I. Course Description

This doctoral course delves into the design, development, and implementation of effective integrated STEM curricula. Through a blend of theoretical foundations, research exploration, and practical applications, students will gain the necessary knowledge and skills to become informed about the field of integrated STEM education.

II. Course Framework

There are several compelling reasons why integrated STEM education is becoming increasingly important:

1) **Reflects the Real World**: Most real-world problems require an understanding of multiple disciplines. STEM fields are inherently interconnected. For instance, designing a sustainable bridge requires knowledge of physics, materials science, engineering principles, and potentially even environmental impact considerations. Integrated STEM education equips students to approach problems holistically, just like professionals in these fields.

2) **Boosts Critical Thinking and Problem-Solving**: By weaving together STEM concepts, students are encouraged to think critically and creatively to solve problems. They learn to not only apply knowledge from different disciplines but also see the relationships between them. This fosters a deeper understanding and ability to tackle complex challenges.

3) **Enhances Engagement and Motivation**: Integrated STEM education can make learning more engaging and relevant for students. By presenting science, technology, engineering, and math in a connected way, students can see the practical applications and how these fields impact their lives. This can spark curiosity and motivate them to delve deeper.

4) **Develops 21st Century Skills**: The ability to collaborate, communicate effectively, and think critically are essential for success in today's workforce. Integrated STEM education fosters these skills by encouraging teamwork, project-based learning, and the communication of complex ideas across disciplines.

This syllabus is subject to change as needed. Any changes to the syllabus will be announced in class.
5) **Prepares Students for Future Careers:** The job market is increasingly demanding a STEM-skilled workforce. By providing a solid foundation in all these areas, integrated STEM education prepares students for a wider range of career options and equips them with the necessary skills to thrive in a rapidly evolving technological landscape.

Overall, integrated STEM education aims to create well-rounded thinkers and innovators who can approach challenges with a multifaceted perspective and a solid foundation in core disciplines.

### III. Course Objectives and Learning Outcomes

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

- Analyze the theoretical foundations of integrated STEM education.
- Understand frameworks for integrated STEM curriculum development.
- Evaluate research on effective STEM teaching and learning strategies.
- Critically assess integrated STEM curricula using STEM roadmaps.
- Effectively communicate the benefits of integrated STEM education.

### IV. Learning Modules:

This course is designed using a **modular format**—that is, each week is “packaged” as a single module so that all the materials, lecture notes, submission areas, discussion posts are in one area for a given week.

### V. Required Text & Readings:


- Other required readings for all students will be available through open-source websites, through Blackboard, and through electronic journals accessible through the UTEP library website.

### VI. Technology Requirements

Course content is delivered via the Internet through the Blackboard learning management system. Ensure your UTEP e-mail account is working and that you have access to the Web and a stable web browser. Google Chrome and Mozilla Firefox are the best browsers for Blackboard; other browsers may cause complications. When having technical difficulties, update your browser, clear your cache, or try switching to another browser.

You will need to have access to a computer/laptop, scanner, a webcam, and a microphone. You will need to download or update the following software: Microsoft Office, Adobe Acrobat Reader, Windows Media Player, QuickTime, and Java. Check that your computer hardware and software are up-to-date and able to access all parts of the course.
If you do not have a word-processing software, you can download Word and other Microsoft Office programs (including Excel, PowerPoint, Outlook and more) for free via UTEP’s Microsoft Office Portal. Click the following link for more information about Microsoft Office 365 and follow the instructions.

**IMPORTANT:** If you encounter technical difficulties beyond your scope of troubleshooting, please contact the UTEP Help Desk as they are trained specifically in assisting with technological needs of students.

**VII. Inclusiveness and Equity**

Learning happens only when we feel respected as a whole human being. My top priority in our classroom is to cultivate relationships of trust and respect and a sense that we see each other as whole, complex human beings. That you experience this in our classroom is important for the sake of your learning in our course and for the sake of your future students’ learning, so that you feel able to cultivate such relationships with them. To that end, I want you to know that all of you is welcome in our classroom space—all the parts of you as a person are welcome in our discussions, our activities, our assignments, and in our assessments. We are all complex people with a variety of perspectives, experiences, challenges, assets, and resources—our gender identities, our sexual orientations, our religions, our races, our ethnicities, our economic statuses, our immigration statuses, our parenthoods, our veteran statuses, our ages, our languages, our abilities and disabilities. All the parts of you are welcome in our learning community to the extent that you feel comfortable bringing them in. I strive to show respect for the variety and wholeness in each of you, and I expect that each of you shows respect for each other as well. If you feel marginalized in our class, and you feel comfortable discussing it, I would like to know so that I can support you, protect you, and make changes that feel more inclusive and equitable. You can also talk with our Department Chair and/or you can report a complaint of discrimination to the University’s Equal Opportunity Office, Kelly Hall, Third Floor, 915-747-5662 or eoaa@utep.edu.

