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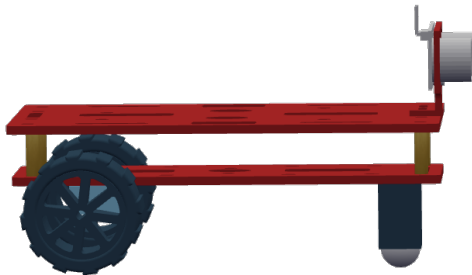
# DISRUPTED LESSONS IN ENGINEERING ROBOTICS: AUTHENTIC LEARNING EXPERIENCES WITH VIRTUAL LABS AND OPEN-SOURCE HARDWARE

+ *GUIDELINES FOR USE*

*SALTISE 2021*

Joel Trudeau<sup>1</sup>, Tanya Chichekian<sup>2</sup>, Tawfiq Jawhar<sup>1</sup>

<sup>1</sup>Dawson College, <sup>2</sup>Université de Sherbrooke



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# OVERVIEW

- **Education 4.0:** Learning for the Fourth Industrial Revolution (4IR)  
*Arduino microcomputing use case*
- **Engineering Robotics:** Active, hands-on learning in and out of the classroom  
*A COVID-19 pivot to the virtual*
- **Blended Learning:** Virtual labs + physical labs  
*Guidelines for use: Open discussion*

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# ARDUINO 101: WHAT IS ARDUINO?

- Arduino is an open-source microelectronics platform based on easy-to-use hardware and software.
- Arduino microcontroller boards can read inputs and turn them into outputs.
- Arduino is composed of two major parts:
  1. Hardware microcontroller
  2. IDE software to program the microcontroller

