Houston...
we STILL have a problem.

Presented by Barbara Forrest
March 31, 2022
University of Waterloo Territorial Acknowledgement

The University of Waterloo acknowledges that much of our work takes place on the traditional territory of the Neutral, Anishinaabeg and Haudenosaunee peoples. Our main campus is situated on the Haldimand Tract, the land granted to the Six Nations that includes six miles on each side of the Grand River. Our active work toward reconciliation takes place across our campuses through research, learning, teaching, and community building, and is centralized within the Office of Indigenous Relations.
Before COVID...

Prior to the pandemic, conversations about the poor math skills of secondary students were common among educators.

“There have been a number of wide-ranging studies out of OECD countries that have found that preparedness for math in postsecondary education is really bad and its getting worse.”

– Big drop in math skills of entering students [University Affairs]

That was then, and here we are now – for two years secondary students have been learning mostly online and will be attending postsecondary institutions in person in the Fall.

Are they ready?

Are we ready?
POLL: Math Preparedness of Incoming Postsecondary Students

Which statement do you agree with most?

It is probably the case that the prerequisite math skills of incoming students are:

- worse than they were before the pandemic.
- about the same as they were before the pandemic, though still poor.
- about the same as they were before the pandemic, but they were satisfactory.
inequity
grade inflation
lost years
lost learning
shadow education systems
third bucket kids
learning gaps
no proctored exams
delecing pass rates
large online classes
inaccurate assessments
inadequate
instructor support
education recovery plan
2 year break
lack of engagement
mental health
shadow pandemic
unfinished
grade inflation
lost learning
cheating
burnout
stress
shadow
pandemic
unfinished
lost years
large online classes
inaccurate assessments
inadequate
instructor support
education recovery plan
2 year break
Two years ago this month, schools closed their doors in 185 countries.

According to UNESCO, roughly 9 out of 10 schoolchildren worldwide were out of school.

It would soon be the biggest, longest interruption in schooling since formal education became the norm in wealthier countries in the late 19th century.

See References: KQED [Public Radio, Television, Digital Media and Educational Services]
Total duration of school closures
Impact of the Pandemic on Student Learning

Our analysis shows that the impact of the pandemic on K-12 student learning was significant, leaving students on average five months behind in mathematics and four months behind in reading by the end of the school year [2020-2021].

...districts oscillated among virtual, hybrid, and in-person learning... Students faced multiple schedule changes, were assigned new teachers midyear, and struggled with glitchy internet connections and Zoom fatigue.

...students were not given the opportunity this year to complete all the learning they would have completed in a typical year. The majority simply learned less than they would have in a typical year...

Students who move on to the next grade unprepared are missing key building blocks of knowledge that are necessary for success.

See References: McKinsey & Company
Calendared assessments, notably high-stakes examinations that determine admission or advancement to new education levels and institutions, are thrown into disarray when schools close.

Strategies to postpone, skip or administer examinations at a distance raise serious concerns about fairness, especially when access to learning becomes variable.

See References:
UNESCO - Adverse consequences of school closures
Students Falling Behind

CBC News questionnaire - responses from N=9,500 educators:

“We’re definitely not on track. We’ve been struggling to get through all of the curricular outcomes. Students who normally perform really well are struggling,” said Peter Zajiczek, who teaches math at Western Canada High School.

Around 65 per cent of respondents who identified as teachers say they are behind in the curriculum, and around 60 per cent of respondents said that fewer students are meeting learning objectives.

See References:
CBC News – Calgary educators concerned students are falling behind, cheating more during pandemic
Many teachers worry that more students are cheating.

“It’s definitely increased a lot. We’re seeing a lot of kids using apps like Photomath for math teachers. There’s a lot of worry about kids sharing exams or quiz questions when they’re at home because we can’t monitor them all”

“...in some cases, students or the parents can hire impersonators to take tests and exams on behalf of the students”

See References:

CBC - Calgary educators concerned students are falling behind, cheating more during pandemic
five months behind

learning objectives not met

skipped exams

cheating
Which statement do you agree with most?

- Students were admitted to University/Post-Secondary Institutions with a sufficiently high average so remedial math options are not required for first-year students.

- Universities/Post-Secondary Institutions have an obligation to offer remedial math options for first-year students.

