

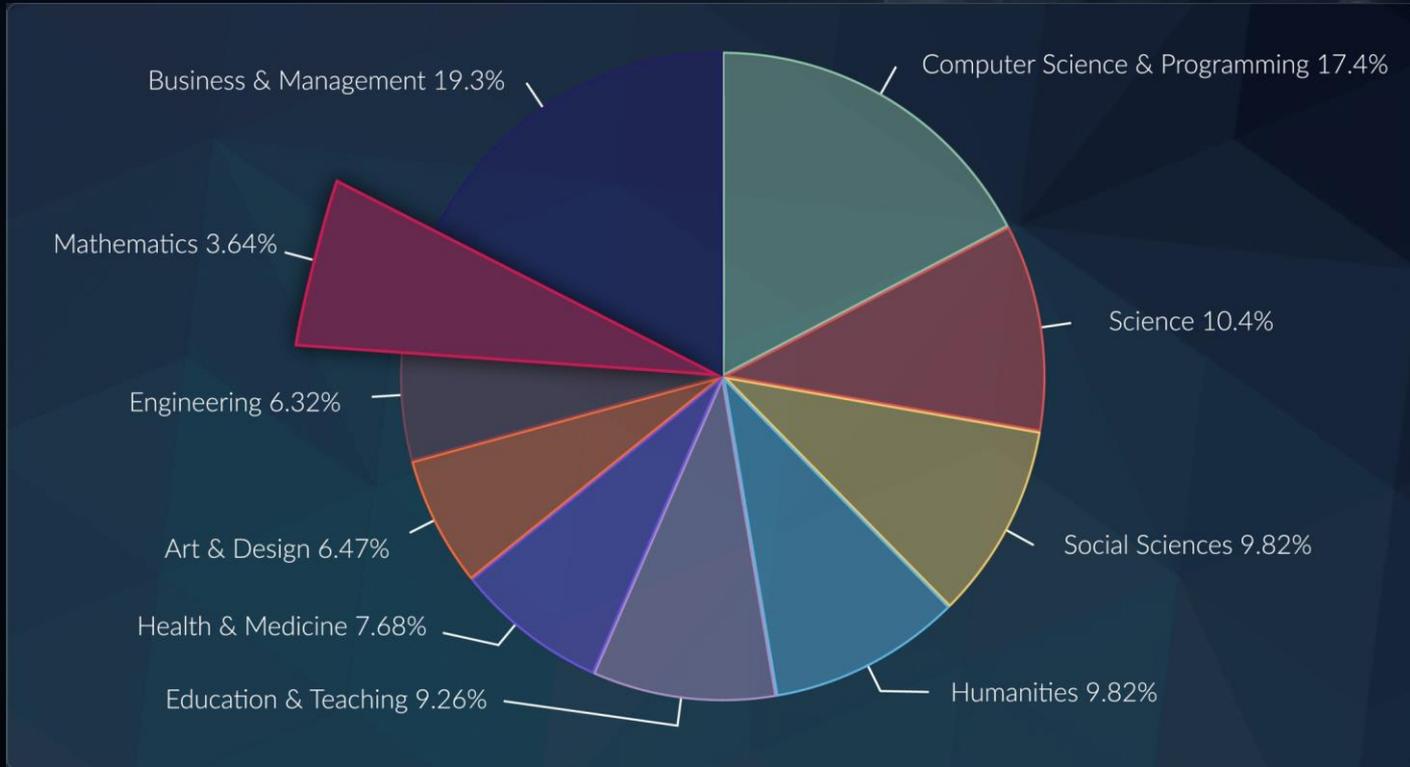
Revolution for Digital Learning



DigitalEd

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VP – Asia Pacific Digital Education

Emergence of Online Learning



Emergence of Online Learning



“Modularized Learning Components”

