Western Education

Transforming Education. Transforming Lives.

EDUC 5466

Curriculum & Pedagogy in STEM Education

Instructor:

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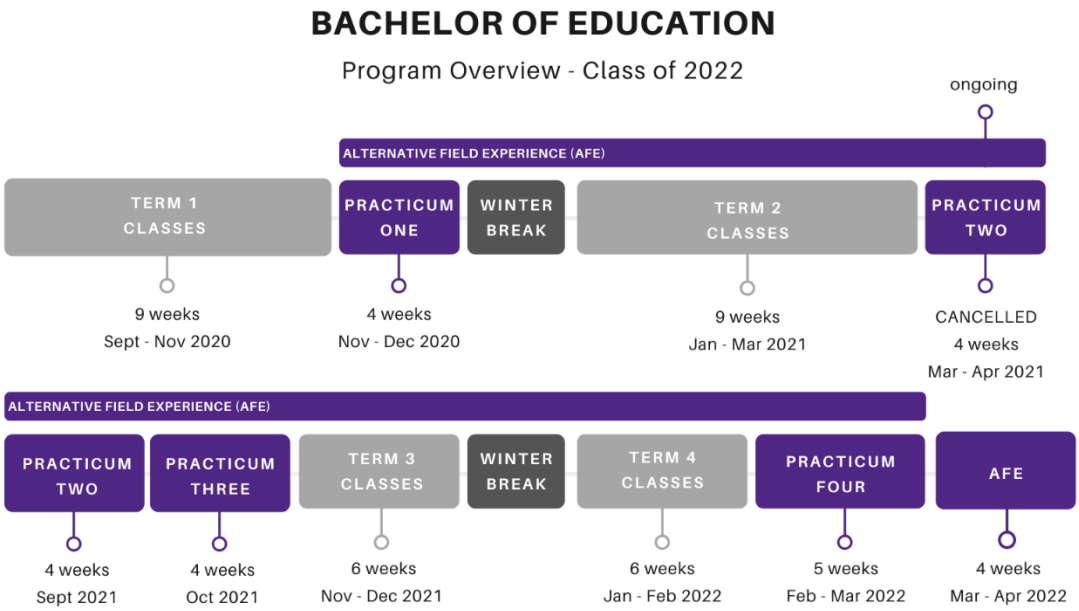
Schedule:

Section 001: Tuesday 9:30AM-12:30PM,
Room: 2046

Program Context:

This is a **Specialty Course** taken by Teacher Candidates during **Year 2, Full Year** of the Bachelor of Education.



Syllabus Report

STEM Education (EDUC 5466)

A focus on STEM education within the broader curricular spectrum. Teacher Candidates develop pedagogical content knowledge, skills, technologies, instructional strategies, and assessments to support the design and development of STEM projects. 3 hours per week, full year, 0.5 credit.

This course promotes the development of science teaching professionals through in-depth analysis of teaching procedures, constructivist models that reveal and promote student understanding of STEM, and materials for selecting and organizing instruction.

Students develop interdisciplinary focused curricula that incorporate these aspects of teaching and learning, the appropriate use of technology, authentic assessment, and current STEM and educational research. The course provides opportunity for professional growth through reviews of professional literature, participation in professional science education organizations, and contribution to national, provincial, and/or local school STEM activities.

You will be given opportunities to reflect upon:
-STEM pedagogy based on “student-centered” and “constructivist” models of learning;
-Strategies for dealing with values education, equity, and environmental issues in STEM;
-Appropriate strategies for assessing student understanding and evaluating student performance;
-How to create “non-threatening” learning environments;
-Curriculum planning and design and program modification strategies;
-Strategies for planning lessons and units of study incorporating STEM education;
-Different backgrounds, levels, interests, and needs of all students; and
-Your own teaching performance and professional growth.

