1st Year Physics labs: Engaging Students During Labs

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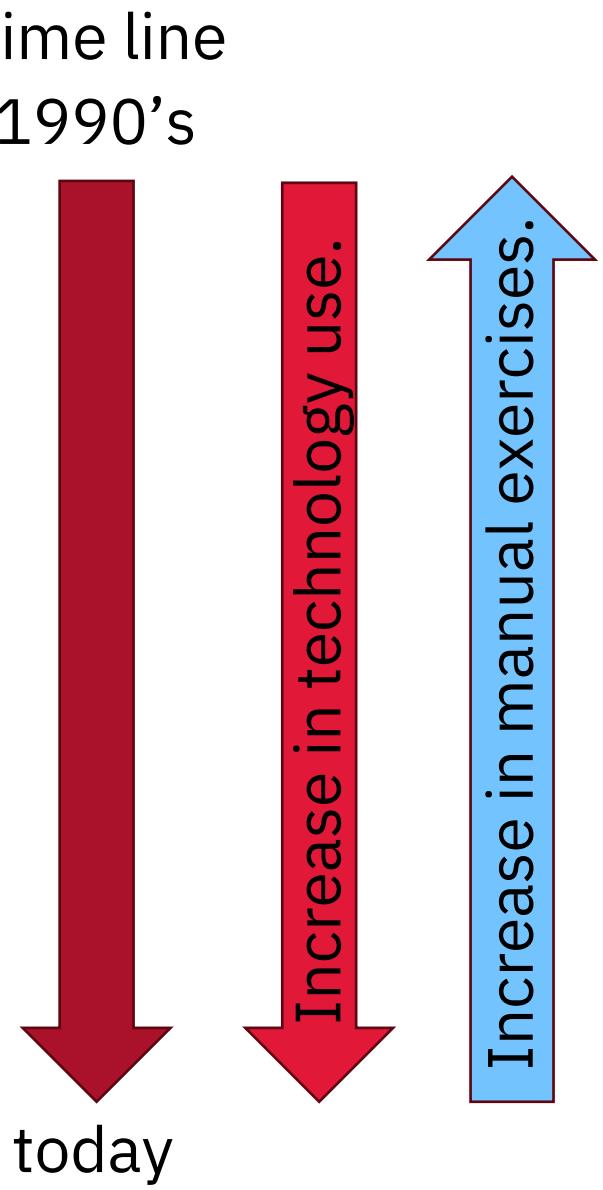
Outline

- Introduction: Timeline of changes over the years in the labs
- Summary of Student Experience at York U for 1st year Physics Labs
- Preparing for Labs
- Active learning and engagement during labs at the York University Markham Campus
- Future/Ongoing Work

1st year PHYSICS labs over the years

- **Back to the 90's**
  - Printed lab manual.
  - Hand-written pre-labs and lab reports including data collection and graphing.
- **90's to ~ 2020 (pre-Covid)**
  - Online lab manual available to all students (pdf).
  - Hand-written pre-las and labs, updated equipment where data is plotted automatically (Logger Pro) (PHYS 1011/1411/1421/1012/1412/1422).
  - Some online submissions via eClass (PHYS 1800/1801).
- **COVID (~2020 to 2022) – online and in-person labs**
  - During this time all in-person labs also converted to online submission via eClass (pre-labs and lab reports). Lab manual updated and lab laptops available for students.
  - Asynchronous introductory online lab for students to become familiar with Logger Pro and Word.
  - **Online access to AI and support (chat GPT and CHEGG examples).**
- **2023 – present (post COVID) – back to in-person labs**
  - Mainly in-person labs with an online component.
  - More automated equipment that collects data and creates graphs.
  - Students analyze graphs and collect data digitally.
  - **How do we engage students during labs????**



Motivation for Change in 1st year Physics Labs

- Why make changes to the lab experience:
  - Noticed students not preparing.
  - Students accessing other sources and not engaging with lab equipment.
  - Students using AI sources to complete pre-lab exercises and lab reports.

- Challenges:
  - Student preparation - reminders, lab journal and discussion assessment
    - Reading the laboratory manual!!!
    - Focusing on experimental procedures and data analysis and less on lab report writing.
    - Using a lab journal during the lab.