Active Learning → Recall → Interactivity → Application → Assessment

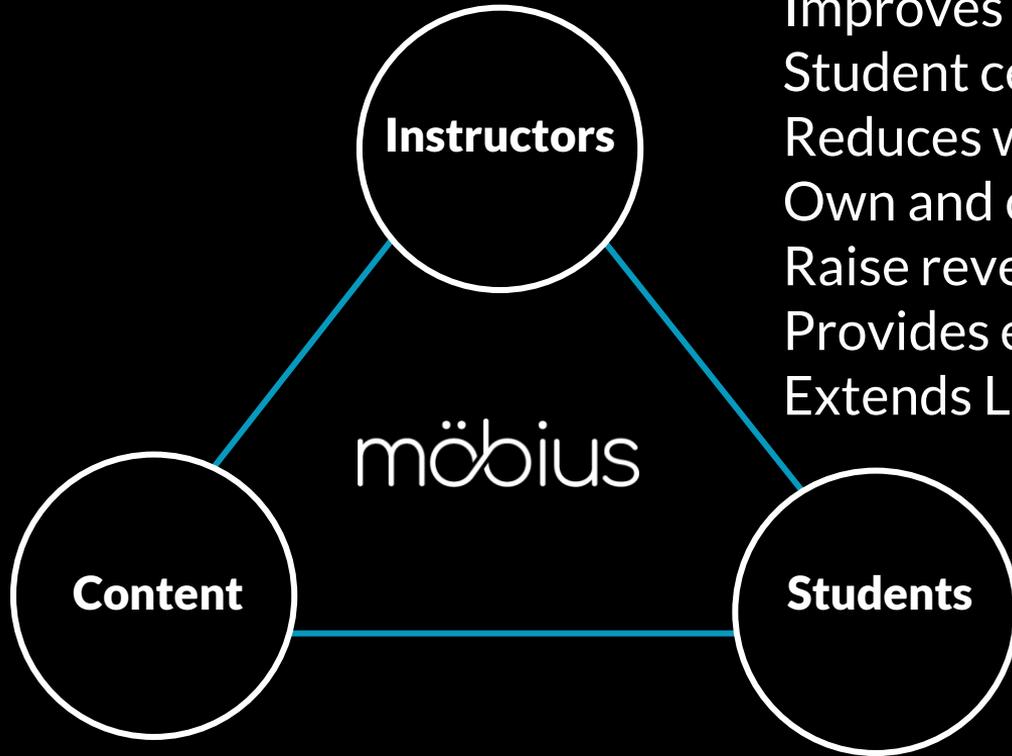


Used by > 260
schools worldwide

Strong community
sharing of content &
best practices



Möbius Platform – Creation & Deployment of Content



- Unique STEM capabilities
- Improves student learning
- Student centric adaptive learning
- Reduces workload
- Own and control your own content
- Raise revenues
- Provides empirical evidence of improvements
- Extends LMS capabilities

Assessments Performed

Measure of the reliability of the Möbius cloud platform

9,659,171 assessments as of May 2019

6,419,171 assessments since Jan 2019

>275,000 Active students

Growing at > 40-45%

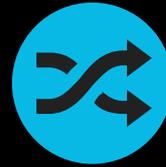
STEM presents *unique* challenges

Science of successful learning:

Repetitive review is a poor learning method

Continuous Testing

- Calibration of knowledge level – The ‘Illusion of Knowing’
- Active Processing: Application of knowledge to creatively solve problems
- Interrupts our process of forgetting / strengthens recall
- Objective: Create desirable difficulties in the classroom
 - Spacing
 - Pre-testing
 - 1:2 ratio (Exposition : Testing)
 - Goal: 15% wrong
- Visualization anchors concepts
 - Interactive Narrative format



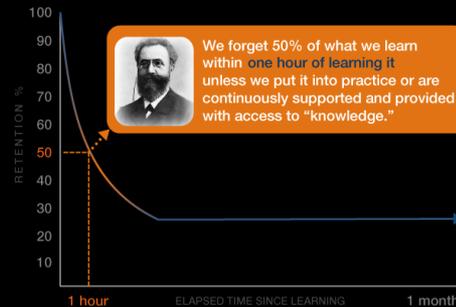
Abstract
Concepts &
Notations



Complex
Visualizations



Application of
Concepts &
Assessment



Testing and Retrieval: **Key to Learning**

Create **desirable difficulties** in the classroom

Continuous Testing: Learning is deeper and more durable when it's effortful

100%

Visualizations anchors
concepts in memory

Visualization: Retention

Example 1: Sphere

The surface of a car tire is designed so that it can be inscribed in a spherical shell of radius 3 units. What is its area, given that it sits at the centre and has width 2 units (i.e., $-1 \leq x \leq 1$)?