Course Resources:

• Differentiated Instruction Educator’s Package. (2010). Retrieved from http://www.edugains.ca/resourcesDI/EducatorsPackages/DIEducatorsPackage2010/2010EducatorsGuide.pdf
• Ontario College of Teachers. (2016). Foundations of Professional Practice. Retrieved from https://www.oct.ca/-/media/PDF/Foundations%20of%20Professional%20Practice/Foundation_e.pdf
• Ontario’s Education Equity Action Plan. (2017). Retrieved from http://www.edu.gov.on.ca/eng/about/education_equity_plan_en.pdf
• Ontario Ministry of Education. (2007). The Ontario Curriculum Grades 1-8: Science and Technology. Toronto: Queen’s Printer.
• Ontario Ministry of Education. (2007). The Ontario Curriculum Grades 9 and 10: Science. Toronto: Queen’s Printer.
• Ontario Ministry of Education. (2008). The Ontario Curriculum Grades 11 and 12: Science. Toronto: Queen’s Printer.
• Ontario Ministry of Education. (2009). The Ontario Curriculum Grades 1-8: Environmental Education.
• Ontario Ministry of Education. (2009). The Ontario Curriculum Grades 9-12: Environmental Education.
• Ontario Ministry of Education. (2010). Growing success: Assessment, evaluation, and reporting in Ontario schools. Toronto, ON: Queen’s Printer for Ontario. Retrieved from http://www.edu.gov.on.ca/eng/policyfunding/growsuccess.pdf

Number of Credits: 0.5

Number of Weeks: 12

Week 1: Introduction (November 2, 2021)

- Syllabus
- Introductions
- Discussion and Articles' Analysis: STEM Education and Contemporary Issues

Learning Activities

Type	Name	Description
Formative Assessment	Week 1 Activities	**•Before Class:** Introduce yourself on Prezi **•In-class:** signup-timelines and class discussions
Reading	Week 1 Readings	**Each student will be assigned one reading of the following list:** • Brown, R., Ernst, J., DeLuca, B., & Kelly, D. (2017). STEM curricula. Technology and Engineering Teacher, 77(1), 26. • DeCoito, I. (2016). STEM education in Canada: A knowledge synthesis. Canadian Journal of Science, Mathematics and Technology Education, 16(2), 114-128. • DeCoito, I. & Estaiteyeh, M. (in press). STEM teachers' experiences with online teaching during the COVID-19 pandemic. • Subotnik, R.F., Tai, R.H., Rickoff, R., & Almarode, J. (2010). Specialized public high schools of science, mathematics, and technology and the STEM pipeline: What do we know now and what will we know in 5 years. Roeper Review, 32, 7-16.

Week 2: Scientific Literacy; Nature of Science (NOS); Equity, Diversity, Inclusion, and Decolonization (EDID); and Digital Timelines (November 9, 2021)

- Scientific Literacy
- NOS
- EDID
- Differentiated Instruction
- Digital Scientific Timelines: Research and Development

Learning Activities

Type	Name	Description
Formative Assessment	Week 2 Activities	**•Before Class:** Readings **•In-class:** R&D-timelines and class discussions
Reading	Week 2 Readings	**Each student will be assigned one reading of the following list:** • Bybee, R., McCrae, B., & Laurie, R. (2009). PISA 2006: An assessment of scientific literacy. Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching, 46(8), 865-883. • Capacity Building Series (2013). Culturally responsive pedagogy: Towards equity and inclusivity in Ontario schools. Retrieved from https://thelearningexchange.ca/wp-content/uploads/2017/02/CBS_ResponsivePedagogy.pdf • Ladson-Billings, G. (2014). Culturally relevant pedagogy 2.0: aka the remix. Harvard Educational Review, 84(1), 74-84. • Laugksch, R. C. (2000). Scientific literacy: A conceptual overview. Science Education, 84(1), 71-94. • Morrell, P. D., & Popejoy, K. (Eds.). (2014). A few of our favorite things: teaching ideas for K-12 science methods instructors. Springer. • Tomlinson, C.A., Brighton, C., Hertberg, H., Callahan, C.M., Moon, T.R., Brimijoin, K., Conover, L.A. & Reynolds, T. (2003). Differentiating instruction in response to student readiness, interest, and learning profile in academically diverse classrooms: A review of literature. Journal for the Educationally Gifted, 27, 119–145. • Tomlinson, C. A., & Imbeau, M. B. (2012). Common sticking points about differentiation. School Administrator, 69(5), 18-22.