- It is the instructor’s responsibility to offer remedial math help to students in their classes.
Tips for Identifying Struggling Students

Administrative Tools

Assessments (Just In Time)
First-Year Calculus Classes at UW

MATH 104 : Introductory Calculus for Arts and Social Science (ARTS)
MATH 116 : Calculus 1 for Engineering (ENG)
MATH 117 : Calculus 1 for Engineering (ENG - ECE, SE, NANO)
MATH 118 : Calculus 2 for Engineering (ENG)
MATH 119 : Calculus 2 for Engineering (ENG - ECE, SE, NANO)
MATH 124 : Calculus and Vector Algebra for Kinesiology (HEALTH)
MATH 127 : Calculus 1 for the Sciences (SCI)
MATH 128 : Calculus 2 for the Sciences (SCI)
MATH 137 : Calculus 1 for Honours Mathematics (MATH)
MATH 138 : Calculus 2 for Honours Mathematics (MATH)
MATH 147 : Calculus 1 (Advanced Level) (MATH)
MATH 148 : Calculus 2 (Advanced Level) (MATH)
Administrative Tools for Identifying Struggling Students

BEFORE THE TERM STARTS

- Identify class composition by Faculty or Program
- Identify class composition by Year of Program

AFTER THE TERM STARTS

- Strongly recommend using an LMS (Learning Management System)
- Identify absentee students using the LMS “last accessed” feature
- Identify procrastinators using the LMS “attempt logs” feature
## Identify Class Composition by Faculty or Program

### Calculus 1

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### REGISTRAR COURSE ROSTER

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Identify Class Composition by Student Year

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**REGISTRAR COURSE ROSTER**

Sort on Year of Program
Use the Features of Your LMS

Moodle

Blackboard Learn

Desire2Learn / Brightspace
**Identify Absentees**

In the Waterloo Learn platform, navigate to the Course Home, then select Classlist to view the attendance records. To sort the list by the last accessed date, click on the column labeled "Last Accessed." This will help in identifying who has been absent from the course recently.
### Identify Procrastinators

#### Attempt Logs

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**DEADLINE:** 4:00 PM
POLL:
Using Assessments to Identify Struggling Students

Do you regularly mark any portion of the assignments in your class?

▶ Yes
▶ No
Final Grade Calculation

35% Weekly Online Assignments

30% Regular Assignments, Maple Labs and Mid-term Assessment

35% Final Exam
Weekly Online Assignments

35% weight in total; so worth it to the student to complete.

Low stakes; individual assignments weighted from 1% - 5%.

∼9 per term/one per week (except for major assignment/midterm weeks).

40 - 60 questions: true/false, multiple select, matching, fill-in-the-blank...

Questions are high school review, from reading assignment, basic concept check of current week’s lectures, and a few challenge questions.


Questions provided at least 1 week in advance via downloadable PDF.

Easy to set-up/grade/quick statistics by creating “bubble sheet” in the LMS.
The LMS “Bubble Sheet”

Weekly Online Assignment

Part 1: True and False

Instructions: Using the printed copy of the electronic assignment for this week, enter your answer for each question on the following electronic answer sheet.

Question 1 (1 point)
Select either true or false for question #1.

- True
- False

Question 2 (1 point)
Select either true or false for question #2.

- True
- False

Question 3 (1 point)
Select either true or false for question #3.

- True
Weekly Online Assignment

Part 2: Multiple Choice

Instructions: Using the printed copy of the electronic assignment for this week, enter your answer for each question on the following electronic answer sheet.

Question 27 (1 point)
Choose your answer for multiple choice question #27.

- a.
- b.
- c.
- d.

Question 28 (1 point)
Choose your answer for multiple choice question #28.
Weekly Online Assignment Completion Rates

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Mathematics is not a spectator sport
# Weekly Online Assignment Completion Rates

## Calculus 2

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**Total Students Submitted**: 241, 249, 252, 255, 250, 248, 249

**Total Assignments Submitted**: 241, 249, 252, 255, 250, 248, 249

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SUCCESS as a motivator!
Weekly Online Assignment Question Creation

Recall:

40 - 60 true/false, multiple select, matching, etc... per assignment.