Solution:

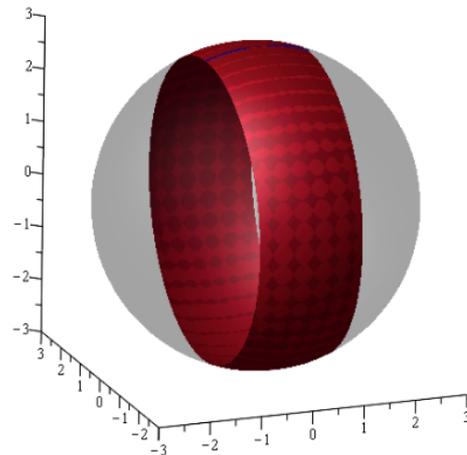
Let's start with the equation of the sphere:

$$f(x) = \sqrt{9 - x^2}$$

Recall that we need the derivative to determine the surface area:

$$\begin{aligned} f'(x) &= \frac{1}{2\sqrt{9-x^2}}(-2x) \\ &= \frac{-x}{\sqrt{9-x^2}} \end{aligned}$$

Now, we're ready to set up our integral.



Interactivity: Improves Student Engagement

Volumes of Revolution

Example

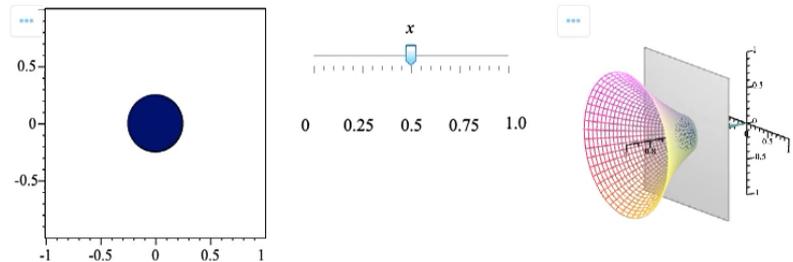
Let R be the two-dimensional region bounded by the curve $y = x^2$ and the x -axis, from $x = 0$ to $x = 1$. Find the volume of the solid S obtained by rotating the region R about the x -axis.

0:05 / 0:48

Volumes of Revolution

Solution Continued

If we fix a point x in $[a, b]$, and intersect S with the vertical plane P_x , we get the cross section of S below. Adjust the point x to see how the cross section changes.



0:21 / 0:48

Interactive Narrative: Encapsulation

Cadence

Dual Channel

Interactive

The screenshot shows a digital learning interface with a dark header bar containing a grid icon and a menu icon. Below the header, the title "Example 2: Gabriel's Horn" is displayed. The main content area contains the text: "Gabriel's Horn is obtained by taking the area enclosed by $y = \frac{1}{x}$, $y = 0$, and $x = 1$ and rotating it about the x -axis. Show that the surface area of Gabriel's Horn diverges." Below this text is a large empty white space. At the bottom of the interface is a video player control bar with a play/pause button, a progress slider, and a timestamp "3:47 / 6:33".

Example 2: Gabriel's Horn

Gabriel's Horn is obtained by taking the area enclosed by $y = \frac{1}{x}$, $y = 0$, and $x = 1$ and rotating it about the x -axis. Show that the surface area of Gabriel's Horn diverges.

Exercise 1: Surface Area of a Torus

Find the surface area of a torus (a.k.a. donut) where R is the distance from the center of the torus to the center of the tube and r is the radius of the tube.

Note: Use Pi for π .

Answer:  

Unique STEM Capabilities

Ask a sophisticated math question

Receive a graded answer with sophisticated feedback

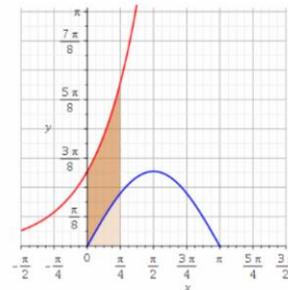
Interactive Math Applications

World's best STEM online platform
(full capabilities of Maple included on platform)

Exercise

Determine the area of the region bounded by the curves $y = e^x$ and $y = \sin(x)$ on the interval $[0, \frac{\pi}{4}]$.

