Mathematics Integrated with Computers and Applications III*

An Undergraduate Programming-Based Mathematics Course for Prospective Teachers, Brock University (Canada)

Math 3P41 Final Project Guidelines

Dr. Chantal Buteau (Brock University)

This final project was in collaboration with the Mathematics Knowledge Network and the Niagara Catholic District School Board.

For some information about the MICA courses, see:

- Ralph, W. (2001). Mathematics takes an exciting new direction with MICA program. Brock Teaching, 1(1), 1.
- Buteau, Muller, & Ralph (2015). Integration of Programming in the Undergraduate Mathematics Program at Brock University. In Online Proceedings of the Math + Coding Symposium, London (Canada), June 2015.

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Final Project Overview

MICA III* Visual and Interactive Mathematics, Winter 2022

Dr. C. Buteau (Brock University)

Your final project concerns selecting (or developing) and implementing in a school classroom a programming-based mathematics activity done in collaboration with a schoolteacher (or two) from NCDSB. It will involve also reflecting on your experience, as well as an oral presentation.

Timeline summary:

-Mon. Feb. 14	List of teachers/schools, with Grade levels available + Etiquette when working with your associate teacher
-Wed. Feb. 16	Meeting with NCDSB teachers
-Fri. Mar. 4	Draft 1 (1%) - Activity description: submission due by 4 p.m.
-Wed. Mar. 9	Meeting with your associate teacher (1hr) during lab
-Mon. Mar. 21	Draft 2 (2%)–Enhanced description: submission due by 4 p.m.
-Between Mar. 28 and Apr. 1	*Implementation of your activity in the classroom*
-Wed. Apr. 6	Reflection with NCDSB teachers
-Mon. Apr. 11	Final project report (22%) submission due at 4 p.m.
-Thurs. Apr. 14	Oral presentation (5%) @8:30 a.m.- 12:00 p.m.

Three possible approaches (types):

A. Design of an activity from scratch.
B. Use and modification of an activity from a resource.
C. Use of an activity from a resource.

Also: some student teams are matched with two teachers (possibly 2x the implementation). Some teams might go to the classroom more than once for their activity.

Oral Presentation: Thurs. Apr. 14 @8:30 a.m.- 12:00 p.m. (5%)

Short presentation (1 per team) of your activity, implementation, and reflections. 6-8 min–3.5%
Your evaluation of two other teams' presentations–1.5%

Final Project Submission: Mon. Apr. 11 (22%)

Your final project report contains two parts for a project of type A: the activity summary with appendices, and the reflection summary. The marking scheme respects these two components, in addition to a third one: fulfillment of roles for the community partnership.

Your final project report contains three parts for a project of type B or C: the implementation report, your analysis of the implementation using the literature, and the reflection summary. The marking scheme respects these three components, in addition to a fourth one: fulfillment of roles for the community partnership.

More details below.

Type A–*designing an activity from scratch*

The report contains 2 parts, the activity summary with appendices and the reflection summary:

1) Your ***Activity Summary with Appendices***[1] (2-3 pages + appendices) will include the following sections (and including these as headlines):
   - **Name of the activity**
   - **Grade level**
   - **Learning objectives**, with links to the curriculum expectations (for math topic(s) and for coding). Clearly outline all of them (possibly distinguishing primary and secondary objectives)
   - **Activity instructions**
   - **Classroom implementation**. Description of how the activity can be integrated in the classroom (possibly different scenarios). Include proposed time.
   - **Discussion points**. List of recommended (at least 3) questions for the class
   - **Things to note** (if applicable). Notes for the teachers.
   - **Agreement statement** to participate or not to the collective class project and have the Activity Summary posted online on the MKN website.

   And Appendices:
   - **Student guidelines**
   - **File(s)** if relevant
   - A **complete solution**, including comments/recommendations to the teachers, possibly based on your implementation experience (e.g., *when drawing an equilateral triangle, a common first approach is to make Sprite turn 60 degrees instead of the supplementary angle 120 degrees*.). Includes also comments to highlight key part(s) of the activity (and why they are 'key' parts) and comments pertaining to some Computational Thinking Affordances[2].

2) Your **Reflection Summary** about your experience will include the following sections:
   - **Associate class (community partnership).** A short description explaining/describing what led you to the proposed activity. Highlight your associate teacher(s)' needs and goals. (8-15 lines)
   - **About the activity implementation**. How did the implementation go? As planned? Any surprise. Include anecdotes (use pseudonyms). If the implementation led you to modify your activity summary, please specify what and why. (6-15 lines)
   - **Two major take-aways.** Select two ideas shared in the collective reflection on April 6 and reflect on how it connected to your experience. (6-15 lines)
   - **What you have learned personally.** Reflect back on your personal goals prior to the implementation. (Each student: 8-15 lines)

[1] Note that you may revise/update/improve your activity summary based on what you have learned from the implementation of your activity.

