Teaching Calculus and Precalculus in the Current Environment

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Proficiency (NRC 2001)

• Conceptual Understanding: Comprehension of mathematical concepts, operations and relations.
• Procedural Fluency: Skill in carrying out procedures flexibly, accurately, efficiently, and appropriately.
• Strategic Competence: The ability to formulate, represent, and solve mathematical problems.
• Adaptive Reasoning: The capacity for logical thought, reflection, explanation and justification.
• Productive Disposition: The habitual inclination to see mathematics as sensible, useful, worthwhile, coupled with a belief in diligence and one’s own efficacy.
Trivia Question

• Who is this and why is he included in this webinar?
During a pandemic, Isaac Newton had to work from home, too. He used the time wisely.
The Great Plague of London occurred in 1665.
Without his professors to guide him, Newton apparently thrived. The year-plus he spent away was later referred to as his annus mirabilis, the “year of wonders.”
First, he continued to work on mathematical problems he had begun at Cambridge; the papers he wrote on this became early calculus.

Next, he acquired a few prisms and experimented with them in his bedroom, even going so far as to bore a hole in his shutters so only a small beam could come through. From this sprung his theories on optics.

And right outside his window at Woolsthorpe, there was an apple tree. *That* apple tree.

https://www.washingtonpost.com/history/2020/03/12/during-pandemic-isaac-newton-had-work-home-too-he-used-time-wisely/
Question

• What have been the greatest challenges that precalculus/calculus students have faced regarding learning during the pandemic?
Students’ Mental Health

• 71% indicated that their stress and anxiety had increased due to the COVID-19 pandemic, but only 5% used mental health counseling services.

Son C, Hegde S, Smith A, Wang X, Sasangohar F
Effects of COVID-19 on College Students’ Mental Health in the United States: Interview Survey Study
J Med Internet Res 2020;22(9):e21279
URL: https://www.jmir.org/2020/9/e21279
DOI: 10.2196/21279
Observed Concerns
• Own health and the health of loved ones
• Difficulty in concentration
• Changing sleeping habits and eating patterns
• Social isolation and changes in living environment
• Academic performance/managing workload
• Financial difficulties
• Depressive thoughts
Concentration Difficulties

• Distracted by family members and responsibilities at home.
• Distracted by social media, internet and video games
• Lack of accountability and motivation.
• Lack of interaction in the learning environment.
• Monotony of life

“Now I'm stuck only doing everything on a computer. So, I'm pretty much on the computer all day.”
Student Preparation

• The studies vary in how severe they gauge the so-called “COVID slide” to be, but all of them found on average, students would lose more ground in math than in reading. Three studies based on NWEA data predicted students could learn half or up to a full year less math in 2020-21, compared to what they would learn in a typical year. The study based on the FastBridge test data showed smaller but still troubling learning losses across every grade: two-and-a-half to four-and-a-half months of learning lost, compared to a month or two in reading.

Illinois Data: 2021 versus 2019

- 17% fewer students met grade-level standards in English language arts.
- 18% fewer students met grade-level standards in math.
- One in five students statewide was reported as chronically absent during the 2020-21 school year.

Illinois test scores from a COVID spring show declines

The number of third-grade students passing the standard IAR tests dropped more than 8 percentage points in math and English since 2019.

Credit: Thomas Wilburn / Chalkbeat
Statewide percentages of students who fall below, meet or exceed standards on the 2021 Illinois SAT assessment

The SAT, the Illinois accountability assessment given to high school juniors last spring, has four performance levels, which are distinct from the College Board’s own performance levels.