# ARDUINO 101: HOW IT WORKS

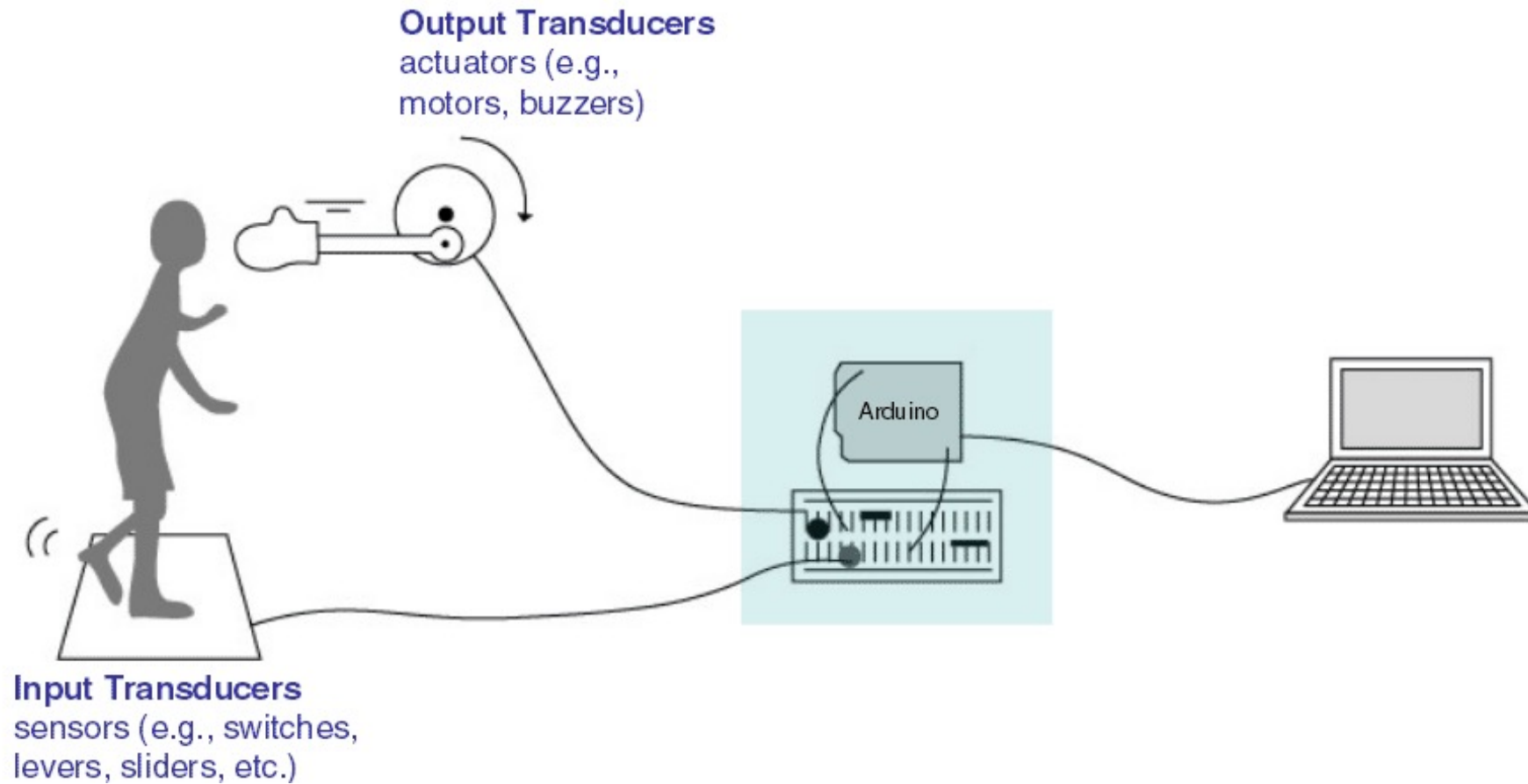


Image: *Theory and Practice of Tangible User Interfaces* at UC Berkley

# ENGINEERING ROBOTICS PRE-COVID USE CASE

## Sample

- $N = 58$  (17F, 40M, 1 missing)
- Final semester Engineering Physics course

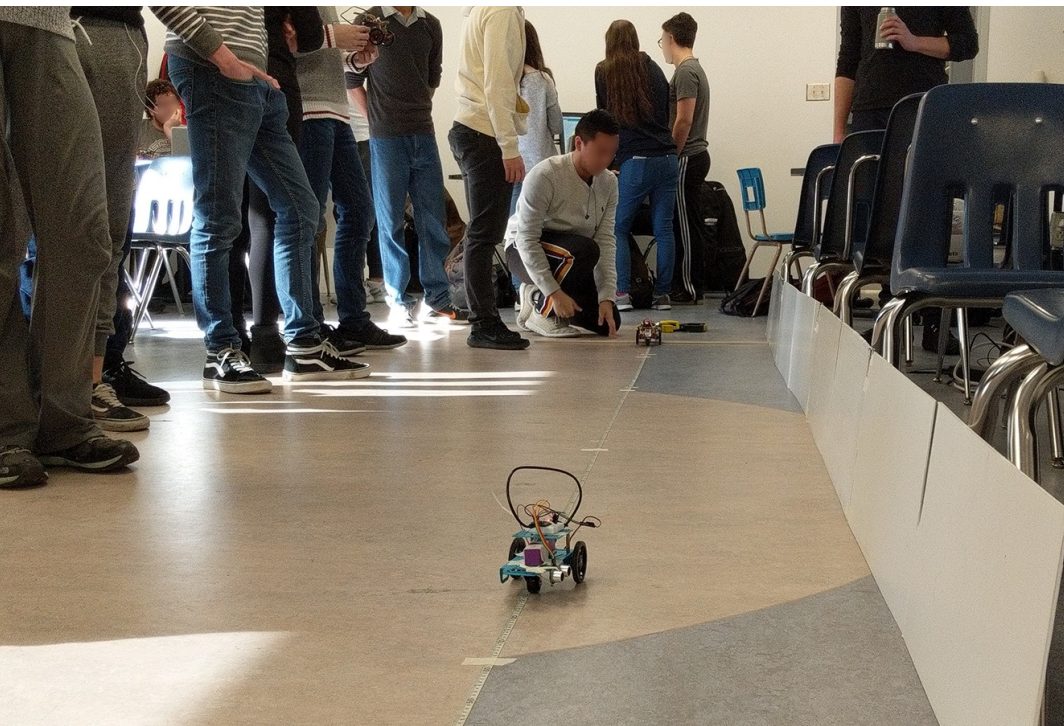
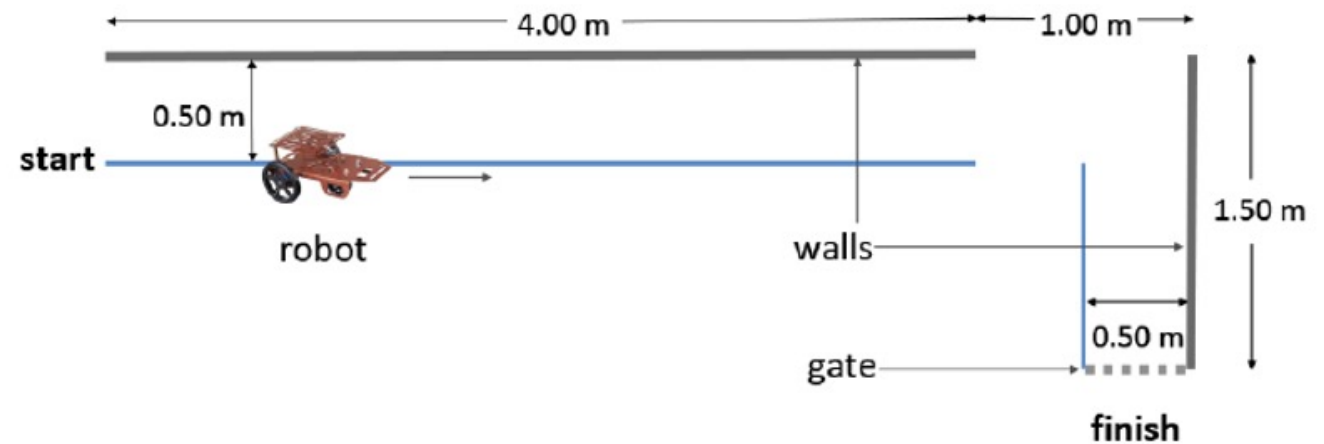


