# **EDUC X408: Integrated Physical Sciences, Math and Scientific Literacy**

# **(3 units)**

*UC Merced Extension Education Programs has developed a plan for preparing teachers, which is defined by our Mission and Vision statements and is aligned with the Teacher Performance Expectations (TPEs) and the California Standards for the Teaching Profession (CSTP)****,*** *developed by the California Commission on Teacher Credentialing (CTC).*

**Mission**

The UC Merced Teacher Preparation Program exists to develop culturally responsive educators who equitably facilitate cross-disciplinary, integrative learning to catalyze student potential and empowerment.

**Vision**

The UC Merced Teacher Preparation Program aspires to be a recognized model for developing culturally responsive teachers who are committed to empowering their students. The Teacher Preparation Program is aligned with the vision of the University of California, Merced—upholding 21st century priorities for interdisciplinary learning and public service. To achieve this aspiration, the Teacher Preparation Program:

1. Aims to establish culturally respectful communication regarding questions, ideas, and solutions in the context of the Teacher Preparation Program courses and clinical placements.
2. Aims to nurture collaboration between teacher candidates and students to achieve learning goals, maximizing collective talent and expertise.
3. Aims to develop skills for critical and creative problem-solving among teacher candidates and students, applicable to all content domains.

**Extension Education Programs Learning Outcomes (EPLOs)**

The Teacher Preparation Program mission and vision are embedded in our Extension Education Programs Learning Outcomes (EPLOs). Teacher candidates graduating from the Teacher Preparation Program will be able to:

**Cultural Responsivity and Values (CRV):** demonstrate awareness, sensitivity, and responsiveness to diversity in every domain of learning, understanding values as opportunity for respectful exchange, collaboration, and shared commitment to the greater good.

**Content Knowledge (CK):** master state standards in the arts, humanities, language, literature, mathematics, physical science, natural science, and applied science along with capacity to monitor and guide personal learning.

**Communication and Information Literacy (CIL):** effectively convey information, engage in respectful dialogue, and share ideas through oral and written discourse, cultivating inquiry inclusive of self, other, and community.

**Professional Development (PD):** deploy problem-solving skills capable of transforming classrooms, promoting justice, fostering collaborative leadership, and addressing community concerns with mature civic identity.

**The Teacher Preparation Program Learning Outcomes (PLOs)**

Candidates (students) who complete the Teacher Preparation Program will be able to:

1. Develop a philosophy of education which uses theory to collaboratively guide practice, attending to the cultural and socio-emotional dimensions of teaching.
2. Personalize instruction and develop co-teaching models.
3. Develop lesson plans and deliver effective cross-disciplinary content, deploy appropriate assessments, distinguish between students of differing abilities, and apply learning-enhancing technologies to promote student potential and empowerment.
4. Practice restorative justice and authentic care.
5. Nurture and educate English language learners through an inclusive and positive class environment.
6. Develop critical and creative problem-solving for student empowerment across all academic subjects and content domains.
7. Communicate effectively through oral, visual, and written means with a wide range of audiences, including colleagues, families, and the community.

Finally, the *Teacher Performance Expectations (TPEs),*developed by the California Commission on Teacher Credentialing (CTC), and aligned with the California Standards for the Teaching Profession (CSTP) define how we formatively and summatively assess candidates.

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| **TPE 1:** Engaging and Supporting All Students in Learning | **TPE 2:** Creating and Maintaining Effective Environments for Student Learning | **TPE 3:** Understanding and Organizing Subject Matter for Student Learning |
| **TPE 4:** Planning Instruction and Designing Learning Experiences for All Students | **TPE 5:** Assessing Student Learning | **TPE 6:** Developing as a Professional Educator |

1. **Course Description:** EDUC X408 provides an integrated approach to Physical Sciences, Mathematics and Scientific Literacy inclusive of effective pedagogy. The focus is to examine and understand the curriculum and strategies that make science and mathematics learning available to all children, how children develop science and mathematics understanding and how assessments help guide meaningful instructional practices. Learning is framed as goal-oriented expertise capable of empowering diverse students and K-12 classroom communities.

1. **Course Goal and Outcomes**

1. ***Course Goal:*** The primary course goal is to provide candidates the opportunity to develop a deep conceptual understanding and mastery of the Physical science concepts (embedded in the Next Generation Science Standards; NGSS) and the mathematics standards (embedded in the California Common Core State Standards; CCSS) and how to integrate these across all content areas.

This course facilitates collaboration among candidates to foster creativity and critical thinking that promote effective science and math instruction across content disciplines and grades, benefitting culturally, ethnically, and linguistically diverse learners.