A graph depicting this area is shown below.



0.25

Feedback

To find the area between these curves we should first note that on the interval $[0, \frac{\pi}{4}]$, $e^x > \sin x$.

Hence, to calculate the area between these curves we integrate the function $e^x - \sin x$ from 0 to $\frac{\pi}{4}$

$$\int_0^{\frac{\pi}{4}} (e^x - \sin(x)) dx = e^x + \cos(x) \Big|_0^{\frac{\pi}{4}}$$

$$= \left(e^{\frac{\pi}{4}} + \cos\left(\frac{\pi}{4}\right) \right) - (e^0 + \cos(0))$$

$$= \left(e^{\frac{\pi}{4}} + \frac{1}{\sqrt{2}} \right) - (1 + 1)$$

$$= e^{\frac{\pi}{4}} + \frac{1-2\sqrt{2}}{\sqrt{2}}$$

Try Another

Continuous testing allows the gathering of detailed data on student progression and understanding...

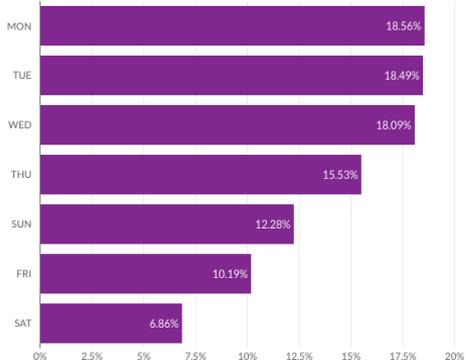
**...enabling
Data-Based Decisions**

Usage Patterns

DAY / TIME / ACTIVE USERS

TIME	Sund...	Mon...	Tues...	Wed...	Thur...	Friday	Satu...
00:00 - 02:00	735	1.1K	1.2K	1.2K	1.3K	1K	514
02:00 - 04:00	426	524	504	543	491	491	297
04:00 - 06:00	356	513	485	616	449	422	262
06:00 - 08:00	644	1.7K	1.6K	1.7K	1.7K	1.4K	480
08:00 - 10:00	1.5K	5.3K	5.6K	5.5K	5.8K	4.4K	1K
10:00 - 12:00	2.9K	6.4K	6.3K	6.2K	5.7K	4.9K	2.1K
12:00 - 14:00	3.6K	6.4K	5.9K	6.1K	5.1K	4.4K	2.5K
14:00 - 16:00	4.1K	4.6K	4.8K	4.4K	4.1K	3K	2.7K
16:00 - 18:00	4K	4.3K	4.8K	4.3K	3.9K	1.9K	2.4K
18:00 - 20:00	4.5K	5.5K	5.9K	5.4K	4.7K	1.6K	2.3K
20:00 - 22:00	4.8K	5.2K	5.6K	5.2K	4.4K	1.7K	2.2K
22:00 - 24:00	2.9K	3.1K	3.3K	3.1K	2.5K	1.1K	1.5K

DAY OF THE WEEK



Historical Usage



Time Spent

Most

- All Exercises, Answers, and Solut...
- Relations and Functions
- Introduction to Calculus: Limits a...
- The Reciprocal of a Polynomial F...
- Interval Notation and Definitions

Least

- Technical Considerations
- Counting in geometry
- Typical Lesson Structure
- Lesson 8: Revisiting Independent ...
- Wrap-up of problem solving techni...

Slideshows Viewed

Lessons with Most

- Inverses: 7
- Lesson 1: What Are Rational Numbe...: 7
- Equations of Polynomial Functions I...: 7
- Solving Linear Inequalities: 7
- Relations and Functions: 7

Lessons with Fewest

- Solving Separable Differential Equa...: 0
- Enrichment, Extension, and Applica...: 0
- The Quotient Rule: 0
- Problem solving wrap-up: 0
- Roots of polynomials: 0

Total Viewers

Most

- Relations and Functions: 11,060
- All Exercises, Answers, and Solutions: 10,677
- Introduction to Calculus: Limits and ...: 6,075
- Lesson 1: What Are Rational Numbe...: 4,909
- Enrichment, Extension, and Applicat...: 4,545