Questions are high school review, from reading assignment, basic concept check of current week’s lectures, and a few challenge questions.
Sample True/False Questions

▶ The function $f(x) = e^x$ has the horizontal asymptote $x = 0$ as $x \to -\infty$.

▶ $\frac{1}{100000} < \frac{1}{100001}$

▶ $0.00000010 < 0.00000050$

▶ $2 \leq 3$

▶ $\frac{1}{n} < \frac{1}{2n}$
True/False Example

The function $f(x) = e^x$ has the horizontal asymptote $x = 0$ as $x \to -\infty$.

False, since the horizontal asymptote is $y = 0$. 
True/False Example

The function $f(x) = e^x$ has the horizontal asymptote $x = 0$ as $x \to -\infty$.

Multiple Choice Related Example

Find the area of the region bounded by $y = x^2 + 1$ and $y = 2$.

(a) $\frac{4}{3}$  (b) $\frac{2}{3}$  (c) $\frac{11}{9}$  (d) $\frac{5}{3}$  (e) None of these
Multiple Choice Related Example

Find the area of the region bounded by $y = x^2 + 1$ and $y = 2$.

(a) $\frac{4}{3}$  
(b) $\frac{2}{3}$  
(c) $\frac{11}{9}$  
(d) $\frac{5}{3}$  
(e) None of these

Student wrote:

Hello Professor,
I am confused by question 16, I am not sure how this region is bounded, can you clarify this for me?
Example: Multiple-select Question

Let $R$ be the region in the first quadrant bounded by the graph of $f(x) = x^2$ and the lines $y = 1$ and $x = 0$. Which of the following solids would have the largest volume?

a) The volume of the solid $S$ obtained by revolving $R$ around the $x$-axis.

b) The volume of the solid $S$ obtained by revolving $R$ around the line $y = 1$.

c) The volume of the solid $S$ obtained by revolving $R$ around the $y$-axis.

d) The volume of the solid $S$ obtained by revolving $R$ around the line $x = 1$.

e) The volume of the solid $S$ obtained by revolving $R$ around the line $y = \frac{1}{2}$. 
Problem 1:
Find the volume of the solid obtained by revolving the region $R$ around the $x$-axis.

and on the same assignment...

Problem 2:
Find the volume of the solid obtained by revolving the region $R$ around the line $y = 0$.

Question from Student: Is the line $y = 0$ the same as the $x$-axis?
Identifying Issues through Assessments

True/False Example

\[
\frac{1}{1001} < \frac{1}{1000}
\]
Identifying Issues through Assessments

Example: Multiple-select Question

We know \( \lim_{n \to \infty} \frac{3n}{n+4} = 3 \). We can show that

\[
\left| \frac{3n}{n+4} - 3 \right| = \left| \frac{3n - (3n + 12)}{n + 4} \right| = \left| \frac{-12}{n+4} \right| < \frac{12}{n}.
\]

If we require \( \left| \frac{3n}{n+4} - 3 \right| < \frac{1}{10^5} \), then we should choose

a) \( n \geq \frac{10^5}{12} \)

b) \( n \geq 12 \cdot 10^5 \)

c) \( \frac{10^5}{12} \geq n \)

d) \( 12 \cdot 10^5 \geq n \)
Identifying Issues through Assessments

The polynomial $f(x) = x^5 + \pi x^3 - 2$ has one real zero. If $f(x_0) = 0$, use Maple’s `plot` command and an appropriate plot range to estimate $x_0$ to 8 decimal places.

```maple
restart:
f := x -> x^5 + Pi*x^3 - 2;
plot(f(x), x=0..1);
```
Identifying Issues through Assessments

The polynomial $f(x) = x^5 + \pi x^3 - 2$ has one real zero. If $f(x_0) = 0$, use Maple’s `plot` command and an appropriate plot range to estimate $x_0$ to 8 decimal places.

```maple
> restart:
> f := x -> x^5 + Pi*x^3 - 2;
f := x ↦ x^5 + \pi x^3 - 2
> plot(f(x), x=0..1);
```
Identifying Issues through Assessments