Figure 1

*Navigation Challenge Before COVID-19 Lockdown*

## Autonomous Navigation Challenge

4-lab sequence in two Engineering Physics final semester courses culminating with class challenge: *Using sensor feedback program a robot to navigate along a complex path in the shortest possible time.*



*First 2 labs done before Covid-19 lockdown*

Video

# **Dawson College Engineering Robotics**

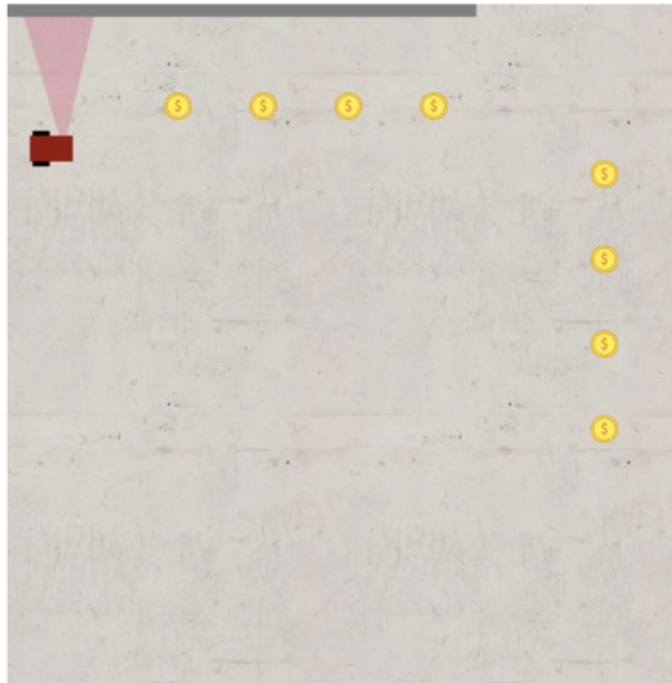
Class Navigation Challenge Robot Testing