1. ***Learning Outcomes:*** Course Student Learning Outcomes (CLOs) are linked with Teacher Performance Expectations (TPEs) outlined by the CTC and with Program Learning Outcomes (PLOs), which are informed by the Extension Education Programs Learning Outcomes (EPLOs).
2. ***Literacy Definition and Course Component:*** CLOs 1, 3, 4, 5

Scientific literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity (NAS, 1996, p. 22).

1. ***English Language Learner (ELL), English Language Development (ELD) and/or Specifically Designed Academic Instruction for English (SDAIE) Course Component:*** CLOs 1, 2, 4, 5
2. ***Inclusive Instruction Course Component:*** CLOs 1, 2, 3, 4, 5, 6
3. ***Technology Course Component:*** CLOs 1, 2, 3, 4, 5

The Course Learning Outcomes (CLOs) support student development of the Program Learning Outcomes (PLOs). The connections between the CLOs are made explicit through the indication of which PLOs are connected to each CLO below.

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| **CLOs & Assessments** | **Grading** |
| **CLO 1:** Candidates will critically evaluate scientific, engineering and mathematical practices to engage and support all students in learning (TPE 1; PLOs 1, 2, 3, 5, 7).  **Assessment:** Class Participation (preparation, engagement, and reflection); TPE Discussion Blogs; Getting to Know Your Students; Content to Practice; Lesson Reflection and Application. | Description, Points, Weight:  see below |
| **CLO 2:** Candidates will use scientific, engineering and mathematical practices to create and maintain effective environments for diverse students and classrooms (TPE 2, PLOs 1, 2, 3, 4, 5, 7).  **Assessment:** Class Participation (preparation, engagement, and reflection); TPE Discussion Blogs; Getting to Know Your Students; Content to Practice; Lesson Reflection and Application. | Description, Points, Weight:  see below |
| **CLO 3:** Candidates will apply their understanding of scientific, engineering and mathematical practices to organize subject matter for student learning, inclusive of scientific literacy instruction (TPE 3; PLOs 3, 6, 7).  **Assessment:** Class Participation (preparation, engagement, and reflection); TPE Discussion Blogs; Getting to Know Your Students; Content to Practice; Lesson Reflection and Application. | Description, Points, Weight:  see below |
| **CLO 4:** Candidates will apply scientific, engineering and mathematical practices as they plan and design learning experiences for all students (TPE 4; PLOs 1, 2, 3, 4, 5, 6, 7).  **Assessment:** Class Participation (preparation, engagement, and reflection); TPE Discussion Blogs; Getting to Know Your Students; Content to Practice; Lesson Reflection and Application. | Description, Points, Weight:  see below |
| **CLO 5:** Candidates will consider scientific, engineering and mathematical practices as they assess student learning (TPE 5; PLOs 2, 3, 6, 7).  **Assessment:** Class Participation (preparation, engagement, and reflection); TPE Discussion Blogs; Getting to Know Your Students; Content to Practice; Lesson Reflection and Application. | Description, Points, Weight:  see below |
| **CLO 6:** Candidates will consider whether/how scientific, engineering and mathematical practices intersect with personal values and biases influencing instruction (TPE 6; PLOs 1, 4, 7).  **Assessment:** Class Participation (preparation, engagement, and reflection); TPE Discussion Blogs; Getting to Know Your Students; Content to Practice; Lesson Reflection and Application. | Description, Points, Weight:  see below |