Week 3: Digital Timelines (November 16, 2021)

- Timelines: Research and Development
- Case Studies: Introduction

Learning Activities

Type	Name	Description
Formative Assessment	Week 3 Activities	•**Before Class:** Readings and continue working on timelines •**In-class:** R&D-timelines and signup-case studies
Summative Assessment	Week 3 Activities	•**After class:** post the timeline and review others' timelines
Reading	Week 3 Readings	DeCoito, I. (2014). Teaching about the nature of science through digital scientific timelines. A few of our favorite things: Teaching ideas for K-12 science methods instructors. Sense Publishers.

Week 4: Digital Timelines and Case Studies (November 23, 2021)

- Timelines: Discussion and Reflection
- Case Studies: Research and Development

Learning Activities

Type	Name	Description
Formative Assessment	Week 4 Activities	•**Before Class:** Review others' timelines •**In-class:** Discuss timelines and R&D-case studies •**After Class:** Reflection-timelines

Week 5: Socio-Scientific Issues (SSI); Science, Technology, Society, and Environment (STSE); and Case Studies (November 30, 2021)

- SSI
- STSE
- Argumentation
- Case Studies: Research and Development

Learning Activities

Type	Name	Description
Formative Assessment	Week 5 Activities	**•Before Class:** Readings **•In-class:** R&D-case studies and class discussions
Reading	Week 5 Readings	**Each student will be assigned one reading of the following list:** • DeCoito, I., & Fazio, X. (2017). Developing case studies in teacher education: Spotlighting socioscientific issues. Innovations in Science Teacher Education, 2(1). • Evagorou, M., Albe, V., Angelides, P., Couso, D., Chirlesan, G., Evans, R.H., Dillon, J., Garrido, A., Guven, D., Mugaloglu, E., & Nielsen, J.A. (2014). Preparing pre-service science teachers to teach socio-scientific (SSI) argumentation. Science Teacher Education, 69, 39-48. • Gray, D. S. & Bryce, T. (2006). Socio-scientific issues in science education: Implications for the professional development of teachers. Cambridge Journal of Education, 36(2), 171-192. • Hughes, G. (2000). Marginalization of socioscientific material in science-technology-society science curricula: Some implications for gender inclusively and curriculum reform. Journal of Research in Science Teaching, 37(5), 426-440. • Pedretti, E., & Bellomo, K. (2013). A time for change: Advocating for STSE education through professional learning communities. Canadian Journal of Science, Mathematics and Technology Education, 13(4), 415-437. • Schwartz, M. (2014), Teaching methods for case studies. Retrieved from https://www.ryerson.ca/content/dam/learning-teaching/teaching-resources/teach-a-course/case-method.pdf • Seethaler, S. (2005). Helping students make links through science controversy. The American Biology Teacher, 67(5), 265-274.

Week 6: Case Studies and Project-Based Teaching (December 7, 2021)

- Case Studies: Research and Development
- Project-Based Teaching
- Entrepreneurship in Projects

Learning Activities

Type	Name	Description
Formative Assessment	Week 6 Activities	**•Before Class:** Readings **•In-class:** R&D-case studies, class discussions, and signup-projects
Reading	Week 6 Readings	**Each student will be assigned one reading of the following list:** • Capraro, M. M., & Jones, M. (2013). Interdisciplinary STEM project-based learning. In STEM project-based learning (pp. 51-58). Brill Sense. • Capraro, R. M., & Slough, S. W. (2013). Why PBL? Why STEM? Why now? An introduction to STEM project-based learning: An integrated science, technology, engineering, and mathematics (STEM) approach. In STEM project-based learning (pp. 1-5). Brill Sense. • Hynes, M. (2012). Middle-school teachers' understanding and teaching of the engineering design process: A look at subject matter and pedagogical content knowledge. International Journal of Technology and Design Education, 22, 345- 360. • Rockland, R., Bloom, D. S., Carpinelli, J., Burr-Alexander, L., Hirsch, L. S., & Kimmel, H. (2010). Advancing the "E" in K-12 STEM education. Journal of Technology Studies, 36(1), 53-64.