[2] Gadanidis, G., Hughes, J. M., Minniti, L., & White, B. J. (2016). Computational thinking, grade 1 students and the binomial theorem. Digital Experiences in Mathematics Education, 1-20.

Grading Scheme (Type A). Names: _____ Grade: ____

Activity:

/75

1) Meaningful use of the potential of programming for mathematics learning/application (incorporates many of the Computational Thinking Affordances[3] for math learning).
   /10
2) Math content/topic addressed in depth.
   /10
3) The activity aligns with the identified learning objectives.
   /10
4) Guidance to students (if appropriate; if not, the weight is added to the next bullet): complete, detailed description.
   /10
5) Guidance to teachers: complete, clear.
   /15
6) The activity is engaging for all learners in the class (low floor, high ceiling![12]).
   /10
7) Communication of mathematics in the documents.
   /10

Reflection:

/15

a) About the implementation (insightful; good choice of anecdote, if relevant).
   /6
b) Two major take-aways (relevance, depth).
   /5
c) What you have learned personally (relevance, depth), with individual answers.
   /2
d) Quality of writing and clarity: no spelling, grammar, and punctuation errors. Ideas are presented in a clear and organized manner.
   /2

Fulfillment of roles for the community partnership:

/10

- Met deadlines and accomplished the expected work, met with the teachers when expected, was attentive to the associate teacher(s)' needs and goals, was on time and professional, respectful of the existing classroom culture. *This grade will be based on comments provided by the associate teacher(s) and Numeracy Consultants, if relevant; on the TA's and professor observations; and on your peer's short comments that will be submitted separately in the google form, and the first part of your reflection.*

[3] Gadanidis, G., Hughes, J. M., Minniti, L., & White, B. J. (2016). Computational thinking, grade 1 students and the binomial theorem. Digital Experiences in Mathematics Education, 1-20.

Types B & C– *use (and modification) of an activity from a resource*

1. Your ***Activity Implementation Report Summary*** (3-5 pages), will include the following sections (and including these as headlines):
    - **Name of the activity**: 'Implementing ....'
    - **Reference of selected resource**
    - **Grade level**
    - **Learning objectives**, with links to the curriculum expectations (for math topic(s) and for coding). Clearly mention what is taken from the resource, and what is new based on your implementation
    - **Activity summary**: in 3-4 lines
    - **Adaption/Modification of Activity, and Rational**
    - **Report on classroom implementation (tell the story!)**: Description of how the activity was integrated in the classroom. Include, but not limited to:
        - Time(s)
        - Guiding questions to the whole class (indicate which of those were from the resource)
        - Anecdotes (use pseudonyms), highlighting key moments of (individual or collective) math and/or coding learning, of students' and/or teachers' challenges, and of some observed Computational Thinking Affordances[4] for math learning
        - Any surprises? Anything unexpected?
        - The use/usefulness of the existing teacher guidelines from the resource (i.e., hints, tips for the teacher)
    - **Our recommendations**: Notes for other teachers based on your implementation, including possibly changes to the implementation and adaptation of the activity.
    - **Agreement statement** to participate or not to the collective class project and have the Activity Summary posted online on the MKN website.
    - *Appendices* (if relevant for other teachers)

2. Your ***Analysis of implementation report using the literature***. (~1-2 pages)

3. Your ***Reflection Summary*** about your experience will include the following sections:
    - **Associate class (community partnership)**. A short description explaining/describing what led you to select the proposed activity and your implementation. Highlight your associate teacher(s)' needs and goals. (8-15 lines)
    - **Two major take-aways**. Select two ideas shared in the collective reflection on April 6 and reflect on how it connected to your experience. (6-15 lines)
    - **What you have learned personally**. Reflect back on your personal goals prior to the implementation. (each student: 8-15 lines)

[4] Gadanidis, G., Hughes, J. M., Minniti, L., & White, B. J. (2016). Computational thinking, grade 1 students and the binomial theorem. Digital Experiences in Mathematics Education, 1-20.

