

## Open-inquiry experiments using sensors controlled by Arduinos in a pandemic-resilient lab course

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# Open-inquiry experiments using sensors controlled by Arduinos in a pandemic-resilient lab course

Picture of students or project

Forrest Bradbury  
Freek Pols  
Paul Vlaanderen

Qr to go  
to  
material  
s

AUC (NL)  
DUT (NL)  
UA (NL)

# Outline

- Motivations
- Choices
- Structure
- Results
- Pandemic
- Conclusions
- Next steps

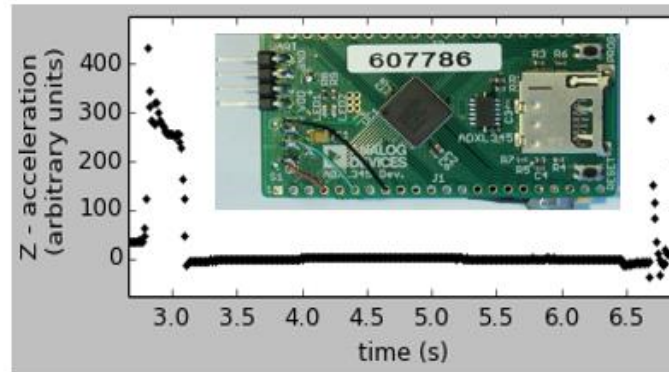
- Motivations for open-inquiry
- Choices for:
  - Flipped Lab methods
  - Arduinos & Maker tools
- Course structure & pandemic resiliency
- Results and advantages
- Pandemic resiliency,
- Conclusions
- Next steps

# Rocket project

- Comparing numerical models to onboard accelerometer data.
- First year was thrilling!



- Motivations
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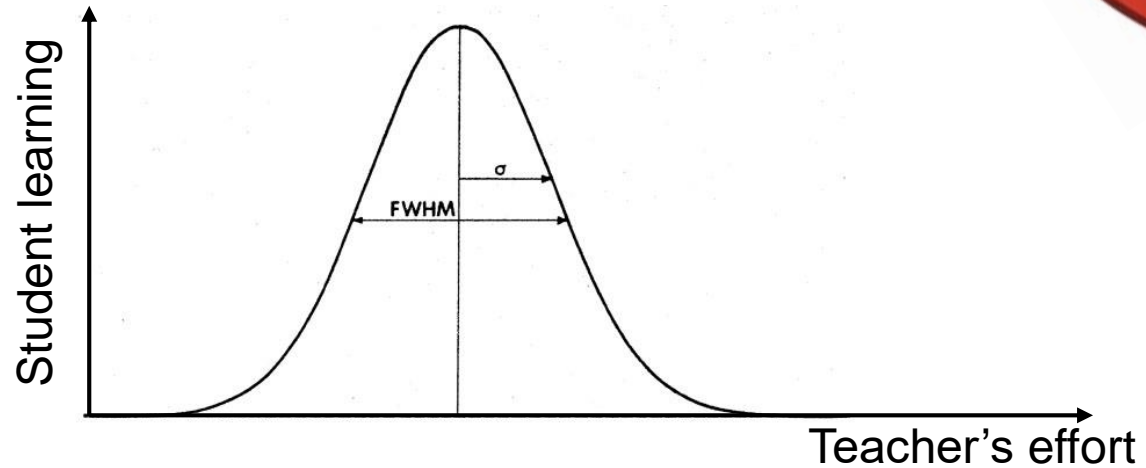


# Rocket project

- Further development work led to diminishing negative results.



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# AUC – Open lab course

- AUC's natural science students pick 1 lab course.
- Experience research cycle.
- No labs available.

Picture of typical AUC

- Motivations
- **Choices**
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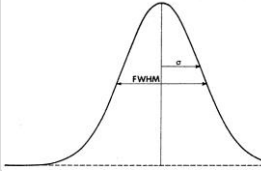
# Requirements

- Open
- Freedom of choice (sensors)
- Cheap
- Safe



# Timeline

skills training  
structured inquiries



1<sup>st</sup> open inquiry  
@home

picture

go/no go

midway

final presentation

2<sup>nd</sup> open inquiry  
@home

picture

go/no go

midway

final presentation

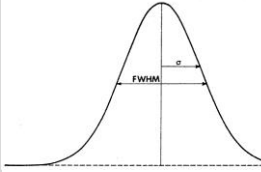
Open-inquiry experiments using Arduinos in a pandemic-resilient lab course

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# Timeline

skills training  
structured inquiries



1<sup>st</sup> open inquiry  
@home

2<sup>nd</sup> open inquiry  
@home



go/no go

building closes

midway

final presentation

go/no go

midway

final presentation

Open-inquiry experiments using Arduinos in a pandemic-resilient lab course

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# Project examples

- Motivations
- Choices
- Structure
- **Results**
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- Conclusions
- Next steps

- Comparing water retention of alternative potting soils against those with unsustainably harvested peat-moss.
- Optically measuring heart rate and characterizing its post-exercise recovery to equilibrium.
- Measuring color fidelity of a Macbook's screen with an RGB sensor.
- Pushing the Arduino's sampling rate for precision sound frequency determination.
- Measuring local wind-speeds to determine suitable bee-habitat.
- Comparing signatures of bicep muscle fatigue between dominant and non-dominant arms with median frequency evolution of the EMG power spectrum.

# Student ownership

- Motivations
- Choices
- Structure
- **Results**
- Pandemic
- Conclusions
- Next steps

- *Their* areas of interest,
- *Their* research question and experimental design,
- *Their* residences as lab room, available at *their* convenience,
- and instructors prevented from taking the reigns!

# Advantages of flipped labs

- Motivations
- Choices
- Structure
- **Results**
- Pandemic
- Conclusions
- Next steps

- More time for personalized attention and feedback (focuses on difficult bits of research cycle).
- Instructor as research supervisor (transforms the student-instructor dynamic).
- Students continually practice communication skills in authentic context.

# Pandemic Resilient

- Motivations
- Choices
- Structure
- Results
- **Pandemic**
- Conclusions
- Next steps

- Flipped teaching methods
- Maker tools (sensors controlled by Arduinos)
- Fully open-inquiry projects

# Conclusions

- Maker Lab pilot demonstrates these methods achieve intended learning outcomes.
- Maker Lab pilot coincidentally proved to be pandemic resilient.

- Motivations
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- Structure
- Results
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- **Conclusions**
- Next steps

# What's next?

- Motivations
- Choices
- Structure
- Results
- Pandemic
- Conclusions
- **Next steps**

- Open-source course materials available: **insert surfdrive link here**
- Faculty Online Learning Community for practitioners - please be in touch: [f.r.bradbury@auc.nl](mailto:f.r.bradbury@auc.nl)
- Continuing work:
  - How best to adapt first third for fully online course?
  - How to include TA's in teaching team?
  - Minimizing risks in at-home experiments by teaching and promoting a safety culture
  - Doing science versus Demonstration of (advanced) physical phenomena
  - Develop shorter variant (~60 student hours instead of 168) with one open-inquiry project

# What's next?

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- Conclusions
- **Next steps**

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