  - TA training and lab expectations,
    - Preparation for lab and demos
    - Leading discussions and supporting students during labs

Student Experience at YUMC* for 1st year Physics Labs

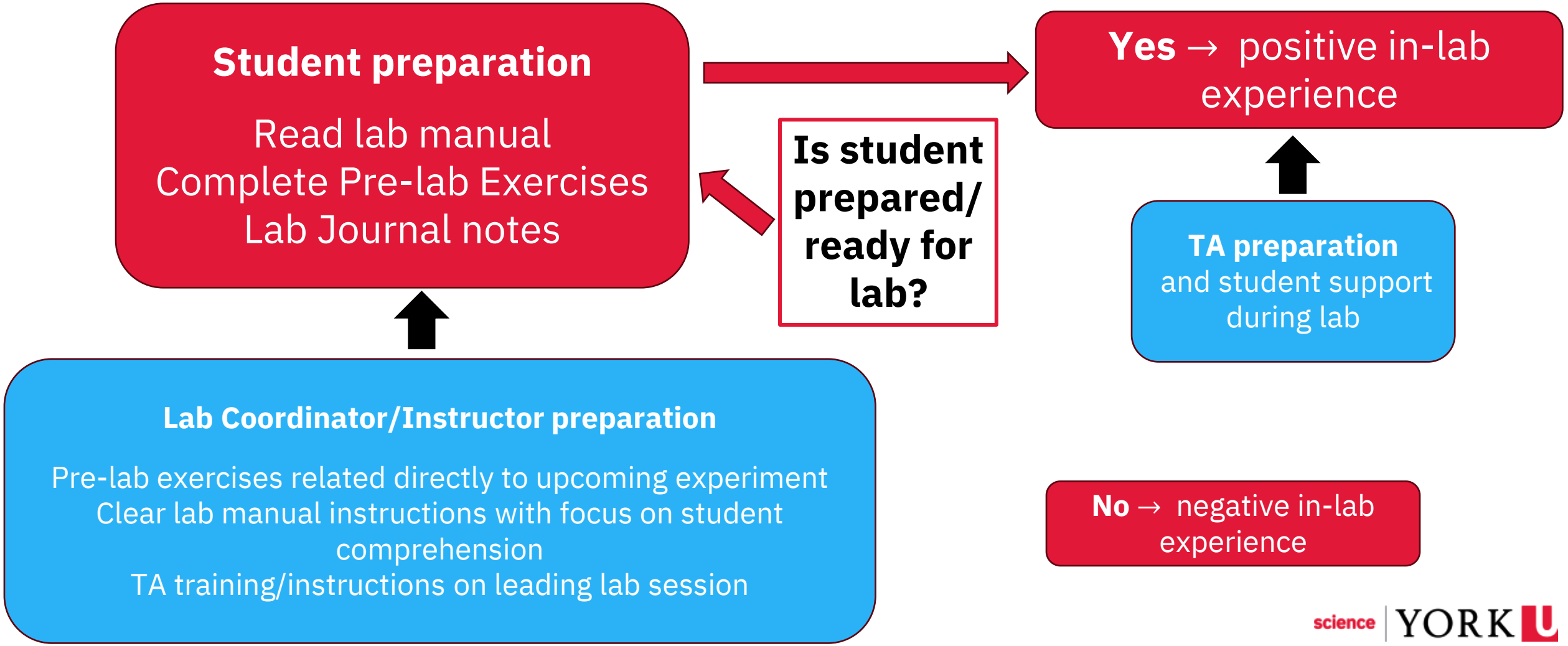
- Students are expected to complete six 3-hour labs per term.
  - One lab is conducted asynchronously and online prior to in-person labs
  - Five scheduled in-person labs

- For each lab students are expected to complete the following:
  - Read lab manual and complete pre-lab exercises prior to lab
  - Conduct experiments and complete an informal lab report submitted at the end of the lab

*YUMC – York University Markham Campus

Engaging students during the labs

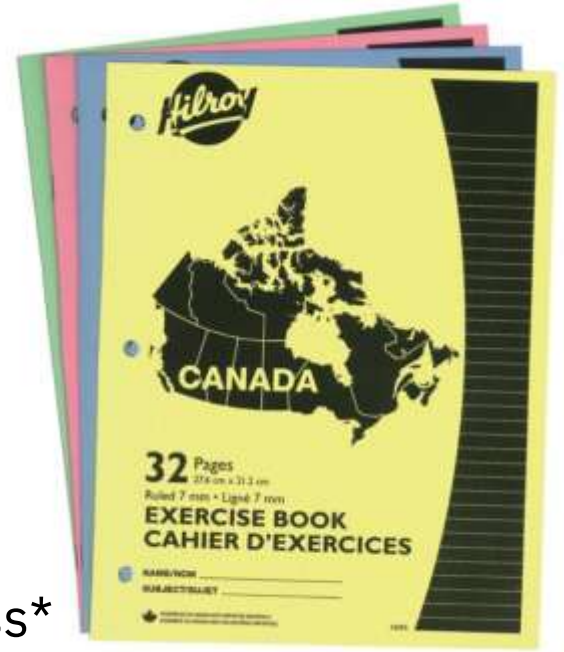
- How can students get the most out of their lab experience?