<table>
<thead>
<tr>
<th></th>
<th>SAT Reading</th>
<th></th>
<th>SAT Math</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below Standards (Levels 1-2)</td>
<td>66.5%</td>
<td>Below Standards (Levels 1-2)</td>
<td>70.4%</td>
</tr>
<tr>
<td>Meets or Exceeds Standards (Levels 3-4)</td>
<td>33.4%</td>
<td>Meets or Exceeds Standards (Levels 3-4)</td>
<td>29.6%</td>
</tr>
</tbody>
</table>

Table: Kori Rumore • Source: Illinois State Board of Education • Created with Datawrapper
Illinois SAT Math Results: Meets or Exceeds

• 2021: 29.6%
• 2019: 35%
• 2018: 34%
• 2017: 37%

Chicago Public Schools SAT Math Results

Meet or exceed state standards

• 2021: 21%
• 2019: 27%
• 2018: 25%
• 2017: 24%

Question

• What have been the greatest challenges that precalculus/calculus instructors have faced regarding learning during the pandemic?
Challenges for Teachers

• Personal Mental Health Struggles
Challenges for Teachers

• Personal Mental Health Struggles
• Assisting Students with Mental Health Struggles
Challenges for Teachers

• Personal Mental Health Struggles
• Assisting Students with Mental Health Struggles
• Adapting Instruction “Roomies” and “Zoomies”
Challenges for Teachers

• Personal Mental Health Struggles
• Assisting Students with Mental Health Struggles
• Adapting Instruction “Roomies” and “Zoomies”
• Implementing Collaborative Learning
Challenges for Teachers

• Work/Life Balance
Challenges for Teachers

• Work/Life Balance
• Technology
Challenges for Teachers

• Work/Life Balance
• Technology
• Professional Isolation
Challenges for Teachers

• Work/Life Balance
• Technology
• Professional Isolation
• Managing Toxic Political Climates
Mathematics instructors have had to learn much about technology in a short time
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• Zoom
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• Learning Management Systems
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• Desmos, TI-SmartView
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• Zoom
• Learning Management Systems
• Desmos, TI-SmartView
• Mathematical text editing LaTeX, MS Word, MathType
Mathematics instructors have had to learn much about technology in a short time

• Computer-based whiteboards and document cameras
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• Lecture recording and editing software
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• Lecture recording and editing software
• Embedded video quiz software
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• Lecture recording and editing software
• Embedded video quiz software
• PhotoMath, Mathway, Chegg, WolframAlpha etc.
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• Google Docs/One Drive
Mathematics instructors have had to learn much about technology in a short time

• Google Docs/One Drive
• Computer based proctoring software
West Point students violated the honor code by cheating on a calculus test, taken when the campus was closed due to the pandemic. The cheating scandal is the worst at West Point since 1976. Cadets were charged with violating the academy's strict honor code which states, "A cadet will not lie, cheat, steal, or tolerate those who do." Four have resigned and 59 admitted to cheating and will be permitted to remain at the academy under a form of probation.

\[ 3^{x+2} = 5^x - 1 \]

\[ \log(3^{x+2}) = \log(5^x - 1) \]

\[ (x+2) \cdot \log 3 = (x-1) \cdot \log 5 \]

\[ \frac{-10 \log 3 (5^{-2})}{1 - 10 \log 3 (5)} = \frac{10 \log \left( \frac{3^{-2}}{5} \right)}{10 \log 3 \left( \frac{3}{5} \right)} \]

\[ 10 \log \left( \frac{3}{5} \right) \left( \frac{1}{5x^2} \right) \]

\[ 10 \log \left( \frac{1}{45} \right) \]
Question

• What have you tried to improve teaching and learning during the pandemic?
MAA Recommendations

• Be flexible in setting expectations for content, assessment, and placement.
  • We encourage institutions to allow faculty to distinguish between essential and discretionary course content, to streamline courses and adjust their pace.
  • Focus less on cheating and more on providing options for students to demonstrate learning in ways that reflect workplace best practices: collaboration, use of tools and resources, and attribution.
MAA Recommendations

• **Ensure there are asynchronous options, without penalty.**
  • Course materials should be made available in an asynchronous manner (through recorded lectures or notes) even if classes are held live.
  • Students may not be comfortable sharing video, conversing, or making mistakes when being recorded, so recording and distributing live classes can be problematic.
  • Live classes should also use available security measures to keep classrooms free of online harassment.
MAA Recommendations

• Consider temporary adjustments to academic policies, clearly document policies on transcripts and communicate these adjustments

• Use course evaluations only to inform future planning, not as part of Faculty/TA files, evaluation, or tenure and promotion decisions.