# ENGINEERING ROBOTICS POST-COVID USE CASE

Figure 2

*Navigation Challenge Ported to a Virtual Lab Environment*

```
1 #include <Servo.h>
2
3 Servo leftservo;
4 Servo rightservo;
5 const int pingPin = 5; // Trigger Pin of Ultrasonic Sensor
6 const int echoPin = 6; // Echo Pin of Ultrasonic Sensor
7
8 void setup() {
9   leftservo.attach(9);
10  rightservo.attach(10);
11
12  //set up the Serial
13  Serial.begin(9600);
14  //setup the pin modes
15  pinMode(pingPin, OUTPUT);
16  pinMode(echoPin, INPUT);
17
18  leftservo.write(90);
19  rightservo.write(90);
20
21 }
22
23 void loop() {
24
25   long duration;
26   //clear the ping pin
27   digitalWrite(pingPin, LOW);
28   delayMicroseconds(2);
```



Surveys were administered by a research assistant during class time at the beginning and at the end of the sequence of labs.

## Instructions

The coins are approximately 110 cm away from the top wall and approximately 70 cm from the right wall. Use the data from the ultrasonic sensor to navigate the robot to collect all coins.

*Last 2 labs done after Covid-19 lockdown*

Video

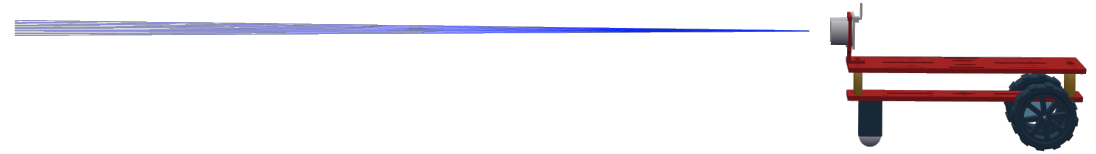
# **Dawson College Engineering Robotics**

Class Navigation Challenge Virtual Simulation

<http://englab.dawsoncollege.qc.ca/>



# OUTCOMES FROM INITIAL STUDY



- We showed how a customized robotics learning activity in an engineering physics course provided **opportunities for students to learn, apply, and experiment with engineering competencies** that often overlap between college and undergraduate levels.

*“I think this was a great lab activity to do related to this class and it was very well modified for the COVID situation we are in. It taught me something I have never fully worked with and showed me something that I did not know I found interesting.”*

- We posit that the knowledge and skills needed to successfully complete computing-based modules have the **potential to generalize to other learning environments.**