Grading Scheme (Type B or C). Names: _____ Grade: ____

Activity Implementation Report:

/70

1. Meaningful adaptation of the resources. /10
2. Implementation: /40
    - Description is well organized, complete, and clear. /10
    - Key moments provide interesting, useful, and deep insights into the activity. /25
    - Indicated use/usefulness of teacher guidelines are relevant. /5
3. Recommendations: /20
    - Takes a critical perspective on the implemented activity (if no or only minor change argues why not). /12
    - Relevant and practical to other teachers. /8

Analysis:

/15

1. Makes use of at least three relevant literature references, with complete citations at the end of this section.

    /2
2. Demonstrates a good understanding of the referenced literature and makes insightful connections between reported key experiences and theory.

    /11
3. Quality of writing and clarity: no spelling, grammar, and punctuation errors. Ideas are presented in a clear and organized manner.

    /2

Reflection:

/5

Discusses the observations and provide a critical analysis of the task/activity in the context of learning mathematics through a computational thinking approach

- Two major take-aways (relevance, depth). /3
- What you have learned personally (relevance, depth), individual answers. /2

Fulfillment of roles for the community partnership:

/10

Met deadlines and accomplished the expected work, met with the teachers when expected, was attentive to the associate teacher(s)' needs and goals, was on time and professional, respectful of the existing classroom culture. *This grade will be based on comments provided by the associate teacher(s)and Numeracy Consultants, if relevant; on the TA's and professor's observations; and on your peer's short comments that will be submitted separately in the google form.*

Meeting Guidelines #1

MKN NCDSB-Brock Coding + Math in the Classroom Collaboration, Winter 2022
February 16, 2022
Laura Cronshaw & Jeffrey Martin, NCDSB
Dr Chantal Buteau & Dr Laura Broley, Brock University

1. Introduce yourselves
    a. Including math + coding background
    b. NCDSB teachers: why you joined this project
2. NCDSB In-service Teacher:
    a. Who is the class (number of kids/students; how are the math lessons usually structured in a lesson/day/week; particular challenges; ...)?
    b. How much classroom time (In 1 lesson? In 2 lessons?) could be dedicated to the implementation of the activity in the week of March 28
    c. What does the class know about coding (in Scratch, in Python)?
3. Topics & technology
    a. Discuss the different math topic(s) that could be at the centre of your activity.
    b. Technology (Scratch? Python?)
    c. What would be the learning objectives of the activity (e.g., any object if pertaining to coding?)
4. Brainstorming about the activity, in relation to your answers in 3 above):
    a. Explore different resources and identify potential activities (as is or as a starting point)
    b. Decide whether you will design an activity or select one from the resources and potentially amend it for the classroom
5. Contacts of associate (in/pre)-service teacher(s)
6. What is to be done by each member of your team, until March 9

LIST OF RESOURCES (not exhaustive, in no particular order)

- Understanding Math + Coding Gr 1-8, e-textbook by Gadanidis, 2021
- Math + Coding Teams, e-textbook by Gadanidis, 2022
- Ontario Association for Mathematics Education (OAME), 'Coding Resources': https://ontariomath.support/?pg=results&type=subject&lang=EN&subject=Coding
- TVO Digital Learning Outreach: Coding in the Classroom (numerous activities by Lisa Floyd): https://outreach.tvolearn.com/codingintheclassroom/#tve-jump-1764b1d0f77
- UCL Scratch Maths (a two-year computing and mathematics-based curriculum for pupils in Grades 5 and 6 in England. Its aim is to enable pupils to engage with and explore important mathematical ideas through learning to program): https://www.ucl.ac.uk/ioe/research/projects/ucl-scratchmaths/ucl-scratchmaths-curriculum

Draft 1

MKN NCDSB-Brock Coding + Math in the Classroom Collaboration, Winter 2022
Due March 4, 2022 @ 4 p.m.
Dr. C. Buteau, Brock University

Submit a 1 to 1.5-page hard copy summary containing the information below (keep the numbering 1 to 9). One copy only per team. Indicate both names and student numbers at the top of the page.

1. **A short summary about who your associate teacher(s)& associate class are**. (*Between 4 to 10 lines*)
   There are required confidentiality standards to follow. In all of your MATH 3P41 reports (March 4, March 21, and final project documents) or potential future reports, refrain from using any identifiers. Which means: no student name; no teacher name; no school name; no city. You would refer to it as e.g., *a Grade 9 class from the NCDSB*. You may use pseudonyms for teacher and student names.
2. **Details of the learning environment constraints**: what technology, setting, time available (up to a few lines)
3. **Planned math topic or possible math topics under consideration** (up to a few lines)
4. **Planned learning objectives (pertaining to math and possibly to coding)** (list them all using bullets if more than one objective)
5. **Planned overall approach type (select and mention the resource details, if relevant)**:
   a. Design of an activity from zero
   b. Use and modification of an activity from a resource (*which one? e.g., textbook X, Activity named XX, at pages XXX*)
   c. Use of an activity from a resource (*which one? e.g., textbook X, Activity named XX, at pages XXX*)
6. **Some *tentative* details about the activity** (between 2 to 5 lines)
7. **Planned/Tentative dates in the classroom (*if decided*)**, including number of lessons and the exact time(s)
8. **At what time do you 'meet'** with your associate teacher(s) on March 9? (Also indicate if there are any meeting planned outside the planned March 9 session)
9. What did you commit to do in preparation of your next meeting on March 9? (Up to a few lines)

