The Modern Traditionalist: Bridging the Post-Secondary Mathematics Gap in the Digital Age

Bringing Rigor and Care Together

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PIMS Changing the Culture, May 2026

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The Philosophical Divide

Modern Movement (K-12)

- Standards-Based Grading (SBG)
- Building Thinking Classrooms (BTC)
- Student well-being & growth mindset
- Formative feedback, retakes, collaboration

Traditional Reality (Post-Secondary STEM)

- Objective precision
- High-stakes, timed exams
- Deep cognitive stamina
- No retakes, no "partial credit for trying"

Result: The "Post-Secondary Cliff"

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The Post-Secondary Cliff: A Brutal Transition

- Students thrive in supportive, modern K-12 settings...
- ...then crash in first-year calculus, physics, or engineering.
- **Why?** The game changes: no safety net, no collaborative problem-solving, no re-dos.
- Universities report: *"Students cannot perform under timed, high-stakes conditions."*

Question: Can we prepare students for this reality *without* abandoning the gains of modern pedagogy?

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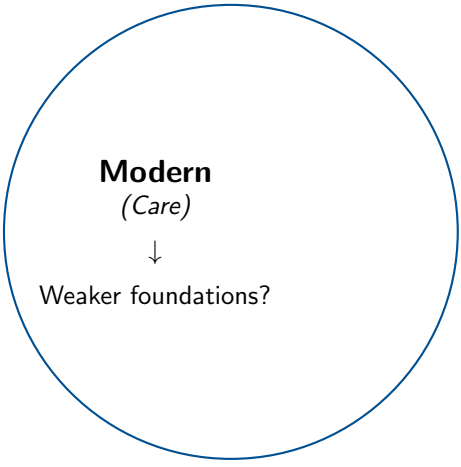
The False Dichotomy



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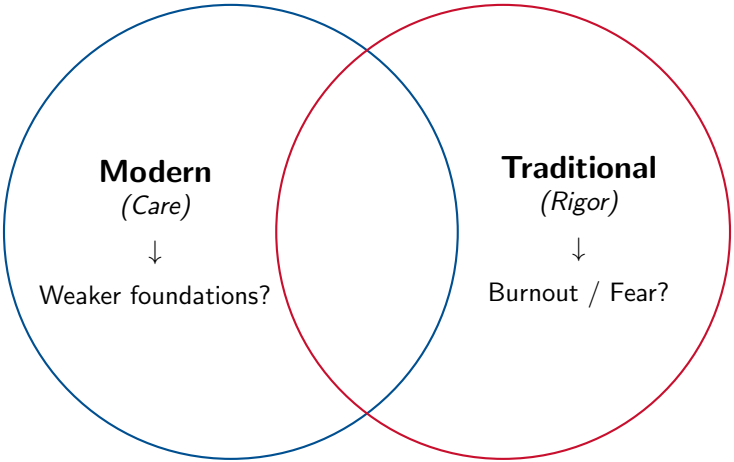

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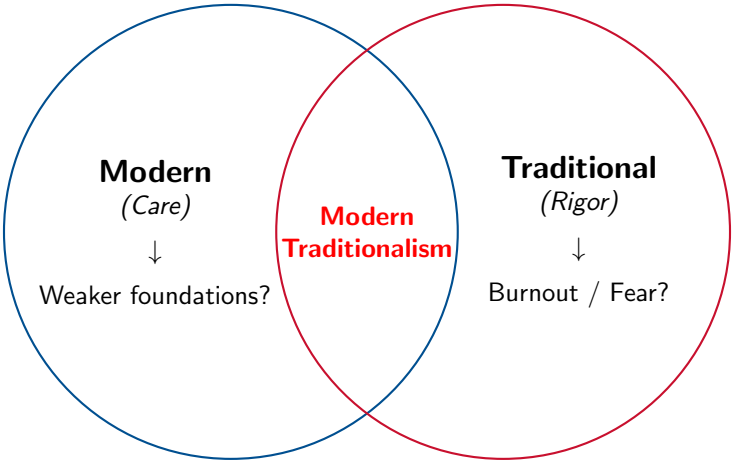

What Is Modern Traditionalism?

Traditional Pillars (non-negotiable)

- Procedural fluency, conceptual depth
- High-stakes cumulative assessments
- Academic integrity (no gaming the system)
- Clear standards and accountability

Modern Enhancements (the "how")

- Level-based, diagnostic grading (Levels 1-7)
- AI-assisted practice and LaTeX efficiency
- Intentional spiral curriculum (interleaving, spaced retrieval)
- Student agency and transparent success criteria

BC Curricular Competencies - Understanding and Solving

Understanding and Solving

- Traditional math questions
- Assessing procedural fluency
- Rote practice generally produces success

Level System

Students are told which skills are expected and their assigned levels.