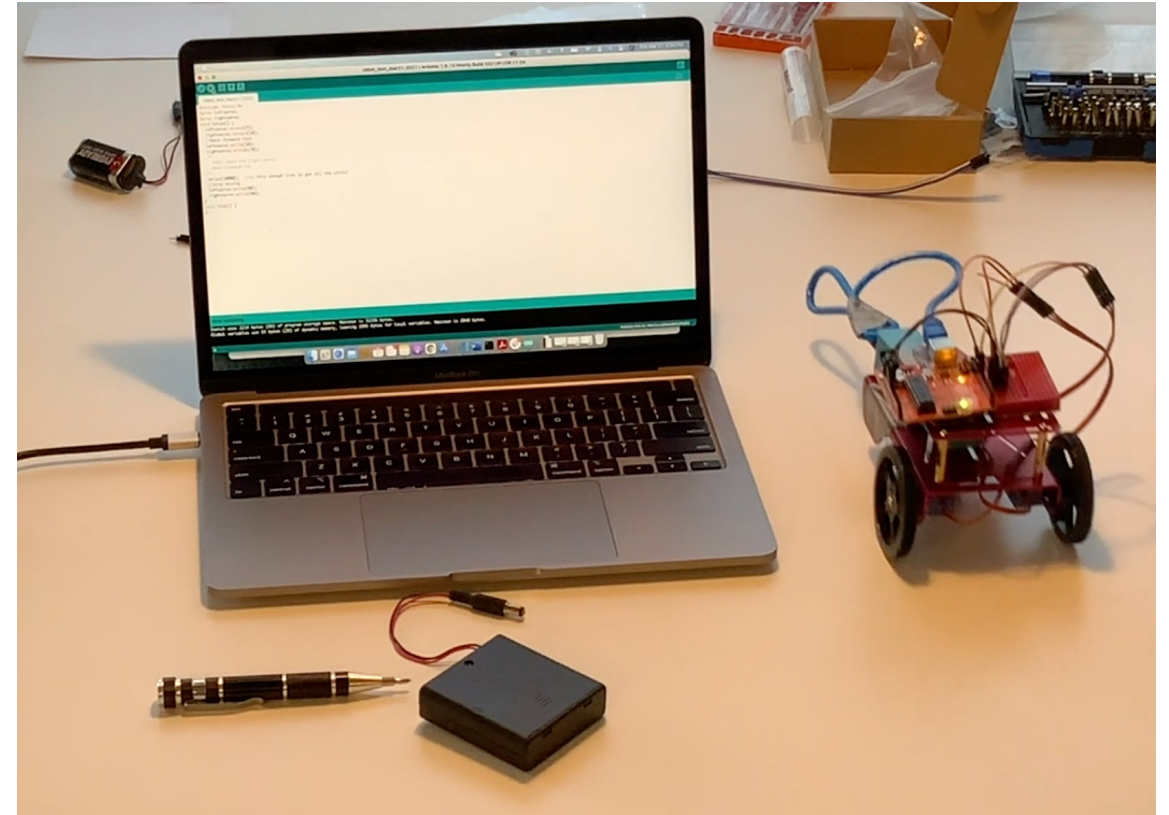
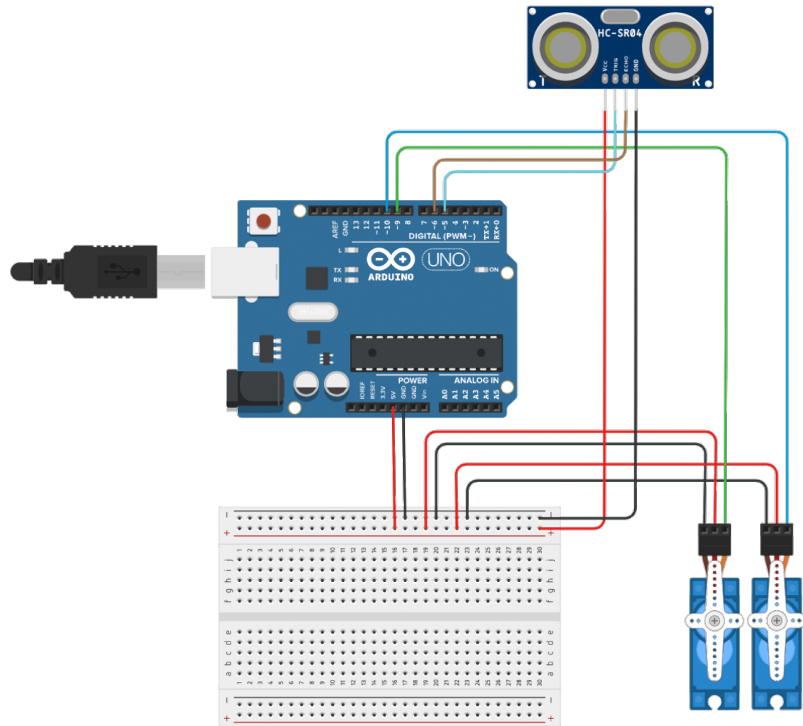
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## OUTCOMES FROM INITIAL STUDY

*“I really appreciate the online simulation we got to play around with. It allowed for individual exploration and a deeper understanding.”*

*“ It was a really fun project to participate in, although I'm a bit sad that we could not do it in reality due to the unfortunate circumstances. However, I appreciate the teachers doing everything they can to [...] create something very similar and very fun.”*

# WORK-IN-PROGRESS



- Recently we have reintroduced robotics hardware designed for home use and expanded the 4-lab engineering robotics sequence studied here to 6 labs.
- Future work will report on outcomes of these authentic blended learning experiences.

