Western Education

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EDUC 5467

Computational Modeling in Mathematics & Science Education

Instructors:

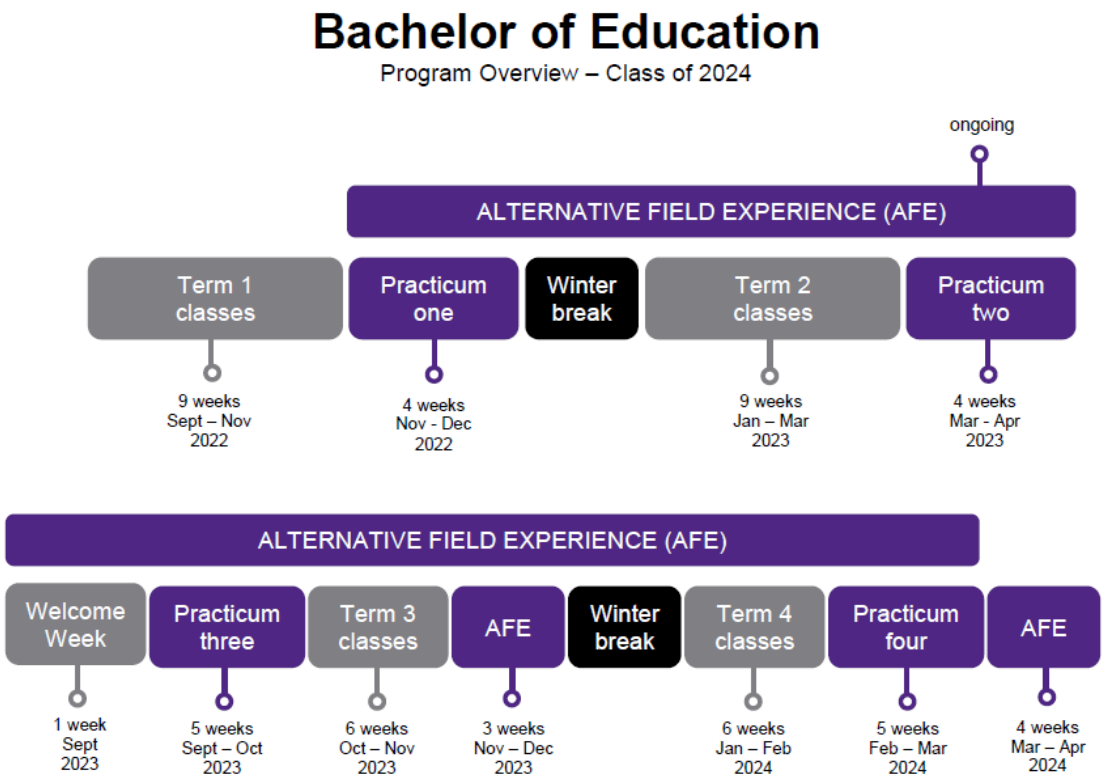
Lisa Floyd, (001)
E: lapennar@uwo.ca
Office Hours: by appointment

Schedule:

Section 001: Thursday, 2:30-4:30pm (Room 2036)

Program Context:

This is a **Speciality Course** taken by Teacher Candidates in **STEM** during **Year 1, Full Year** of the Bachelor of Education.



Course Description:

A critical introduction to the role of computer coding and digital making as ways of teaching mathematics and science concepts and relationships. The history, current trends, and future possibilities of computational modelling in mathematics and science education are situated with the broader context of mathematics, science and technology education. 2 hours per week, two terms, .5 credit.

Assignment details, course resources, including readings, videos and podcasts, can be found in OWL. Several freely available online coding platforms will be used throughout the course. Students should bring a laptop to class if they have one. All required hardware will be available onsite and can be signed out of the library to expand upon learning.

The majority of this course will be face-to-face, however, to facilitate a research-to-practice approach, five of the 18 weeks will be held asynchronously, online as detailed in the week-by-week descriptions.

Details about each class will be provided in OWL each week. Please do not hesitate to contact your instructor if you have any questions or concerns.