| Description of Assessments | Points | **Weight** | Due Date |
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| **Class Reflection (Weekly Assignment in Canvas)**  Under each week you will find the agenda for the class session. You will be assessed on preparation for and attendance in class (10), engagement with your colleagues (10), and thoughtful reflection of the content (10) each week.  **Preparation: Video 3, 2, 1** (Bullet points - 100 words max)  What are three ideas/concepts new to you?  What are two things you wonder about?  What is one strategy/idea that you will incorporate into your classroom?  *Come prepared for a 10 minute discussion at the beginning of class.* | 30 | 15% | Weekly |
| **TPE Discussion Blogs (Weekly Assignment in Canvas)**  This course includes weekly online discussion. Critical engagement with readings, videos and course topics is required. This assignment consists of weekly blog entries on assigned readings, videos, and course topics. Your blog (minimum 250 words) should consider the following:  *Thoughtful synthesis and analysis of the content (10). Include any titles or authors as appropriate.*  *Specific connection of the content to 3- 4 TPE subcomponents, such that you have interacted with all 45 by the end of the term (10). Please include/quote the TPE subcomponent text and number.*  *Specific application of the content to math and science teaching and learning (10).*  In addition, you must respond to the entries of at least two other students per week. Please address the student to whom you are responding by first name. | 30 | 15% | Weekly |
| **Lesson Analysis**  You will observe a teacher conduct a science lesson (in a formal or informal environment). At the TK/K level, this may include whole group and small group instruction and stations, while upper grades may be entirely whole group instruction. You will analyze the lesson in light of the course content and TPEs.  We will use components of the CalTPA rubrics, which will be shared in class. | 30 | 10% | Week 7 |
| **Getting to Know Your Students**  You will identify three focus students in your class and locate and apply their current academic status, content- and standards-related learning needs and goals, assessment data, language proficiency status, and cultural background for both short-term and long-term instructional planning purposes.  We will use components of the CalTPA rubrics, which will be shared in class. | 30 | 10% | Week 11 |
| **Content to Practice: Lesson Planning, Design and Implementation**  Using the BSCS 5E Instructional Model, you will plan, design and implement a lesson which integrates math and science, making effective use of instructional time to maximize learning opportunities and provide access to the curriculum for all students by removing barriers and providing access through instructional strategies (see TPE 4.4).  This assessment affords the candidate the opportunity to practice for CalTPA Instructional Cycle 1.  We will use components of the CalTPA rubrics, which will be shared in class. | 30 | 30% | Week 13 – Discuss Lesson with Colleagues  Week 14 - Implement |
| **Lesson Reflection and Application: Annotated Video Recording of Lesson, Written Reflections and Video or Written Application**  You will annotate your video with titles and brief rationales for your teaching practices.  You will reflect on your own teaching and level of subject matter and pedagogical knowledge with respect to the whole class and your three focus students.  You will explain how what you learned during this assessment will advance your teaching practice and describe the next instructional steps for your students.  This assessment affords the candidate the opportunity to practice for CalTPA Instructional Cycle 1.  We will use components of the CalTPA rubrics, which will be shared in class. | 30 | 20% | Week 15 |

1. **Format and Procedures:** This synchronous, face-to-face class meets weekly for a semester. Some course content and all assessment submissions are handled through the Canvas learning management system.

1. **Course Requirements**
   1. ***Class Attendance and Participation Policy*** 
      1. Attendance: Attendance for all class sessions is required. A candidate is responsible for the content and experiences of any missed class sessions. Missing more than one class session for any reason constitutes excessive absences, which may be handled in the following way:
         1. Absences may impact a candidate’s final grade.
         2. The candidate may be granted an incomplete (in the case of illness or death in the family) and asked to retake a portion of, or the entire course in the following term.
         3. The candidate may be asked to re-enroll or retake the course.
      2. Anticipated Absences: The candidate is responsible for clearing anticipated absences with his/her professor of the class BEFORE committing to an event which conflicts with class (e.g., Back to School Night). This assures that a candidate has either developed a plan for receiving full benefit from the course or does not commit to the conflicting event.
      3. Late Work: In general, the policy regarding late work is that if work is late due to an excused absence (an absence cleared in advance), the work may be turned in up to one week late without penalty. All other late work is docked one letter grade and must be turned in within one week of its due date. Work turned in later than one week will receive no credit.
      4. Participation**:** Candidates are expected to participate fully in each class session, as each Teacher Preparation Program course is a combination of theory and praxis to facilitate development of the California Standards for the Teaching Profession (CSTP) as outlined in the Teaching Performance Expectations (TPEs), developed by the CTC.
      5. Tardiness: A candidate who is late to class is considered absent for that portion of the class. Habitual tardiness will accumulate to equal an absence of one or more class sessions (refer to section on Attendance above).
   2. ***Technology Policy***

Candidates are preparing to become professional educators. Candidates are expected to conduct themselves as professionals, fully engaging classroom learning as a matter of courtesy extended to colleagues. Smart phone and laptop technologies are for learning purposes only. These cannot be used during class for personal texting, email, or social media. Violators will receive a “F” grade for class participation.

* 1. ***Time Expenditure***

EDUC X408.2 is 3-unit course requiring a total of 135 hours (including class time) over the semester. The following is an estimated breakdown of time candidates can expect to spend in completing this course:

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| Class Sessions | 45 hours |
| Class Preparation and Reflection | 15 hours |
| TPE Discussion Blogs | 30 hours |
| Lesson Analysis | 5 hours |
| Getting to Know Your Students | 5 hours |
| Content to Practice | 20 hours |
| Lesson Reflection and Application | 15 hours |
| **Total** | **135 hours** |

*Note:* Hours spent in clinical practice (e.g., implementing a lesson) are part of your Teaching Practicum and are not considered part of your hours for this course.