Week 7: Case Studies and STEM Projects (January 4, 2022)

- Case Studies: View the Presentations, Peer Feedback, and Discussion
- STEM Projects: Research and Development

Learning Activities

Type	Name	Description
Formative Assessment	Week 7 Activities	•**Before Class:** Submit case study + case study ppt •**In-class:** View and discuss case study + peer feedback and R&D-STEM project
Summative Assessment	Week 7 Activities	•**After Class:** Reflection & final submission-case study

Week 8: Constructivism; Inquiry-Based Teaching; and STEM Projects (January 11, 2022)

- Constructivism
- Inquiry: Types and Models of Implementation
- STEM Projects: Research and Development

Learning Activities

Type	Name	Description
Formative Assessment	Week 8 Activities	•**Before Class:** Readings •**In-class:** Class discussions and R&D-STEM project
Summative Assessment	Week 8 Activities	•**After Class:** Submit project
Reading	Week 8 Readings	**Each student will be assigned one reading of the following list:** • Brame, C. (2016). Active learning. Vanderbilt University Center for Teaching. • Chinn, C. A., & Malhotra, B. A. (2002). Epistemologically authentic inquiry in schools: A theoretical framework for evaluating inquiry tasks. Science Education, 86(2), 175-218. • Colburn, A. (2000). Constructivism: Science education's "grand unifying theory". The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 74(1), 9-12. • Duran, L. B., & Duran, E. (2004). The 5E instructional model: A learning cycle approach for inquiry-based science teaching. Science Education Review, 3(2), 49-58.

Week 9: STEM Projects and Curriculum Resources Websites (January 18, 2022)

- STEM Projects: Discussion
- Curriculum Resources Websites: Introduction, Research, and Development

Learning Activities

Type	Name	Description
Formative Assessment	Week 9 Activities	•**Before Class:** Review others' projects •**In-class:** Projects discussion and websites: signup + R&D
Summative Assessment	Week 9 Activities	•**After Class:** Reflection & final submission-STEM project

Week 10: TPACK; Digital Literacy; Buzz-words in STEM Education; and Curriculum Resources Websites (January 25, 2022)

- TPACK
- Digital Literacy
- Buzz-words in STEM Education
- Curriculum Resources Websites: Research and Development

Learning Activities

Type	Name	Description
Formative Assessment	Week 10 Activities	•**Before Class:** Readings •**In-class:** R&D-websites and class discussions •**After Class:** Website structure and progress report
Reading	Week 10 Readings	**Each student will be assigned one reading of the following list:** • Bowers, J. S., & Stephens, B. (2011). Using technology to explore mathematical relationships: A framework for orienting mathematics courses for prospective teachers. Journal of Mathematics Teacher Education, 14, 285-304. • DeCoito, I., & Richardson, T. (2018). Teachers and technology: Present practice and future directions. Contemporary Issues in Technology and Teacher Education, 18(2), 362-378. • Ng, W. (2011). Why digital literacy is important for science teaching and learning. Teaching Science, 57(4), 26-32.