**VIII. Standards of Academic Integrity**

Students are expected to uphold the highest standards of academic integrity. Any form of scholastic dishonesty is an affront to the pursuit of knowledge and jeopardizes the quality of the degree awarded to all graduates of UTEP. Any student who commits an act of scholastic dishonesty is subject to discipline. Scholastic dishonesty includes, but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are not attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts. Proven violations of the detailed regulations, as printed in the Handbook of Operating Procedures (HOP) and available in the Office of the Dean of Students, may result in sanctions ranging from disciplinary probation, to failing grades on the work in question, to failing grades in the course, to suspension or dismissal, among others.

**IX. Students with Disabilities Statement**

If you have or believe you have a disability, you may wish to self-identify. You can do so by providing documentation to the Center for Accommodations and Support Services (CASS) located in Union E Room 106. Students who have been designated as having a disability must reactivate their standing with CASS on a yearly basis. Failure to report to this office will place a student on the inactive list and nullify benefits received. If you have a condition which may affect your ability to exit safely from the premises in an emergency or which may cause an emergency during class, you are encouraged to discuss this in confidence with the instructor and/or the director of CASS. You may call 915-747-5148 for general information about the Americans with Disabilities Act (ADA).
X. Evaluation & Coursework Requirements of Students:

<table>
<thead>
<tr>
<th>Coursework Requirements</th>
<th>Points</th>
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<tbody>
<tr>
<td>Discussion Boards – 4 x 10 pts</td>
<td>40</td>
</tr>
<tr>
<td>Writing Assignments (Original Literature Review) – 3 x 20 pts</td>
<td>60</td>
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<tr>
<td>Final Paper</td>
<td>100</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>200</strong></td>
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<thead>
<tr>
<th>How Grades are Determined</th>
<th>Grade</th>
<th>Percentage (%)</th>
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<tbody>
<tr>
<td>A</td>
<td>90-100</td>
<td>90 - 100</td>
</tr>
<tr>
<td>B</td>
<td>80-89.9</td>
<td>80 - 89.9</td>
</tr>
<tr>
<td>C</td>
<td>70-79.9</td>
<td>70 - 79.9</td>
</tr>
<tr>
<td>D</td>
<td>60-69.9</td>
<td>60 - 69.9</td>
</tr>
<tr>
<td>F</td>
<td>Below 60</td>
<td>Below 60</td>
</tr>
</tbody>
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XI. Course Assignments

1. Final Paper

   **Option 1:**

   The focus of the final paper is to write a synthesis paper on a topic that is aligned well with your developing research interest(s) in the area of curriculum and instruction in STEM education. You will be responsible for writing a **minimum 25 page** paper. For your paper, you must include an introduction section and a literature review. You are required to have a **minimum of twelve solid references** from peer-reviewed journals and edited books. Some examples example topics include, but are not limited to the following:

   **Impact and Effectiveness**

   o **Long-term effects of integrated STEM curricula:** This research could track students who participated in integrated STEM programs in elementary school and assess their STEM knowledge, critical thinking skills, and career aspirations in high school or even college.
   o **The role of integrated STEM in fostering creativity and innovation:** This research could explore how different instructional strategies within integrated STEM curricula promote creative problem-solving and innovative thinking in students.
   o **Closing the achievement gap through integrated STEM:** This research could investigate how integrated STEM education can address achievement gaps in traditionally underrepresented groups in STEM fields.

   **Curriculum Design and Implementation:**

   o **The impact of teacher professional development on successful integrated STEM implementation:** This research could explore how specific professional development programs equip teachers with the knowledge and skills necessary to effectively implement integrated STEM curricula.
   o **The role of technology in integrated STEM classrooms:** This research could investigate the effectiveness of different technology tools (e.g., simulations, artificial intelligence technology, etc.) in supporting integrated STEM learning.
   o **Developing culturally relevant integrated STEM curricula:** This research could explore how to design integrated STEM curricula that are culturally relevant and engaging for students from diverse backgrounds.
Assessment and Evaluation:

- **Developing effective assessment tools for integrated STEM learning**: This research could examine different assessment methods (e.g., performance-based assessments, portfolios) to accurately measure student learning in integrated STEM environments.