The polynomial $f(x) = x^5 + \pi x^3 - 2$ has one real zero. If $f(x_0) = 0$, use Maple's `plot` command and an appropriate plot range to estimate $x_0$ to 8 decimal places.
The polynomial \( f(x) = x^5 + \pi x^3 - 2 \) has one real zero. If \( f(x_0) = 0 \), use Maple’s `plot` command and an appropriate plot range to estimate \( x_0 \) to 8 decimal places.
Identifying Issues through Assessments

The polynomial \( f(x) = x^5 + \pi x^3 - 2 \) has one real zero. If \( f(x_0) = 0 \), use Maple's `plot` command and an appropriate plot range to estimate \( x_0 \) to 8 decimal places.

\[
> \text{plot}(f(x), x=0.807..0.808);
\]
The polynomial $f(x) = x^5 + \pi x^3 - 2$ has one real zero. If $f(x_0) = 0$, use Maple’s \texttt{plot} command and an appropriate plot range to estimate $x_0$ to 8 decimal places.
Identifying Issues through Assessments

The polynomial $f(x) = x^5 + \pi x^3 - 2$ has one real zero. If $f(x_0) = 0$, use Maple’s `plot` command and an appropriate plot range to estimate $x_0$ to 8 decimal places.

```
> plot(f(x), x=0.80780..0.80781);
```

![Graph showing the polynomial](image)
Identifying Issues through Assessments

The polynomial $f(x) = x^5 + \pi x^3 - 2$ has one real zero. If $f(x_0) = 0$, use Maple’s `plot` command and an appropriate plot range to estimate $x_0$ to 8 decimal places.
Identifying Issues through Assessments

True/False Example

______  2 ≤ 3
Assume that $f(x)$ is continuous and strictly increasing on $[1, 4]$ with $f(1) = 1$ and $f(4) = 3$. Let $g(y) : [1, 3] \rightarrow [1, 4]$ be the inverse of $f(x)$ on $[1, 4]$. Note: $g(y)$ is also continuous and increasing on $[1, 3]$ and as such integrable on $[1, 3]$.

**Question:** By using the geometric interpretation of the integral, determine if the following statement is True or False.

$$3 \leq \int_{1}^{4} f(x) \, dx \leq 9$$
Identifying Issues through Assessments

**Question:** By using the geometric interpretation of the integral, determine if the following statement is True or False.

\[ 3 \leq \int_{1}^{4} f(x) \, dx \leq 9 \]

**Graded Student Solution:**

Because \( f(x) \) is continuous and strictly increasing on \([1, 4]\), \( \int_{1}^{4} f(t) \, dt \neq 3 \) and \( \int_{1}^{4} f(t) \, dt \neq 9 \). Therefore, we have

\[ 3 < \int_{1}^{4} f(t) \, dt < 9 \]

The statement is a False statement.

If \( a < b \), then \( a \leq b \) is also True.
Identifying Issues through Assessments

True/False Example

\[ \frac{1}{n} < \frac{2}{n} \]
Identifying Issues through Assessments

Example: Multiple-select Question

Let

\[ f(x) = \begin{cases} 
0 & \text{if } x \in [0, 1] \setminus \{ \frac{\sqrt{2}}{2} \} \\
1 & \text{if } x = \frac{\sqrt{2}}{2} 
\end{cases} \]

Let \( P^{(n)} = \{0 = t_0 < t_1 < \cdots < t_i < \cdots < t_{n-1} < t_n = 1\} \) denote the \( n \)-regular partition of \([0, 1]\). Which of the following statements are true?

a) The right-hand Riemann sum \( R_n = \sum_{i=1}^{n} f\left(\frac{i}{n}\right) \cdot \frac{1}{n} = 0 \) for all \( n \in \mathbb{N} \).

b) The left-hand Riemann sum \( L_n = \sum_{i=1}^{n} f\left(\frac{i-1}{n}\right) \cdot \frac{1}{n} = 0 \) for all \( n \in \mathbb{N} \).