- Level 1-2 : Foundational skills to the unit, low entry. **All** students should be able to do.
- Level 3-4 : Key skills of the unit at grade level. **Most** students should be able to do.
- Level 5-6 : Advanced skills of the unit at grade level. **Some** students can do.
- Level 7 : Use of current and past skills in novel situations. **Very few** students can do.

Setting Goal Posts

Traditional

- Goal is some percentage or letter grade
- Unsure how to get there?
  - Do more practice
  - Make less careless mistakes
- What does an 86% mean the student can do and cannot do?

Modern Traditionalism

- Goal is a broader Level
- Path to that level is clearly laid out
- Colleagues agree upon the levels
- Vocabulary changes

If students know where the goal posts are, they are much more likely to reach them.

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Sample - Pre-Calculus 11 Rational Expressions

Level 1 to Level 2

- Stating NPVs
- Simplifying individual rational expressions of various forms
- Multiplying and dividing simple rational expressions
- Adding/Subtracting with like denominators

Level 3 to Level 4

- Multiplying and dividing rational expressions with multiple simplification steps
- Adding and subtracting with unlike denominators
- Solving rational equations with simple steps

Level 5 to Level 6

- Simplifying mixed operations
- Solving more complicated rational equations
- Application problems

Level 7

- Unfamiliar problems
- Open-ended problems with explanation

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Example (Level 1-2 Questions)

Simplify the following rational expressions. State the NPVs.

a) $\dfrac{24x^4y^2}{36x^2y^6}$

b) $\dfrac{5x+25}{x^2-25}$

Perform the indicated operation and simplify. State the NPVs.

a) $\dfrac{y^2-4y}{y^2-25} \cdot \dfrac{2y+10}{3y}$

b) $\dfrac{x^2-8x+15}{x^2-9} \div \dfrac{x-5}{2x-6}$

c) $\dfrac{4x}{x-5} + \dfrac{20}{x-5}$

d) $\dfrac{x^2+5x}{x+7} - \dfrac{3x+35}{x+7}$

Level Examples - High Ceiling

Example (Level 7)

Consider the rational function $R(x) = \dfrac{12}{x^2 - 6x + 13}$.

a) Determine the non-permissible values of $R(x)$, if any exist. Show your reasoning.

b) If a fraction has a constant positive numerator, what must happen to its denominator to make the overall value of the fraction as **large** as possible?

c) Hence, determine the absolute **maximum** value of the function $R(x)$ and the x-value at which it occurs. Show your algebraic steps.

BC Curricular Competencies - Reasoning and Analyzing

Reasoning and Analyzing

- Conceptual math questions
- Assessing analyzing and justifying skills
- Justifying and explanation required

RA Tasks

- Always/Sometimes/Never Statements
- Identify the Error
- Which One Doesn't Belong

Always/Sometimes/Never Statements

State if the following statement is always true, sometimes true, or never true. Provide a brief justification.

Example (Pre-Calculus 11 - Radicals Unit)

Let A, B be any real number, then $A + B\sqrt{3}$ is an irrational number.

Example (Math 10 - Linear Relations Unit)

If two lines have slopes m and $-m$ respectively, then they are perpendicular.

Example (Calculus 12 - Integrals Unit)

If $f(x)$ is a positive function and $f''(x) < 0$ everywhere, then a Trapezoidal Approximation on any interval $[a, b]$ where $a < b$ will result in an over-approximation.

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Find the Error

Example (Math 10 - Systems of Equations)

A student was solving the following system of equations by substitution. Identify which step the student first made the mistake, and explain.

$$\begin{cases} y = 2x - 16 \\ 3x - 2y = 13 \end{cases}$$

$$\begin{aligned}
3x - 2(2x - 16) &= 13 && \text{Step 1} \\
3x - 4x - 32 &= 13 && \text{Step 2} \\
-x - 32 &= 13 && \text{Step 3} \\
-x &= 45 && \text{Step 4} \\
x &= -45 && \text{Step 5} \\
y &= 2(45) - 16 = 74 && \text{Step 6} \\
\textit{intersection} &: (-45, 74) && \text{Step 7}
\end{aligned}$$

Which One Doesn't Belong

Example (Pre-Calculus 11 - Quadratic Functions and Trigonometry)

Which expression doesn't belong? Explain.

i. $\tan 90^\circ$ ii. $\cos(-90^\circ)$ iii. $\sin 0^\circ$ iv. $\tan 45^\circ$

Which quadratic function doesn't belong? Explain.

i. $f(x) = (x-3)^2 + 1$ ii. $g(x) = -2(x+3)^2 - 1$

iii. $h(x) = 2(x-3)^2 - 1$ iv. $i(x) = 2x^2 + 1$

BC Curricular Competencies - Communicating

Expectations

- Organized work - vertically whenever possible
- Correct use of math symbols and standards
- A Level 7 communication would imply no math teacher can find any faults

What it provides

- Targets written mathematics as a valuable skill
- Shows students that the final answer isn't always the most important
- Separates communication flaws from understanding flaws

BC Curricular Competencies - Connecting and Reflecting

What is it?