- **The role of student self-assessment in integrated STEM learning**: This research could explore how fostering student self-assessment skills can enhance their metacognition and ownership of learning within integrated STEM projects.

- **The impact of integrated STEM on student motivation and engagement**: This research could investigate how integrated STEM curricula can influence student motivation and engagement in learning compared to traditional, siloed approaches.

Additional Ideas:

- **Investigating the integration of arts and humanities into STEM curricula (STEAM)**: This research could explore the potential benefits of incorporating elements of art, music, history, or language arts into integrated STEM units to promote creativity and interdisciplinary connections.

- **The role of community partnerships in enhancing integrated STEM learning**: This research could examine how collaborating with local businesses, museums, or research institutions can provide authentic learning experiences for students within integrated STEM projects.

**Option 2:**

Based on the STEM Road Map template (Appendix A of this syllabus) as well as examples in the textbook, create an integrated STEM module on your choice of project topic. Include a minimum of three learning activities and assessment methods. You are encouraged to utilize multimedia tools such as simulations, animations, or educational games within the module. Your accompanying paper must include an introduction and a literature review focusing on why it is important for students and teachers to learn your topic or topics and why they should learn it based on your understanding of philosophy, nature, and history of integrated STEM education.

2. **Original Literature Review**

You will complete 3 short writing assignments over the course of the Summer (see calendar) that will constitute a final literature review or knowledge map. Guidelines for conducting this review will be provided by me. The purpose of this assignment is to help you develop your personal philosophy, theoretical framework, and epistemology for your personal research in STEM education. It is also intended to help you with your final paper for the course (either Option 1 or Option 2).

- **Writing assignment 1**: Use the AI-powered academic search engine, Litmaps, as well as Google Scholar to find relevant papers based on keywords related to your research interest. Compile a bibliography that lists a minimum of 12 references including journal articles, book chapters, and/or research reports.

- **Writing assignment 2**: After thoroughly reading the articles on your list, conduct an analysis of the literature -- Take notes while reading, summarizing key points, methods, findings, and arguments presented by each author. You may use the AI-powered workspace, PopAI, to help you summarize and highlight the key points of articles in your bibliography. Pay attention to recurring themes, debates, or contradictory findings across the literature. This will help you identify knowledge gaps and formulate your own research questions. For this assignment, you will develop an outline for
your literature review, using your identified themes as a guide. This will give your writing a clear structure and flow.

- **Writing assignment 3**: Create an initial draft of your literature review. Write your introduction, which should provide background information on your research topic and highlight the purpose of your literature review. Briefly mention the key themes and arguments you will explore. Use your outline as a roadmap, dedicating sections to address the different themes or categories of sources you identified. Do not just summarize each source. Analyze and synthesize the information. Explain how different studies relate to each other, identify areas of agreement and disagreement, and highlight any research gaps. Do not just present information passively. Evaluate the strengths and weaknesses of the research you are discussing. Point out methodological limitations or potential biases in the studies you reviewed. Ensure a smooth flow between sections by using clear transitions that connect your analysis of various sources.

### 3. Discussion Boards

You will be reading journal articles and the required textbooks, and you will be asked to write a reflection on certain reading assignments. I will provide you the prompt and each reflection will be posted on the discussion board. A rubric for your discussion board posts will be provided to you. Each initial response should be substantive and must be posted by midnight, Mountain Standard Time, on the due date. In your substantive posts you are encouraged to use references (e.g. class notes and/or other resources I provide to you). Show evidence of critical thinking as it applies to the concepts or prompt and/or use examples of the application of the concepts to STEM education. Your replies should build on the concept discussed, offer a question to consider, or add a differing perspective, etc. YOU MUST RESPOND TO ALL OF YOUR CLASSMATES.

### XII. Course Requirements

1. **Participation**: It is expected that students will attend class and actively participate in working on projects and class discussions. With the emphasis on collegiality, it is important that all group members be in class to contribute to the group’s effort in developing an understanding of the course material.

2. **Due dates**: Assignments are due on the specified dates. Type or word-process written assignments. All assignments should be double spaced with a 12-point font. Number your pages.