Instructor: Lisa Anne Floyd
lpennaru@uwo.ca

Course Credits: 0.5

Number of Weeks: 18

Week 1: Introduction to Our Course and Exploring Geometry and Spatial Reasoning Concepts Through Coding

Overview of course schedule, structure and content

Introduction to concepts and approaches surrounding computational modelling, computational thinking, and coding in Mathematics and Science

Exploring geometry concepts with Scratch programming environment

Learning Activities		
Type	**Name**	**Description**
Discussion	Where we are starting from	Experiences and opportunities with computational modelling and coding
Practice	Week 1 Experiential, hands-on computational modelling and coding	Let's get started with geometry Using https://scratch.mit.edu/ to learn geometry concepts

Week 2: Exploring Spatial Reasoning with Scratch - Part 2

Review and expand upon concepts and approaches from week 1

Dive deeper with Scratch and Spatial Reasoning

Select Presentation Topics and Dates

Learning Activities		
Type	**Name**	**Description**
Practice	Week 2 - Experiential, hands-on computational modelling and coding	Programming in Scratch: https://scratch.mit.edu/
Reading	Week 2 - Introductory Reading	Readings: Wing, J. M. 2006 Computational thinking. Commun. ACM 49, 33–35. Optional: Smith, C. P., & Neumann, M. D. (2014). Scratch it out! Enhancing Geometrical Understanding. Teaching Children Mathematics, 21(3), 185-188.

Week 3: Exploring Electricity and Circuits with Makey Makey

Introduction to Papert's "Objects to think with"

Exploring science concepts related to electricity, and bringing them to life with Makey Makey

Learning Activities		
Type	**Name**	**Description**
Playful Activity	Week 3 - Experiential, hands-on computational modelling and coding	Explore science concepts using Makey Makey https://makeymakey.com/pages/educators#resources

Week 4: The Roots of Computational Thinking and Computational Modelling in Mathematics – Affordances and Powerful Ideas (Asynchronous week)

Exploring Papert's ideas of Turtle Geometry and their applications today

Exploring the affordances of computational thinking/modelling and the power of coding in the classroom

Learning Activities		
Type	**Name**	**Description**
Discussion	Weeks 4,7,8,12,15 - Owl Discussion Forum	Consider the readings, respond to assigned questions and discuss the implications of research for classroom practice, with peers in the course.
Reading	Week 4 - Roots of Computational Modelling	Papert, S. (1980) Turtle geometry: A mathematics made for learning. Chapter 3 in Mindstorms: Children, Computers, and Powerful Ideas. Gadanidis, G. (2017). Five Affordances of Computational Thinking to support Elementary Mathematics Education, 36, 143–151.

Week 5: Teacher Candidate Presentations on Selected Topics, Course Reflection

Presentations by four groups on selected topics

Reflect on course learning thus far, connect to readings/videos/activities

Assessment Activities		
Type	**Name**	**Description**

Assessment Activities

Type	Name	Description
Presentation	Due Week 5, 11 or 16 - Presentation on Selected Topics	Presentation: In groups of 4, select from special topics list* see OWL for more information. Each student will complete ONE presentation. Please submit a one paragraph reflection via Assignments under Presentation. Details about reflection can be found in OWL.
Assignment	Reflection - Due Week 5 or 16	Select one of own posts from an on-line discussion and/or one of a classmates' post – expand, reflect. OR Create a mindmap (your choice of software) on a selection of one or more readings/activities so far and/or summarize forum discussion for selected topic. OR Select a mode of your choice to complete a reflection - please consult with teacher if you select this option. Requirements: The length is the equivalent of about 250-400 words (not including references or selected post) Please submit via Assignments under Reflection.

Week 6: Exploring activities that integrate a wide range of concepts, including sensors, using the micro:bit – Part 1

Explore science and math concepts using microbit

Incorporate sensors and physical computing in math and science education

Learning Activities		
Type	**Name**	**Description**
Practice	Weeks 6 and 9 - Experiential, hands-on computational modelling and coding	Modeling and coding with MakeCode and micro:bit Using https://microbit.org/ with https://www.microsoft.com/en-us/makecode

Week 7: Coding and Computational Modelling in the Curriculum – Ontario and other jurisdictions (Asynchronous Week)

Explore coding and computational modelling in curriculum documents

Consider current and past models and research related to implementation of coding and computational modelling in math and science education

Learning Activities		
Type	**Name**	**Description**
Discussion	Weeks 4,7,8,12,15 - Owl Discussion Forum	Consider the readings, respond to assigned questions and discuss the implications of research for classroom practice, with peers in the course.