c) If \( S_n = \sum_{i=1}^{n} f(c_i) \cdot \frac{1}{n} \) is any Riemann sum associated with \( P^{(n)} \), then \( S_n \leq \frac{1}{n} \). \( \Rightarrow \) student correctly chooses (c)

d) If \( S_n = \sum_{i=1}^{n} f(c_i) \cdot \frac{1}{n} \) is any Riemann sum associated with \( P^{(n)} \), then \( S_n \leq \frac{2}{n} \). \( \Rightarrow \) student INCORRECTLY does NOT choose (d)

e) If \( S_n = \sum_{i=1}^{n} f(c_i) \cdot \frac{1}{n} \) is any Riemann sum associated with \( P^{(n)} \), then \( S_n = 0 \).
"free lessons are cross-referenced to help you find related material, and the "Search" box on every page is available to help you find whatever math content you’re looking for"
Just-In-Time Review

Purplemath

Alternately, go directly to the Purplemath Index page:
https://www.purplemath.com/modules/

### Preliminary Topics

- Absolute Value
- Factoring Numbers
- Fractions
- Geometric Formulas
- LCM and GCF
- Metric Conversions
- Negative Numbers
- Number Bases (binary, octal, etc.)
- Number Properties (Distributive, Associative, Commutative, etc.)
- Number Types (natural, integer, real, etc.)
- Converting between Decimals, Fractions, and Percents
- Place Value
- Roman Numerals
- Rounding (and significant digits)
- Set Notation

### Beginning Algebra Topics

- Canceling Units
- Distance Formula
- Engineering Notation
- Evaluation
- Exponents:
  - Basic rules
  - Negative exponents
- Midpoint Formula
- Order of Operations
- Polynomials (definitions & “like terms”)
- Polynomials: Adding & Subtracting
- Polynomials: Multiplying
- Polynomials: Dividing
- Simplifying with Parentheses
- Slope of a straight line
- Slope and Graphing
- Slope and y-intercept (their meaning in the context of word problems)
- Solving Absolute Values
- Solving inequalities
Exponents: Basic Rules

Exponents are shorthand for repeated multiplication of the same thing by itself. For instance, the shorthand for multiplying three copies of the number 5 is shown on the right-hand side of the "equals" sign in $5(5)(5) = 5^3$. The "exponent", being 3 in this example, stands for however many times the value is being multiplied. The thing that's being multiplied, being 5 in this example, is called the "base".

Purplemath

Google the required topic. Example: “purplemath, exponents”
Image References

**TITLE PAGE:** The Earth & Moon graphic
Image Credit: NASA/JPL/USGS, courtesy NASA/JPL-Caltech.
https://www.jpl.nasa.gov/jpl-image-use-policy

**SLIDE:** University of Waterloo Territorial Acknowledgement
https://uwaterloo.ca/indigenous/

**SLIDE:** UNESCO
Global monitoring of school closures: Total duration of school closures
https://en.unesco.org/covid19/educationresponse#schoolclosures

**SLIDE:** Miami Herald
Wordle cheating is at all-time high, study shows. Where do the worst offenders live? -Mariah Rush

**SLIDE:** Purplemath
https://www.purplemath.com/
The state of the global education crisis: a path to recovery
A Joint UNESCO, UNICEF, and World Bank Report
https://unesdoc.unesco.org/ark:/48223/pf0000380128

Learning loss due to school closures during the COVID-19 pandemic
PNAS [Proceedings of the National Academy of Sciences]
https://www.pnas.org/doi/10.1073/pnas.2022376118

Two years ago schools shut down around the world. These are the biggest impacts.
KQED [Public Radio, Television, Digital Media and Educational Services]
https://www.kqed.org/mindshift/59194/two-years-ago-schools-shut-down-around-the-world-these-are-the-biggest-impacts

Education: From disruption to recovery
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Adverse consequences of school closures
UNESCO
https://en.unesco.org/covid19/educationresponse/consequences
Big drop in math skills of entering students
University Affairs

COVID-19 and education: The lingering effects of unfinished learning
McKinsey & Company

Calgary educators concerned students are falling behind, cheating more during pandemic
CBC News

Purplemath
https://www.purplemath.com/
Questions / Discussion Topics

- Do you anticipate more math prerequisite issues than usual in Fall 2022? If so, what are they?

- Will you incorporate some sort of high school math review in your planning for the FALL?

- Remedial Math Classes - yes or no? before term or during term? just-in-time review instead?

- Do remedial classes really help struggling students?

- Should we care about cheating?

- What are the objectives of Math courses? (instructor point of view)

- What are the objectives of Math courses? (student point of view)