3. **Calendar changes**: The schedule of topics and reading assignments may change over the course of the semester. Any changes to the syllabus will be announced. Every student is responsible for these changes.
XIII. **Class Schedule:** *Please note that the schedule below is subject to change. All assignments are DUE ON THE DATE INDICATED.*

<table>
<thead>
<tr>
<th>DATE</th>
<th>TOPIC</th>
<th>ASSIGNMENT</th>
</tr>
</thead>
</table>
| **Week 1** | • Demystifying STEM  
| June 12    |   o The nature of science (NOS) as a foundation for STEM teaching and learning  
|            |   o Theoretical foundations of integrated STEM education             | Reading: McComas, Almazroa & Clough (1998) |
| **Week 2** | • Epistemological perspectives on integrated STEM education          | DISCUSSION 1 DUE    |
| June 19    |                                                                 | Reading: Reynante, et al. (2020) |
| **Week 3** | • STEM curriculum and instruction by design                           | PAPER 1 DUE         |
| June 26    |   o STEM learning environments                                        | Reading: Holstein & Keene (2013) |
| **Week 4** | • STEM Curriculum Maps EC - 5                                         | DISCUSSION 2 DUE    |
| July 3     |                                                                 | Reading: Johnson, et al. (2021) Chapters 4 and 5                      |
| **Week 5** | • STEM Curriculum Maps 6 - 8                                          | PAPER 2 DUE         |
| July 10    |                                                                 | Reading: Johnson, et al. (2021) Chapter 6                             |
| **Week 6** | • STEM Curriculum Maps 9 - 12                                         | DISCUSSION 3 DUE    |
| July 17    |                                                                 | Reading: Johnson, et al. (2021) Chapter 7                             |
| **Week 7** | • Assessment in STEM Education                                        | PAPER 3 DUE         |
| July 24    |                                                                 | Reading: Gao, et al. (2020)                                           |
| **Week 8** | • Bringing it all together                                            | DISCUSSION 4 DUE    |
| July 31    |                                                                 | FINAL PAPER DUE       |
| **August 7**| Exam week                                                              |                      |
APPENDIX A: STEM Road Map Curriculum Module Planning Template

This template can be used to plan and develop engaging STEM curriculum modules that integrate Science, Technology, Engineering, and Mathematics (STEM) concepts. It provides a framework to design well-structured and engaging STEM modules. Remember to adapt and modify it to fit your specific learning objectives and student needs.

Module Title: (Enter a captivating title that reflects the central theme)

Grade Level: (Specify the target grade level)

Estimated Time: (Indicate the approximate number of days or weeks required)

Learning Objectives: (List the specific skills and knowledge students will gain by completing the module)

(Learning Objective 1)
(Learning Objective 2)
(Learning Objective 3)
(Learning Objective 4)

Driving Force/Central Challenge: (Describe the real-world problem or challenge that will motivate student engagement with the module)

STEM Integration: (Outline how each STEM discipline (Science, Technology, Engineering, and Mathematics) will be integrated throughout the module)

Science: (Specify the scientific concepts and principles students will explore)
Technology: (Describe the technology tools or applications students will utilize)
Engineering: (Explain the engineering design process students will follow)
Mathematics: (Identify the mathematical concepts and skills students will apply)

Module Activities: (List the individual activities or lessons that make up the module, with a brief description of each)

Activity 1: (Title and brief description)
Activity 2: (Title and brief description)
Activity 3: (Title and brief description)

Assessment: (Describe how you will assess student learning throughout and at the end of the module)

Formative Assessments: (Examples: Observations, Exit Tickets, Quizzes)
Summative Assessments: (Examples: Projects, Presentations, Tests)

Differentiation: (Explain how you will adapt the module to meet the needs of diverse learners)

(Strategies for scaffolding instruction)
(Methods for providing enrichment opportunities)
Materials and Resources: (List all the necessary materials, technology tools, and resources for the module)

(Required materials)
(Technology tools)
(Online resources)

Extension Activities: (Suggest optional activities that students can pursue for further exploration)

(Ideas for independent research)
(Opportunities for real-world application)

Alignment to Standards: (List the specific national or state standards addressed by the module)

(Standard 1)
(Standard 2)
(Standard 3)
... (Continue adding standards if necessary)

Notes: (Use this section for any additional information or considerations)