Learning Activities

Type	Name	Description
Reading	Week 7 - Curriculum + Current Practices	Grades 1-8 Math (Ontario) https://www.dcp.edu.gov.on.ca/en/curriculum/elementary-mathematics Grade 9 Math (Ontario) https://www.dcp.edu.gov.on.ca/en/curriculum/secondary-mathematics/courses/mth1w Grades 1-8 Science and Technology (Ontario) https://www.dcp.edu.gov.on.ca/en/curriculum/science-technology Grade 9 Science (Ontario) https://www.dcp.edu.gov.on.ca/en/curriculum/secondary-science/courses/snc1w Gadanidis, G., Floyd, S., Hughes, J.M., Namukasa, I.K., & Scucuglia, R. (2021). Coding in the Ontario Mathematics Curriculum, 1-8: Might it be transformational? Math Knowledge Network. Retrieved from http://mknrcm.ca/coding-in-the-ontario-mathematics-curriculum-1-8-might-it-be-transformational/ Gadanidis, G., Cummings, J. (2018). Integrated Mathematics + Computer Studies. Reforming Secondary School Mathematics Education. KNAER Mathematics Knowledge Network. http://mkn-rcm.ca/wp-content/uploads/2018/04/MKN-white-paper-April-2018.pdf

Week 8: Culturally Relevant/Responsive Making and Pedagogy (Asynchronous Week)

Develop an understanding of culturally responsive and relevant practice

Explore important topics surrounding culturally responsive making, equity, diversity and inclusion in computational modelling, computational thinking and coding

Consider classroom practices that are inclusive, diverse, and authentic and that honour the life experiences of students

Learning Activities

Type	Name	Description
Discussion	Weeks 4,7,8,12,15 - Owl Discussion Forum	Consider the readings, respond to assigned questions and discuss the implications of research for classroom practice, with peers in the course.
Reading	Week 8 - Culturally responsive making and the broadening of coding related education opportunities	Searle, K. A., & Kafai, Y. B. (2015, April). Culturally responsive making with American Indian girls: Bridging the identity gap in crafting and computing with electronic textiles. In Proceedings of the third conference on genderIT (pp. 9-16). Margolis, J., Ryoo, J. J., Sandoval, C. D., Lee, C., Goode, J., & Chapman, G. (2012). Beyond access: Broadening participation in high school computer science. ACM Inroads, 3(4), 72-78.
Video	Week 8 - Culturally Relevant/Responsive Computing	Video - https://www.youtube.com/watch?v=RE3J8_9rSdw

Week 9: Exploring activities that integrate a wide range of concepts, including sensors, using the micro:bit and Makecode/Python programming environment – Part 2

Explore science and math concepts using microbit - diving deeper

Incorporate sensors and physical computing in math and science education

Learning Activities

Type	Name	Description
Practice	Weeks 6 and 9 - Experiential, hands-on computational modelling and coding	Modeling and coding with MakeCode and micro:bit Using https://microbit.org/ with https://www.microsoft.com/en-us/makecode
Reading	Week 9 - micro:bit reading	Ball, T., Protzenko, J., Bishop, J., Moskal, M., Halleux, J. De, Braun, M., … Riley, C. (2016). Microsoft Touch Develop and the BBC micro : bit, (August 2015), 2–5. https://doi.org/10.1145/2889160.2889179

Week 10: Exploring Geometry and Physics with Programmable Robots (Sphero)

Explore physics concepts with Sphero programmable robots

Explore geometry and spatial reasoning with Sphero programmable robots

Learning Activities

Type	Name	Description
Playful Activity	Week 10 - Experiential, hands-on computational modelling and coding	Let's take a look at physics, spatial reasoning and geometry Using https://sphero.com/products/sphero-bolt
Reading	Week 10 - Sphero and Science Classrooms Reading	Sneider, C., Stephenson, C., Schafer, B., & Flick, L. (2014). Computational Thinking in High School Science Classrooms. Science Teacher, 81(5), 53-59.