# WORK-IN-PROGRESS

Dawson Virtual Lab

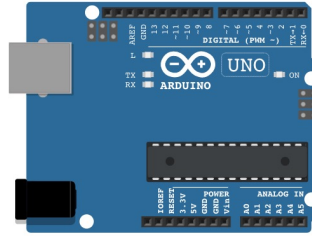


[Arduino Intro](#)

[Robot Lab](#)

[Homework](#)

[About](#)



## Dawson Virtual Lab

[Start Learning Arduino Now →](#)

[Robot Lab →](#)

### No Installation Required

Dawson Virtual Lab runs everything in the browser. You don't need to install anything to be able to use it.

### No Prerequisites

Anyone can start learning how to program with Dawson Virtual Lab. There are no prerequisites required.

### Simulate hardware

Learn engineering robotics without the environmental constraints. Then test your code on real hardware.

Several learning activities have been created to introduce skills and knowledge (programming and microcomputing) while developing computational thinking and problem-solving prowess.

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## FUTURE WORK

- Designing experiential learning solutions to develop *4IR* competencies, targeting the overlapping levels of high school, college and undergraduate
- Generalizing the Arduino-based modules to other hardware and customizable environments
- Developing a support model for custom curriculum implementation and teacher training

# WORK WITH US

## Dawson Virtual Lab

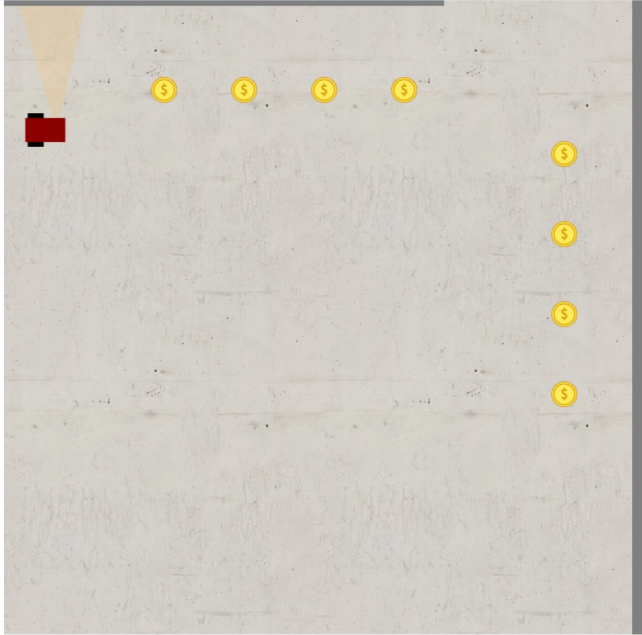
### Engineering Physics Lab

- Move A Robot
- Ultrasonic Sensor
- Follow The Wall
- Class Challenge
- Super Challenge**

RUNSTOPTime:

```
1 #include <Servo.h>
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15    rightservo.write(90);
16 }
17 :void loop() {
18     long duration;
19     //clear the ping pin
20     digitalWrite(pingPin, LOW);
21     delayMicroseconds(2);
22     //send the 10 microsecond trigger
23     digitalWrite(pingPin, HIGH);
24     delayMicroseconds(10);
```

Arduino IntroRobot LabHomeworkAbout



CHALLENGE 1

CHALLENGE 2

CHALLENGE 3

CHALLENGE 4

Video of SALTISE 2021 presentation at <https://englab.dawsoncollege.qc.ca/saltise2021>

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# THANK YOU!

Joel Trudeau

[jtrudeau@dawsoncollege.qc.ca](mailto:jtrudeau@dawsoncollege.qc.ca)

Tanya Chichekian

[tanya.chichekian@usherbrooke.ca](mailto:tanya.chichekian@usherbrooke.ca)

Tawfiq Jawhar

[tjawhar@dawsoncollege.qc.ca](mailto:tjawhar@dawsoncollege.qc.ca)

[englab.dawsoncollege.qc.ca](http://englab.dawsoncollege.qc.ca)

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THANK YOU!



Éducation  
et Enseignement  
supérieur



Social Sciences and Humanities  
Research Council of Canada

Conseil de recherches en  
sciences humaines du Canada



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