My Strategies

• Encourage sick students to stay home.
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• Eliminate attendance policies.
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• Allow students to submit work past deadlines.
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• Encourage sick students to stay home.
• Eliminate attendance policies.
• Allow students to submit work past deadlines.
• Require students to come to the office to view graded exams.
My Strategies

• Allow a small number of students to “re-test”
My Strategies

• Allow a small number of students to “re-test”
• Discourage cheating, but do not become an “anti-cheating” police officer.
My Strategies

• Allow a small number of students to “re-test”
• Discourage cheating, but do not become an “anti-cheating” police officer.
• Strive to be supportive and compassionate.
My Strategies

• Focus on the most essential elements of the courses.
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• Build review into lesson planning.
My Strategies

• Focus on the most essential elements of the courses.
• Build review into lesson planning.
• Make all lessons available online.
My Strategies

• Focus on the most essential elements of the courses.
• Build review into lesson planning.
• Make all lessons available online.
• Implement more frequent low-stakes assessments.
My Strategies

• Focus on the most essential elements of the courses.
• Build review into lesson planning.
• Make all lessons available online.
• Implement more frequent low-stakes assessments.
• Use a “flipped classroom” model to encourage preparation and collaboration.
Research on Teaching and Learning Mathematics and Science During the Pandemic
MAA Student Study of 155 Students Regarding Online Math Learning (January 2021)

• 104 of them found it challenging to develop connections with their classmates.
• 101 had trouble developing “study buddy” relationships.
• 99 had difficulty getting together for group work
• 94 felt exhaustion from feeling overwhelmed
• 87 struggled with social isolation
• 74 said it was harder to ask questions
MAA Student Study of 155 Students Regarding Online Math Learning (January 2021)

• 63 said it was difficult prioritizing responsibilities
• 61 struggled with anxiety
• 56 said it was more work than usual
• 51 said they had no appropriate place to work
• 46 said online office hours are intimidating
• 45 said they had poor internet
MAA Student Study of 155 Students Regarding Benefits of Online Math Learning (January 2021)

- 114 mentioned video lectures
- 82 stated, “could roll out of bed”
- 70 mentioned the deadlines were more flexible
- 69 said professors were more organized
- 68 mentioned that they could keep their video off
MAA Student Study of 155 Students Regarding Worries about Returning to In-Person Learning (January 2021)

- 94 mentioned overwhelming workload
- 76 thought they did not learn enough to move on.
- 65 thought faculty would require more
- 63 were concerned about social exhaustion
- 62 were afraid that they forgot how to interact with others.
- 48 were worried about getting to class on time.
Blended Learning Study

• Traditional blackboard lectures, including the gestures and facial expressions of the teacher are highly very efficient and highly appreciated.

• Teaching of mathematics is a dynamic, creative process that requires the physical presence of the students so that the professor can fine-tune the lecture based on student reactions.

• Students need to have the possibility to interact with other students.

Online Pandemic Calculus 2 - Not Effective

• Insufficient technology/internet resources
• Students lacked the discipline/motivation needed to be successful
• Learning media was not effective and was not interesting.

The effectiveness of online calculus 2 learning during the Covid-19 pandemic - https://doi.org/10.1088/1742-6596/1657/1/012089
Question

• What are some benefits that may arise from our experiences teaching and learning during the pandemic?
Possible Benefits

• Empathy, compassion, understanding
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• Empathy, compassion, understanding
• Fewer in person faculty meetings. Less traveling between campuses
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• Empathy, compassion, understanding
• Fewer in person faculty meetings. Less traveling between campuses
• Fewer canceled classes/substitutes
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• Empathy, compassion, understanding
• Fewer in person faculty meetings. Less traveling between campuses
• Fewer canceled classes/substitutes
• More knowledge about technological resources that can improve teaching and learning
Possible Benefits

• Students taking advantage of computer-based tutoring/office hours
Possible Benefits

• Students taking advantage of computer-based tutoring/office hours
• Large collections of newly developed materials like video lessons, interactive assignments, and discussion board questions
Math Intensive Committee - IMPACT LIVE

Math Intensive Community - my.amatyc.org

https://my.amatyc.org/mathematicsintensivecommittee/home
See you in Toronto!

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