Week 11: Digital Curriculum Resources (February 1, 2022)

- Curriculum Development: Planning, Implementation, and Authentic Assessment
- How to Choose Digital Curriculum Resources
- Curriculum Resources Websites: Research and Development

Learning Activities

Type	Name	Description
Formative Assessment	Week 11 Activities	•**Before Class:** Readings •**In-class:** R&D-websites and class discussions
Reading	Week 11 Readings	**Each student will be assigned one reading of the following list:** • Annetta, L. A. (2008). Video games in education: Why they should be used and how they are being used. Theory into Practice. 47(3), 229-39. • Black, P., & William, D. (1998). Inside the black box- raising standards through classroom assessment. Phi Delta Kappan, 80(2). 139-148. • Davis, E. A., & Krajcik, J. (2005). Designing educative curriculum materials to promote teacher learning. Educational Researcher, 34(3), 3-14. • DeCoito, I. (2020). The case for digital timelines in teaching and teacher education. International Journal of E-Learning & Distance Education, 35(1). • DeCoito, I., & Richardson, T. (2018). Beyond Angry Birds™: Using web-based tools to engage learners and promote inquiry in STEM learning. In Information and Technology Literacy: Concepts, Methodologies, Tools, and Applications (pp. 410-433). IGI Global. • Wiggins, G. & McTighe, J. (2005). Understanding by Design. Expanded 2nd Ed. USA: Association for Supervision and Curriculum Development.

Week 12: Consolidation (February 8, 2022)

- Curriculum Resources Websites: Presentations and discussion
- Course Wrap-up: What to remember…
- Looking ahead...

Learning Activities

Type	Name	Description
Formative Assessment	Week 12 Activities	•**Before Class:** Websites' submission •**In-class:** Presentation & discussion
Summative Assessment	Week 12 Activities	•**After Class:** Final Reflection

Assessment Activities

Type	Name	Description
Summative Assessment	Due Wk 03/04: Digital Scientific Timelines	In groups of 3, teacher candidates are required to prepare a digital-based presentation suitable for inclusion in a continuous scientific timeline, within an assigned period of time (e.g., pre-1600, 1600–1699, 1700–1799, 1800–1899, 1900–1949, 1950–1969, 1970–1989, and 1990–2021). The contents of the timelines should be based on significant discoveries and inventions that occurred within an assigned period of time in the history of the discipline (e.g., Biology, Chemistry, Physics, and Geology). The contents of the presentation should include technical/scientific information about the discovery or invention; information about the individuals and groups involved in the discoveries and inventions; relevant particulars about the inventors'/discoverers' personal lives, education, places of study and work, etc.; and information about the sociocultural milieu (including politics, the economy, art, religion, fashion, literature, etc.) during the assigned time period or era. The timeline should include content reflecting inventions and discoveries from all cultures and nationalities, as well as those contributed by women. The information should be presented in a 10-minute visually engaging format, with concise explanatory text, audio, and/or videos, etc. The digital format of the Scientific Timeline presentation may include Prezi, Movie Maker, Digital Storytelling, Tiki Toki, or other digital forms. The Scientific Timelines will be presented online and will be followed by class discussion.
Summative Assessment	Due Wk 07: Case Studies in STEM Education	This assignment involves a team of 5 teacher candidates working together to develop a digital case study that is interactive (including videos, images, simulations, etc.). The digital case study will be based on a socio-scientific issue around STEM education (e.g., environmental sustainability, healthcare, social issues, etc.). It should be aligned with the Application expectations of the Ministry of Education Ontario Curriculum: Science, Grades 10-12.
Summative Assessment	Due Wk 08/09: STEM Projects in Teacher Education	The STEM project involves 4 teacher candidates working together to prepare 4 lesson plans, using a digital format and an inquiry STEM project for a topic in one of the strands from the Ministry of Education Ontario Curriculum: Science, Grades 10-12.