Week 11: Coordinate Grids with block-based and text-based coding + Teacher Candidate Presentation on Selected Topic

Explore spatial reasoning and coordinate grids with the Scratch and Python programming environments

Review and expand upon concepts and approaches surrounding computational modelling and coding in Mathematics and Science

Teacher Candidate presentation on selected topic

Learning Activities

Type	Name	Description
Practice	Week 11 - Coordinate Grids - Experiential, hands-on computational modelling and coding	Explore coordinate grids with Scratch and Python
Video	Week 11 - Scratch Maths Project	http://mkn-rcm.ca/online-seminar-series-on-programming-in-mathematics-education/

Assessment Activities

Type	Name	Description

Assessment Activities

Type	Name	Description
Presentation	Due Week 5, 11 or 16 - Presentation on Selected Topics	Presentation: In groups of 4, select from special topics list* see OWL for more information. Each student will complete ONE presentation. Please submit a one paragraph reflection via Assignments under Presentation. Details about reflection can be found in OWL.

Week 12: Math, Science and Computational Thinking/Modelling in Research, Prototyping and making with Tinkercad (Asynchronous week)

Explore the connections between mathematics and modelling and relevance to the K-12 classroom

Consider current research related to coding and computational thinking/modelling in math and science education

Explore prototyping and making with virtual environments such as Tinkercad

Learning Activities

Type	Name	Description
Discussion	Weeks 4,7,8,12,15 - Owl Discussion Forum	Consider the readings, respond to assigned questions and discuss the implications of research for classroom practice, with peers in the course.
Practice	Week 12 - Experiential, hands-on computational modelling and coding	Prototyping with Tinkercad Using https://www.arduino.cc/ and https://www.tinkercad.com/

Learning Activities		
Type	**Name**	**Description**
Reading	Week 12 - Readings	Grover, S., & Pea, R. (2018). Computational Thinking: A Competency Whose Time Has Come. Computer Science Education: Perspectives on Teaching and Learning, (December), 1997–2004. Retrieved from http://hub.mspnet.org/index.cfm/33300 Andrea A. diSessa (2018) Computational Literacy and "The Big Picture" Concerning Computers in Mathematics Education, Mathematical Thinking and Learning, 20:1, 3-31, DOI: 10.1080/10986065.2018.1403544 Weintrop, D., Beheshti, E., Horn, M., Orton, K., Jona, K., Trouille, L., & Wilensky, U. (2016). Defining Computational Thinking for Mathematics and Science Classrooms. J Sci Educ Technol, 25:127–147.

Week 13: Connecting electricity concepts and our environment through sensors and programmable controllers (Arduino) – Part 1

Connect to electricity concepts through programming with Arduino

Collect data from the physical environment using sensors and Arduino

Explore systems (traffic lights, bat's echolocation) and modelling with tangible, computational devices

Learning Activities		
Type	**Name**	**Description**
Practice	Week 13 - Intro to Arduino	https://www.arduino.cc/en/main/education

Week 14: Connecting electricity concepts and our environment through sensors and programmable controllers (Arduino) – Part 2

Expand on the connections between electricity concepts and our environment through sensors and Arduino

Explore further systems and modelling with tangible, computational devices

Learning Activities		
Type	**Name**	**Description**

Learning Activities		
Type	**Name**	**Description**
Practice	Week 14 - Adding complexity and expanding upon modelling systems and making with tangible devices	Review the approaches, considerations and guidelines for making and exploring more complex microcontroller concepts (arduino)

Week 15: Meaningful Making, Democratizing Making and Computational Participation (Asynchronous week)

Consider makerspaces and meaningful making for the science classroom

Explore the approaches, considerations and guidelines for making in the classroom

Learning Activities		
Type	**Name**	**Description**
Discussion	Weeks 4,7,8,12,15 - Owl Discussion Forum	Consider the readings, respond to assigned questions and discuss the implications of research for classroom practice, with peers in the course.
Reading	Week 15 - Makerspaces and the approaches students and teachers should have when “making” + Computational Participation	Hughes, J.M. (2017). Meaningful making: Establishing a makerspace in your school or classroom. What works: Research into practice. Retrieved from https://oere.ca/wp-content/uploads/2018/02/meaningful_making_en.pdf Kurti, R., Kurti, D., & Fleming, L. (2014). The philosophy of educational makerspaces. Teacher Librarian, 41(5), 8–11. Retrieved from http://teacherlibrarian.com/2014/06/18/ educational-makerspaces/ Burke, Q., & Kafai, Y. (2016). Computational Participation. Journal of adolescent & adult literacy 59(4): 371-375.