1. **Grading Procedures:** All UC Merced Extension Teacher Preparation Program courses are graded. The course grade will be calculated as follows:

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| --- | --- |
|  | % |
| Class Preparation and Reflection | 15 |
| TPE Discussion Blogs | 15 |
| Lesson Analysis | 10 |
| Getting to Know Your Students | 10 |
| Content to Practice | 30 |
| Lesson Reflection and Application | 20 |
| **Total** | **100%** |

Candidates must achieve a B course grade for credit in the UC Merced Extension Teacher Preparation Program. A course grade lower than B is not acceptable for credit in the Teacher Preparation Program. Letter grades will be assigned as follows:

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| **Letter Grade** | **Percentage** | **Grade Point Equivalent** | **Graduate Level Grades** |
| A | 93-100% | 4.0 | Excellent |
| A- | 90-92% | 3.7 | Outstanding |
| B+ | 87-89% | 3.3 | Above Average |
| B | 83-86% | 3.0 | Average |
| B- | 80-82% | 2.7 | Satisfactory |
| C+ | 77-79% | 2.3 | Marginal, but not acceptable for credit in the Teacher Preparation Program |
| C | 73-76% | 2.0 |
| C- | 70-72% | 1.7 |
| D | 60-69% |  | Not acceptable |
| F | 0-59% |  | Not acceptable |

1. **Academic Integrity:** Each candidate in this course is expected to abide by the University of California, Merced Academic Honesty Policy. Any work submitted by a candidate in this course for academic credit will be the candidate's own work. Candidates are encouraged to study together and to discuss information and concepts covered in the course with other students. Candidates can give "consulting" help to or receive "consulting" help from each other. However, this cooperation should never involve one student taking credit for work done by someone else. Violation of UC Merced Academic Honesty Policy will result in an automatic “F” for the assignment. At instructor discretion, the policy may be extended to include failure of the course and/or University disciplinary action.
2. **Accommodations for Students with Disabilities:** The University of California, Merced is committed to ensuring equal academic opportunities and inclusion for candidates with disabilities based on the principles of independent living, accessible universal design and diversity. The instructor is available to discuss appropriate academic accommodations that may be required for a candidate with disabilities. Requests for academic accommodations are to be made during the first three weeks of the semester (or equivalent), except for unusual circumstances. Candidates are encouraged to register with the Disability Services Center to verify their eligibility for appropriate accommodations.
3. **Tentative Weekly Schedule** (Outlined as if offered during Fall or Spring Semester for 15 weeks. For summer, multiple sessions are taught in a single week).