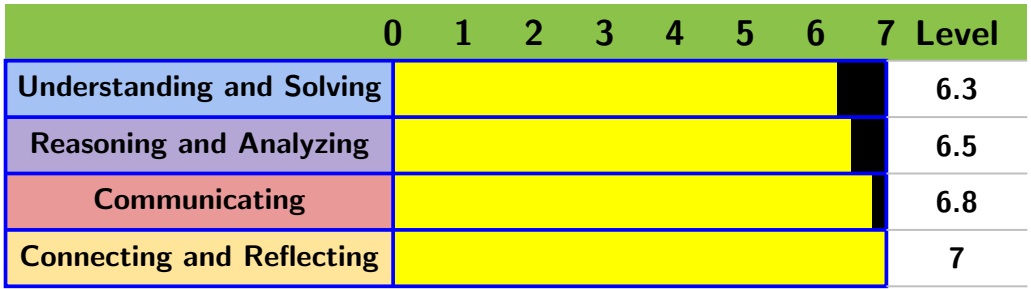
- Low-stakes quizzes with correction opportunity
- Reflecting on learning progress
- Connecting math skills (projects, explorations, etc...)
- For some, it's creating high ceiling questions

Weight Distribution

At St. George's School, our current weight distribution of skills are as follows

- Understanding and Solving - 60%
- Reasoning and Analyzing - 20%
- Communicating - 10%
- Connecting and Reflecting - 10%

Math Character Stats #1



Consistent, all-around excellent student.

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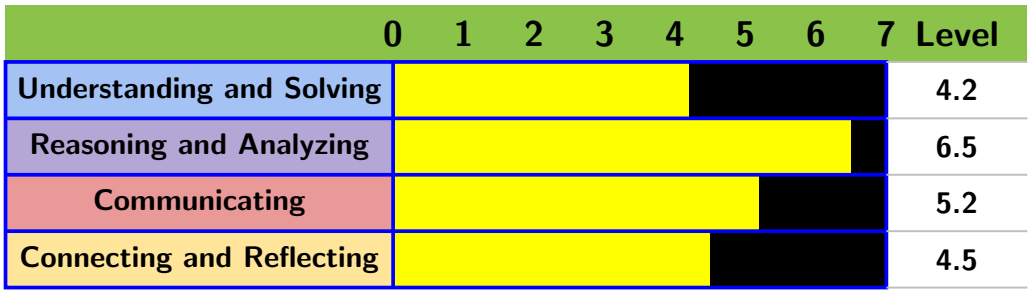
Math Character Stats #2



High conceptual understanding. Weaker procedural skills. Careless?

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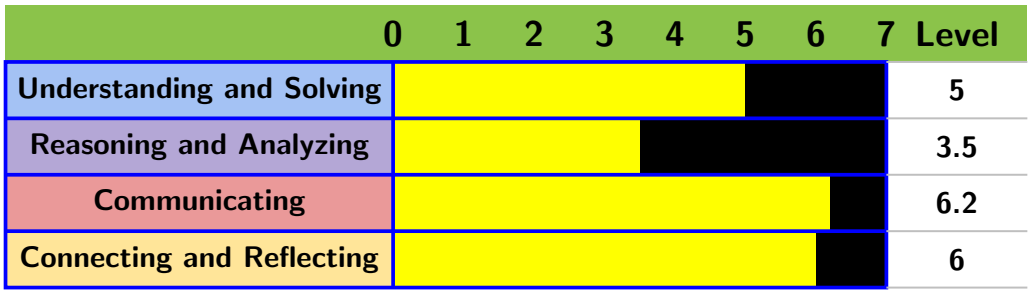
Math Character Stats #3



Solid procedural skills. Weaker conceptual understanding. Memorizes steps?