Assessment Activities

Type	Name	Description
Summative Assessment	Due Wk 12: Curriculum Resources Website	In groups of 5, teacher candidates will develop and produce a multimedia resource website suitable for use by grades 10, 11 or 12 science teachers. Each resource will address topics within one unit/strand of the Biology, Chemistry or Physics curriculum (not including Unit A). Each resource will include a variety of instructional and assessment exercises focused on the development of curriculum- based concepts, inquiry skills (including STEM connections), creativity, and STSE skills. The resource will include an introduction containing the title of the resource, the curricular course code, author names, and the rationale of choice. The website will also include a table of contents near the beginning and a glossary of key technical terms near the end. Groups may establish active links to specific websites, images, and multimedia learning objects on the Internet, but will not copy into the resource any copyright protected materials (found in print books or the Internet). A minimum of one creative piece is required per student; each creative piece will be identified with the creator's name. The included resources need to showcase student-centered and inquiry-based pedagogical strategies. Groups are encouraged to develop and include as many self-created prints and/or digital multimedia learning objects as possible.
Summative Assessment	Ongoing Self-Assessment: Professionalism	Course participation focuses on how well each candidate contributes to the learning of others. Candidates are expected to demonstrate participation through careful preparation, critical analysis, and thoughtful commentary on the material being discussed in each class. Each individual bears the responsibility of making a significant contribution to the learning of others. Success in this component of the course will also reflect appropriate attendance and punctuality. The Professionalism Rubric will be posted on OWL. Teacher candidates are asked to share a weekly record of their self-assessment with the instructor and submit their final recommendation at the end of the course supported by documentation.
Formative Assessment	Learning Activities	Please refer to the weekly content.

How to Protect Your Professional Integrity:

The Bachelor of Education is an intense and demanding program of professional preparation. Teacher Candidates are expected to demonstrate high levels of academic commitment and professional integrity that align with both Western University's Academic Rights and Responsibilities and the Professional Standards and Ethical Standards set by the Ontario College of Teachers. These expectations govern your time in class, in your Practicum, in your Alternative Field Experiences, and include the appropriate use of technology and social media.

The Teacher Education Office will only recommend teacher candidates for Ontario College of Teachers certification when candidates have demonstrated the knowledge of, and adherence to, the faculty polices throughout the two-year program.

To review the policies and practices that govern the Teacher Education program, including attendance, plagiarism, progression requirements, safe campus and more, visit: edu.uwo.ca/CSW/my-program/BEd/policies.html

Faculty of Education Pass/Fail Policy:

All courses and assignments in the Bachelor of Education are assessed as Pass/Fail.

Instructors will make the Success Criteria of the assignments clear, and refinements of the criteria may take place in class as a means of co-constructing details of the assignments in the first two weeks of a course. This will allow for differentiation of process, product and timeline depending upon student needs.

Success Criteria will

- Articulate what needs to occur to demonstrate learning outcomes for a course/assignment;
- Inform the instructional process so that teaching can be adapted to ensure students continue to remain on track to meet the criteria as needed and appropriate.
- Align with the assignments created to provide opportunities for students to demonstrate the knowledge, skills and abilities they are working toward;
- Establish clear descriptive language that allows Teacher Candidates to identify, clarify and apply the criteria to their work and to their engagement in peer feedback;
- Focus the feedback on progress toward meeting the overall and specific tasks/assignment goals for the course.

Participation:

Participation is essential to success in the Teacher Education program. As a professional school, you need to treat coming to class as showing up for work in the profession. If you are not in class, you cannot participate. Actively participating in discussions, peer reviews/feedback, group work and activities is integral to the development of your own learning and to the learning within your classroom community.

Given the varied experiences of Teacher Candidates in the program, you may engage with ideas/concepts or skills that are familiar or unfamiliar to you.

A Professional Teacher Candidate is one who:

- Arrives in class (virtual or online) on time, and prepared. This includes completing any readings, viewing assignments or tasks in advance of class as requested.
- Listens to others and contributes thoughtfully to discussions;
- Models respectful dialogue and openness to learn, monitors, self-assesses and reformulates one's prior beliefs and understandings in light of new information;
- Monitors and addresses their wellness, practices self-care, and seeks appropriate support when necessary.

Support Services & Resources:

Health and Wellness
uwo.ca/health

Peer Support
westernusc.ca

Learning Skills
uwo.ca/sdc/learning

Indigenous Services
Indigenous.uwo.ca

Student Accessibility Services
sdc/uwo.ca/ssd

Writing Support
writing.uwo.ca

Financial Assistance
registrar.uwo.ca

Not sure who to ask?
Contact the Teacher Education Office at eduwo@uwo.ca