Student Preparation for Labs @ YUMC

- Read lab manual for assigned experiment before the lab
  - Brief introduction followed by experimental setup and procedures, discussion questions are also available.
  - Prepare for **in-lab TA led discussion**.

- Complete pre-lab exercises before the lab
  - Implemented in FW25 – **lab journal** and answers must be **handwritten**.
    - A 32-page exercise book is used to keep track of all lab journal work.
    - Students take a picture of completed pre-lab exercises and upload on eClass* prior to start of in-person lab.
  - Lab journals are collected at the end of term and checked for completion. (New for FW26 – TAs will physically check journal for completion during each lab.)



Lab Journal

*eClass – York's online LMS

Active Learning During the Labs @ YUMC

- Attend lab and complete experiments, data analysis and discussion questions
  - Students generally work individually or in pairs for most of the lab session
  - Complete in-lab ***Group activities***, max 4 students/group
    - Hand-written work submitted in lab
  - TA Led Discussion

- Submit informal lab report by the end of the lab session
  - Students are provided with a WORD template via eClass
    - This is completed individually
    - Prepare an informal lab report using provided lab laptops

How we are limiting access to unwanted internet sources:

Students must use provided lab laptops to complete lab report (No personal devices allowed)

NEW!!! Only online access available is eClass

NEW: In-lab individual and group activities completed on paper during lab

Engaging students during the labs – YUMC status

- Student preparation:
  - Read Lab manual
  - Lab journal (for pre-lab and notes)
  - In-lab TA led discussion

Motivation to prepare: Assigned ***lab grade*** weight (20%)

- TA preparation:
  - Review lab manual and run through experiment
  - Prepare demo and TA led discussion

In-Lab Grading

- Lab Coordinator/Instructor preparation:
  - **Train TAs to lead engaging lab sessions**
  - **Create in-lab activities for students**
  - **Develop discussion questions**

Engage students and TAs for a positive in-lab experience

Engaging students during the labs

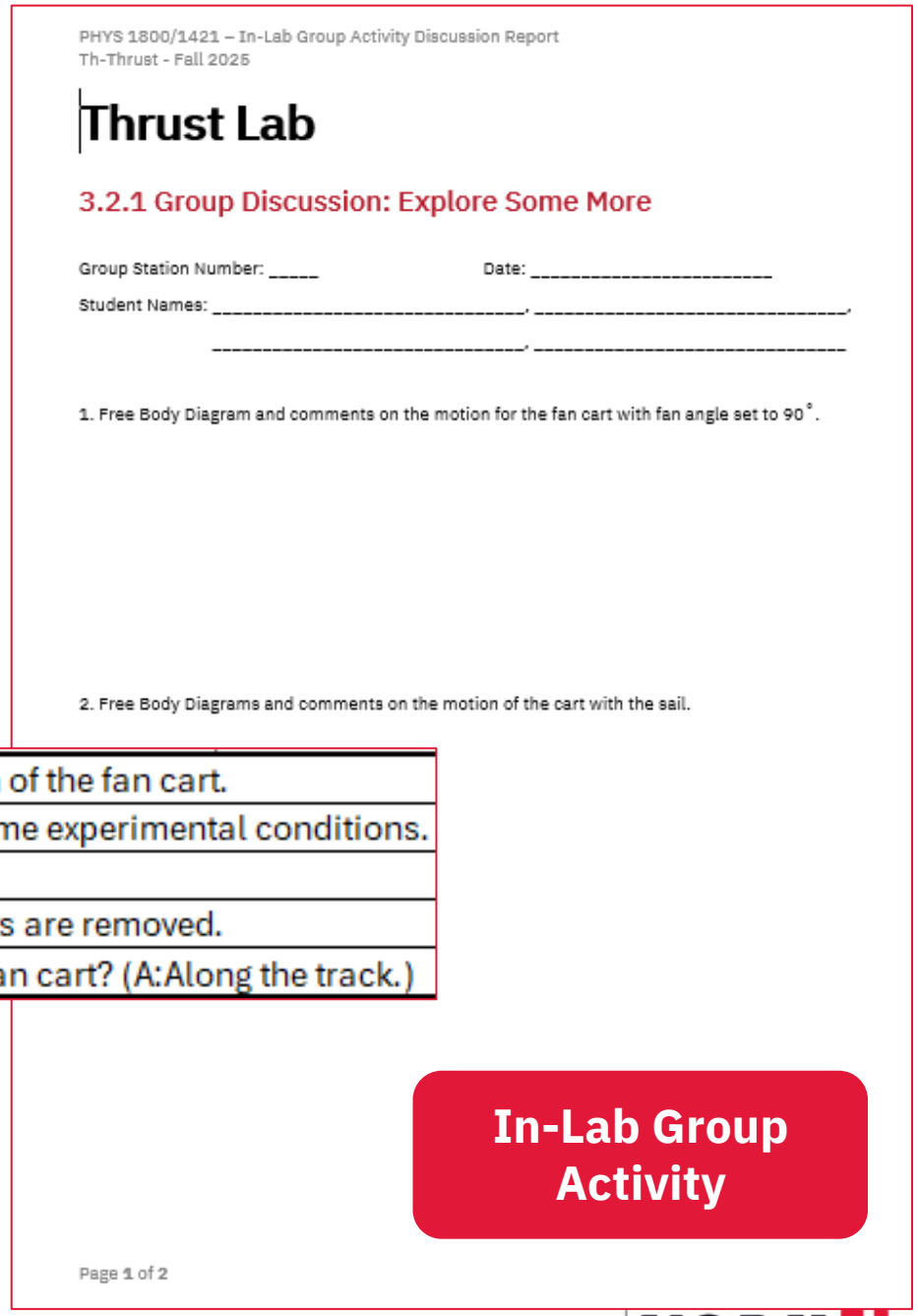
Lab Journal Checks and Submission (hand written)
(used to complete pre-labs and for lab notes during lab)