Week 16: Teacher Candidate Presentations on Selected Topics, Course Reflection

Presentations by four groups on selected topics

Reflect on course learning thus far, connect to readings/videos/activities

Assessment Activities		
Type	**Name**	**Description**

Assessment Activities

Type	Name	Description
Presentation	Due Week 5, 11 or 16 - Presentation on Selected Topics	Presentation: In groups of 4, select from special topics list* see OWL for more information. Each student will complete ONE presentation. Please submit a one paragraph reflection via Assignments under Presentation. Details about reflection can be found in OWL.
Assignment	Reflection - Due Week 5 or 16	Select one of own posts from an on-line discussion and/or one of a classmates' post – expand, reflect. OR Create a mindmap (your choice of software) on a selection of one or more readings/activities so far and/or summarize forum discussion for selected topic. OR Select a mode of your choice to complete a reflection - please consult with teacher if you select this option. Requirements: The length is the equivalent of about 250-400 words (not including references or selected post) Please submit via Assignments under Reflection.

Week 17: Exploring Patterns and Linear Relations in Mathematics with Text-based coding

Engage with experiential, hands-on computational modelling and coding for the mathematics classroom

Discuss growing patterns and relationships to computational modelling opportunities

Explore growing patterns through text-based programming

Learning Activities

Type	Name	Description
Practice	Week 17 - Experiential, hands-on computational modelling and coding	Explore linear relations and growing patterns with Python: Modelling and coding with Python https://www.python.org/ Python – Colab and CS Circles (https://cscircles.cemc.uwaterloo.ca/console/) https://researchideas.ca/mathncode/simsgrowpatt.html

Week 18: Exploring the use of stickers in art, and other electronic components with an emphasis on cross-curricular activity design + Unplugged Tools.

Explore unplugged activities related to computational modelling and computational thinking

Explore alternative and creative tools for mathematics and science education

Consider the potential cross-curricular connections of various tools for STEM learning

Learning Activities

Type	Name	Description
Discussion	Where we started from, where we are now	Experiences and opportunities with computational modelling and coding, and final thoughts on course concepts
Playful Activity	Week 18 - Experiential, hands-on computational modelling and coding	Unplugged activities and computational modelling in mathematics and science. Exploring the use of stickers in art, and other electronic components with an emphasis on cross-curricular activity design + Unplugged Tools. Chibitronics and cross-curricular connections Using https://chibitronics.com/

Learning Activities

Type	Name	Description
Reading	Week 18 - Readings	Eisenberg, M., Eisenberg, A., Blauvelt, G., Hendrix, S., Buechley, L., & Elumeze, N. (2009). Mathematical Crafts for Children: Beyond Scissors and Glue. University of Colorado. Retrieved from: http://l3d.cs.colorado.edu/~ctg/pubs/artmath05.pdf Li, Y., Schoenfeld, A. H., Graesser, A. C., Benson, L. C., English, L. D., & Duschl, R. A. (2020). On computational thinking and STEM education. Retrieved from https://link.springer.com/content/pdf/10.1007/s41979-020- 00044-w.pdf

Assessment Activities

Type	Name	Description
Assignment	Due Week of March 9th, 2022: Computational Modelling/Coding Task for Teaching Mathematics and/or Science	OPTION 1 - Teach and reflect on a computational modelling/coding + math/science task (submit short description of task and reflection) OPTION 2 - Design a math/science/STEM task (plugged or unplugged) through Computational Modelling/Coding based on the readings and in-class activities presented in this course. OPTION 3 – Analyze a Computational Modelling/Coding + Math/Science Lesson Plan/Task OPTION 4 – Create a Critical Analysis Checklist designed to determine which devices are best for teaching STEM concepts. Using the Critical Analysis Checklist, assess a minimum of four digital devices/applications that educators might consider implementing in their classrooms. Reflect on how effective the Critical Analysis is to support educators who are deciding on which devices/applications are best to use within their classroom. OPTION 5 - Please connect with your instructor for an alternate assignment Please submit via Assignments on or before March 10th, 2022

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 on-site) 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.

Ontario Curriculum & Supplementary Resources:

Curriculum & Resources
dcp.edu.gov.on.ca/en

Campus 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