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| **TENTATIVE SCHEDULE**  **(subject to change)** | | | |
| **Week** | **Topic** | **Readings for TPE Discussion Blog** | **Due** |
| 1  Aug. 22 | *Welcome, introductions, and overview.*  *How are engineering, technology, science and society interconnected?*  Science: Interdependence of Science, Engineering and Technology; Influence of Engineering, Technology and Science on Society and the Natural World |  |  |
| 2  Aug. 29 | *How do engineers solve problems?*  Science: Defining and Delimiting an Engineering Problem; Developing Possible Solutions; Optimizing the Design Solution  Math: How math relates to engineering | 4 articles | Class Reflection  TPE Discussion Blog  Video – Reflection  Video – 3, 2, 1 Practice |
| 3  Sept. 5 | *How do particles combine to form the variety of matter one observes?*  Science: Structures and Properties of Matter  Math: Fractions, Decimals, Percent(s) and Ratios | 1 article – SEP science activity | Class Reflection  TPE Discussion Blog  Video – 3, 2, 1: States of Matter |
| 4  Sept. 12 | *How do substances combine or change (react) to make new substances? How does one characterize and explain these reactions and make predictions about them?*  Science: Chemical Reactions  Math: Dimensional Analysis | Teaching Science Through Inquiry Based Instruction – pp. 97-107 | Class Reflection  TPE Discussion Blog  Video – 3, 2, 1: Chemical Reactions |
| 5  Sept. 19 | *What forces hold nuclei together and mediate nuclear processes?*  Science: Nuclear Processes  Math: Fractions, Decimals, Percent(s) and Ratios | Teaching Science Through Inquiry Based Instruction – pp. 84-97 | Class Reflection  TPE Discussion Blog  Video – 3, 2, 1 |
| 6  Sept. 26 | *How can one predict an object’s continued motion, changes in motion, or stability?*  Science: Forces and Motion  Math: Geometry | Teaching Science Through Inquiry Based Instruction – pp. 111-119 | Class Reflection  TPE Discussion Blog  Video – 3, 2, 1 |
| 7 | *What underlying forces explain the variety of interactions observed?*  Science: Types of Interactions  Math: Geometry | Teaching Science Through Inquiry Based Instruction – pp. 120-126 | Class Reflection  TPE Discussion Blog  Video – 3, 2, 1 |
| 8 | *What is energy?*  Science: Definitions of Energy  Math: Algebraic Thinking, Equations and Functions | Teaching Science Through Inquiry Based Instruction – pp. 126-138 | Class Reflection  TPE Discussion Blog  Video – 3, 2, 1  **Lesson Analysis** |
| 9 | *What is mean by conservation of energy? How is energy transferred between objects?*  Science: Conservation of Energy and Energy Transfer  Math: Probability and Data Analysis |  | Class Reflection  TPE Discussion Blog  Video – 3, 2, 1 |
| 10 | *How are forces related to energy?*  Science: Relationship Between Forces and Energy  Math: Probability and Data Analysis |  | Class Reflection  TPE Discussion Blog  Video – 3, 2, 1 |
| 11 | *How do food and fuel provide energy? If energy is conserved, why do people say it is produced or used?*  Science: Energy in Chemical Processes and Everyday Life  Math: Probability and Data Analysis; Number Sense |  | Class Reflection  TPE Discussion Blog  Video – 3, 2, 1 |
| 12 | *How are waves used to transfer energy and information?*  Science: Wave Properties  Math: Probability and Data Analysis; Mastering Basic Facts |  | Class Reflection  TPE Discussion Blog  Video – 3, 2, 1  **Getting to Know Your Students** |
| 13 | *What is light? How can one explain the varied effects that involve light? What other forms of electromagnetic radiation are there?*  *Discuss Lesson with Colleagues*  Science: Electromagnetic Radiation |  | Class Reflection  TPE Discussion Blog  Video – 3, 2, 1  **Content to Practice** |
| 14 | *How are instruments that transmit and detect waves used to extend human senses?*  *Model Lesson Video Workshop*  Science: Information Technologies and Instrumentation | Implement Lesson | Class Reflection  TPE Discussion Blog  Video – 3, 2, 1 |
| 15 | *Final Presentations* |  | Class Reflection  TPE Discussion Blog  **Lesson Reflection and Application** |

**Required Texts**

National Council of Teachers of Mathematics (NCTM). (2014). *Principles to actions: Ensuring mathematical success for all*.\*

**Required Resources (available online or in Canvas)**

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.\*

California Department of Education - Common Core State Standards (CCSS) and Resources\* <https://www.cde.ca.gov/Re/cc/>

Common Core State Standards (CCSS) – Mathematics\* <https://www.cde.ca.gov/be/st/ss/documents/ccssmathstandardaug2013.pdf>

Common Core State Standards (CCSS) – English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects\* <https://www.cde.ca.gov/be/st/ss/documents/finalelaccssstandards.pdf>

The Next Generation Science Standards (NGSS) – California\* <https://www.nextgenscience.org/california>

Marshall, J. (2013). *Succeeding with inquiry in science and math classrooms*. ASCD.\*

Murphy, A., Grooms, J., Enderle, P., Hutner, T., & Sampson, V. (2016). *Argument-Driven inquiry in physical science: Lab investigations for grades 6-8.* Arlington, VA: NSTA Press.

National Academy of Sciences. (1996). *National Science Education Standards*. National Academy Press, Washington, D.C.

Spiegel, J. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Adapted from the National Research Council. San Diego County Office of Education.\*

Tomlinson, C. A., & McTighe, J. (2006). *Integrating differentiated instruction & understanding by design: Connecting content and kids*. ASCD.\*

**Recommended Resources (Selected readings will be provided in Canvas)**

Van de Walle, J., Karp, K. & Bay-Williams, J. (2014). *Elementary and middle school mathematics: Teaching developmentally (9th edition)*. New York: Addison & Wesley\*

Marcarelli, K. (2010). *Teaching science with interactive notebooks.* Thousand Oaks, CA: Corwin Press. ISBN 978-1-4129-5403-7\*

Morgan, E., & Ansberry, K. (2017). *Picture-Perfect STEM lessons, K-2: Using children’s books to inspire STEM Learning*. Arlington, VA: NSTA Press.\*

Morgan, E., & Ansberry, K. (2017). *Picture-Perfect STEM lessons, 3-5: Using children’s books to inspire STEM Learning*. Arlington, VA: NSTA Press.\*

\*This resource/text is used in multiple courses.