZDM: The International Journal on Mathematics Education 50.3 (2018): 491–506.
- Chi, M.T.H. (2009), Active-Constructive-Interactive: A Conceptual Framework for Differentiating Learning Activities. *Topics in Cognitive Science*, 1: 73-105.

Reading Set B: How can instructional materials be designed to promote and support these types of interactions?

- National Council of Teachers of Mathematics. (2018). Catalyzing change in high school mathematics: Initiating critical conversations, 1-35.
- Lee, O., Llosa, L., Grapin, S., Haas, A., & Goggins, M. (2019). Science and language integration with English learners: A conceptual framework guiding instructional materials development. *Science Education*, *103*(2), 317-337.
- Kelly, G. J., & Cunningham, C. M. (2019). Epistemic tools in engineering design for K-12 education. *Science Education*, *103*(4), 1080-1111.

Reading Set C: What criteria should be used to determine if instructional materials are of high-quality?

- National Council of Teachers of Mathematics (NCTM). (2014). Principles to actions: Ensuring mathematical success for all.
- Biological Sciences Curriculum Study. (2017). Guidelines for the evaluation of instructional materials in science.
- Cunningham, C. M., & Kelly, G. J. (2017). Epistemic practices of engineering for education. *Science Education*, *101*(3), 486-505.

Reading Set D: What are some other instructional models that can be used to develop instructional materials?

- Hamilton, E., Lesh, R., Lester, F. R. A. N. K., & Brilleslyper, M. (2008). Model-eliciting activities (MEAs) as a bridge between engineering education research and mathematics education research. *Advances in Engineering Education*, *1*(2), n2.
- Krajcik, J. S., & Blumenfeld, P. C. (2006). *Project-based learning.* The Cambridge Handbook of the Learning Sciences. (2006). R. Keith Sawyer (ed). Cambridge University Press (pp. 317-34).
- Bybee, R. W., Taylor, J. A., Gardner, A., Van Scotter, P., Powell, J. C., Westbrook, A., & Landes, N. (2006). The BSCS 5E instructional model: Origins and effectiveness. *Colorado Springs, Co: BSCS*, *5*, 88-98.