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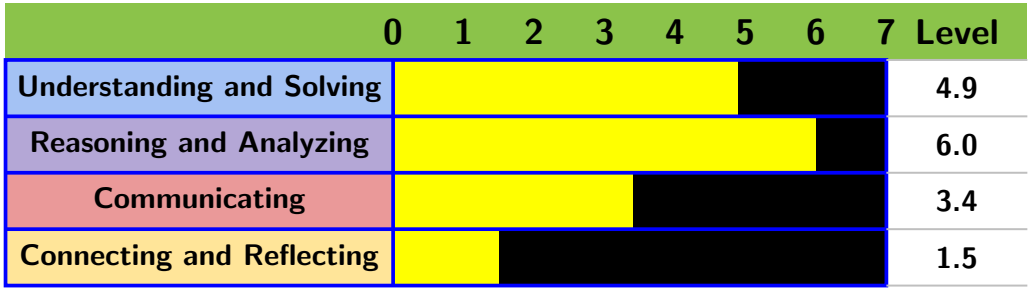
Math Character Stats #4



The capable crammer. Only focuses on the main marks.

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The High-Stakes Exam: Diagnosing True Retention

- **BC Curriculum:** Big ideas, flexible pacing. No provincial exam. Missing: timed, high-stakes exam endurance.
- **The "Cram and Flush" Reality:** Some schools have removed final exams, or value traditional assessments less than before. Some in favour of alternative modes of assessing learning.
- **Our Response: April Cumulative Exams** (instead of June).

Why April?

- Provides exam conditions to build cognitive stamina.
- Exposes the difference between temporary memorization and a permanent "Conceptual Web."
- Built-in recovery time (May/June) to avoid "one and done" panic.

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Shifting Department Culture: A Case Study

Traditional (Before)	**Modern Traditionalist**	**Outcome**
Percentage grading (0-100%)	Level 1-7 + skill descriptors	Diagnostic, not just judgmental
Unit tests only	Tests with clear levels	Students self-identify gaps
No retakes, try harder	Targeted revision on weak levels	Growth, not punishment
June final (exhausted)	April cumulative (focused, energy)	Buzz, studying, fairness
Teacher-made arbitrary points	Leveled question bank	Consistency across sections

Result:
Almost all math courses with multiple teachers use a level system on major assessments.
12 of 13 teachers now use LaTeX+AI in some or all their work.
Department culture shifted.

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Scaling the Architect: AI as a Rendering Engine

AI is often misunderstood as a "magic wand" that creates competence. In reality, it is an **amplifier** that scales existing infrastructure.

- **The Trap:** Feeding AI generic zero-shot prompts yields generic, poorly formatted slop.
- **The Solution (The API):** We feed AI our custom `stg-math.sty` LaTeX macros and the strict parameters of our Level 1-7 matrix.
- **The Workflow:**

$$\text{Pedagogical Rubric} + \text{Custom LaTeX} + \text{LLM} = 99\% \text{ Flawless Output}$$

- **Result:** Generating an 18-page, perfectly tiered cumulative review package with exact-value answer keys drops from 10 hours to 30 minutes.

Technology & AI as Enablers, Not Replacements

- **LaTeX Ecosystem:** Professional test creation (Google Sheets → LaTeX bridge).
- **AI in Tutoring:** Students use AI for *extra practice* after live diagnosis. I provide the strategy, AI provides the reps.
- **Overleaf + Browser Workflow:** OS-agnostic, cloud-native, reproducible.
- **Data Privacy Sovereignty:** Moving towards localized, offline open-source LLMs to protect student data while maintaining scaling power.

AI doesn't replace the teacher. It amplifies the teacher's diagnostic reach.

From "Cliff" to "Ramp": Key Takeaways for Educators

1. **Protect the bottom, raise the top.** Level 1 should be achievable; Level 7 should be exceptional.
2. **Time assessments strategically.** April $\rightarrow$ June. Students need energy and a safety net.
3. **Mandate consistency.** Common question banks, level descriptors, and conversion rules.
4. **Embrace AI as a co-pilot.** Build your pedagogical API first, then let the machine scale it.
5. **Document and share.** Your systems should outlast you.

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Conclusion: Building a Bridge, Not a Wall

- We don't have to choose between caring and rigorous.
- **Modern Traditionalism** is a design philosophy: build structures that challenge and support simultaneously.
- Our students leave with:
  - Deep procedural fluency.
  - Cognitive stamina for high-stakes exams.
  - A clear, level-based understanding of their own ability.
- **The future:** Scalable, documented systems that any teacher can adopt.

Let's build the ramp together.

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Contact & Resources

- Email: `dtam@stgeorges.bc.ca`
- LaTeX templates: `https://tinyurl.com/4y6zb27c`
- Level-based assessment bank: in development – contact for collaboration

"The most powerful educational technology is not a gadget – it's a well-designed system."

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