Evaluation criteria – 1% of final grade:
(1) Clarity – 50%
(2) Complete information – 50%

Meeting Guidelines #2

MKN NCDSB-Brock Coding + Math in the Classroom Collaboration, Winter 2022
March 9, 2022
Laura Cronshaw & Jeffrey Martin, NCDSB
Dr Chantal Buteau & Dr Laura Broley, Brock University

**You are meeting with your associate pre/in-service teacher(s) for about 60 minutes

Purpose: Finalize decisions on the math + coding activity to be implemented in the classroom in the week of March 28, 2022. By the end of the session, you should be able to describe:

1. **Learning objectives (pertaining to math and possibly to coding)** (list them all using bullets if more than one objective)
2. **Math topic(s) and computational concepts involved**
3. **Overall approach of your 'math + coding' activity:**
    a. Design of an activity from zero
    b. Use and modification of an activity from a resource
    c. Use of an activity from a resource
4. **Date(s) and time(s)** for the implementation of the activity. Will the Brock pre-service teachers be in the classroom in person, or will they participate virtually?
5. **A description of your activity**, including how 1-2 affordances[5] of programming for mathematics learning are part of your activity.
6. **What everyone has left to do until the implementation of the activity** (any other meeting?), with expected dates for completion
7. **Everyone's role(s) during the implementation**

[5] Gadanidis, G., Hughes, J. M., Minniti, L., & White, B. J. (2016). Computational thinking, grade 1 students and the binomial theorem. Digital Experiences in Mathematics Education, 1-20.

Draft 2

MKN NCDSB-Brock Coding + Math in the Classroom Collaboration, Winter 2022
Due March 21, 2022 @ 4 p.m.
Dr. C. Buteau, Brock University

Submit an up to 2-page hard copy summary containing the information below (keep the numbering 1 to 10), in addition to other documents if relevant (see point 7 below). One copy only per team.

1. **Name of your activity/project** (tentative)
2. **Math topic or topics** (up to a few lines)
3. **Computational concepts involved** (up to a few lines)
4. **Learning objectives (pertaining to math and possibly to coding)** (list them all using bullets if more than one objective)
    a. List the 'Coding expectations' that your activity will address/involve (e.g., 'Gr6-C3.1' and 'Gr7-C3.1')
5. **Number of lessons in total, dates and times, and duration of each (include preparatory lessons)**. Mention all lessons and indicate which one(s) you are involved with in the design/preparation, and which ones you will also be involved (online? in person?) within the classroom implementation.
6. **Has your planned overall approach type changed since Draft 1? If yes, select (mention the resource details, if relevant) and give a *very short* rational as to why you decided to change:**
    a. Design of an activity from zero
    b. Use and modification of an activity from a resource (*which one? e.g., textbook X, Activity named XX, at pages XXX*)
    c. Use of an activity from a resource (*which one? e.g., textbook X, Activity named XX, at pages XXX*)
7. **Briefly describe your activity**. Up to ¾-page. Include mentioning how 1-2 affordances[6] of programming for math learning are part of your activity and
    a. If you use student guidelines, include a *complete draft* as a separate document.
    b. If your activity includes file(s), include them (or provide the URL)
    c. Include a draft of the full solution of your activity, in a separate document

** *this part should provide the instructor with a complete picture of your planned activity*

8. **Briefly describe your roles and your associate teacher(s)' roles in the implementation of your activity**. (Up to 5 lines)
9. **What are your personal goal(s)?** (Up to 6 lines)
10. **Confirm that you shared points 1-8 with your associate teacher(s)**

Evaluation criteria – 2% of final grade:

- Points 1-6, 10: clarity and complete information–15%
- Points 7-8: clarity and complete information, activity organization, depth of overall activity approach, and mention of 1-2 affordances–75%
- Point 9: clarity–10%

[6] Gadanidis, G., Hughes, J. M., Minniti, L., & White, B. J. (2016). Computational thinking, grade 1 students and the binomial theorem. Digital Experiences in Mathematics Education, 1-20.