Sample In-Lab TA Led Discussion Questions:

Thrust (Markham Campus)	1	Describe which Newton's law(s) can be used to describe the motion of the fan cart.
	2	What is the reason for taking multiple time measurements of the same experimental conditions.
	3	How does the fan angle affect the force along the track length?
	4	Describe how the motion of the cart is affected if the two side weights are removed.
	5	Which component of the thrust force contributes the motion of the fan cart? (A:Along the track.)

Individual Lab Report Submission

(includes data collection, graphing and analysis, discussion questions)



PHYS 1800/1421 – In-Lab Group Activity Discussion Report
Th-Thrust - Fall 2025

Thrust Lab

3.2.1 Group Discussion: Explore Some More

Group Station Number: _____ Date: _____

Student Names: _____, _____,
_____, _____

1. Free Body Diagram and comments on the motion for the fan cart with fan angle set to 90°.

2. Free Body Diagrams and comments on the motion of the cart with the sail.

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In-Lab Group Activity

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Engaging students during the labs

- Preliminary TA feedback:
  - “having the journal with them in lab allows the students to quickly work out equations/formulas by hand before inputting the relevant formulas/solutions into their lab reports. This method results in less complaints about having to type the equations into Word, and less time devoted to inputting their equations.”
  - “**Some students are excited to answer questions and request to be quizzed**”
  - “**Students that are not being questioned listen intently to the question being asked, and the answers being given.** This seems to help students work through some of the conceptual questions being asked in the lab manual, or how to properly approach quantitative measurements/calculations”
  - “**The 5 questions to ask seemed annoying at first, but it made me realize they pay attention really well knowing they could be called on.** Maybe I just have a really good group, but they pay solid attention during the demos and look visibly very alert when i do the 5 question thing. Calling on them randomly seems to be working really well, especially since the questions are easy to answer if you paid attention (so it's not like they are picked on to be embarrassed publicly).”
  - “In-lab activity worksheets:
    - group activities promote better collaboration and discussion amongst the students
    - step-by-step calculations are performed more efficiently on paper than on Word
    - **so much eraser shavings! But this is okay since it is an indication of students actively working through ideas**”

Future/On going Work

- TA preparation – a training course prior to the labs
- Implementation of more active learning strategies in the labs
  - Ongoing research project with undergraduate student
- Continue to fine tune lab manual and pre-lab exercises
  - Add new experiments/lab topics
- Workshops for students on how to prepare for labs

Thank you! ☺

Acknowledgements

- York University Markham Campus IT: Arif Rahman and Alex Stewart
- Drs. Charles-Eduard Boukaré, Eric Hessels and Matthew George from the department of Physics and Astronomy at York University.
- All the lab TAs assigned to my labs!

References

- Mestre, J. and Docktor, J. (2021).*The Science of Learning Physics: Cognitive Strategies for Improving Instruction.* World Scientific.
- Domenikos S. and Siren A. (2022). *Introductory Guide for Laboratory Demonstrators.* Teaching Commons, York University.
- Lehesvuori, S. *et al.* (2023). *Student-centredness in physics laboratory teaching sessions.* Learning, Culture and Social Interaction. 43, 100773
- Deslauriers, L. *et al.* (2019). *Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom*. PNAS, 116(39):19251-19257.