Fewest

- Lesson 8: Revisiting Independent ...: 45
- QM-AM-GM-HM inequality: 46
- Eliminate possibilities: 47
- Consider cases: 49
- Wrap-up of problem solving techn...: 49

CLASS



TIME SPENT IN SESSIONS



TIME SPENT IN ASSIGNMENTS

OVERALL
 172:38:00
 + 05:12:42

TIME SPENT IN LESSONS



RESTRICT TO: [dropdown]

UNIT	TOTAL ATTEMPTS	AVG. TIME PER ATTEMPT	AVG. GRADE
1. unit	1	01:11:19	60.0%
2. unit	19	00:47:54	74.7%
3. unit	9	00:50:39	60.7%
4. unit	2	01:08:31	63.0%
5. unit	13	00:52:19	64.1%
6. unit	12	01:09:58	56.3%
7. unit	6	00:40:11	59.0%
8. unit	10	00:40:07	59.1%
9. unit	6	01:20:16	54.1%
10. unit	9	01:18:16	55.0%

The University of Waterloo



Conviction:

Digital course delivery could provide superior education

Goal:

To become the leading provider of digital online materials



7,000 undergraduate

1,000 graduate

240 faculty

34th world ranking

Environment

5,000 students Differential Calculus students each term with both remedial / enrichment options

26 different calculus courses

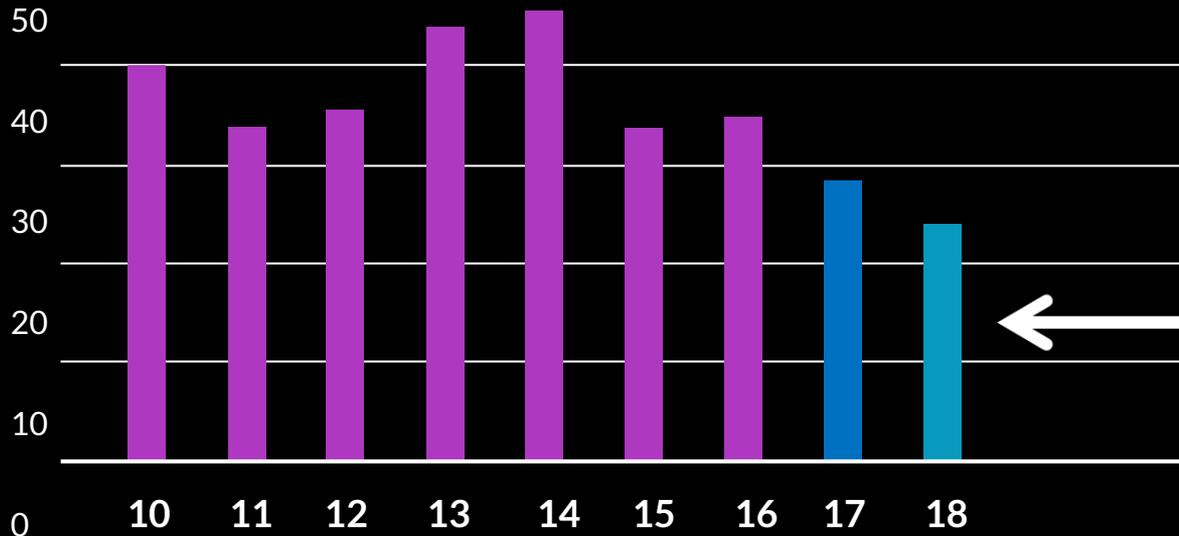
Need for a rich set of question types and tools for visualizations and interactivity

Maintain and update > 300 online courses

How to collect empirical evidence that students are learning; supporting evidence for specific changes?

37%

60 Calculus I: Fall Term DFW Rates



500,000

Questions per term

70,000

Auto-marked assignments
per term

3,000

Increased class enrollments

“Instant feedback is a strong
tool for learning and practice,”

University of
Gothenburg



60,000

Questions converted
from Moodle to Möbius
in 30 days

10,000

Interactive Examples

“The ability to quickly create and share interactive content across the institution held tremendous appeal for us.”

Northern Alberta Institute of Technology



Summary of Best Practices:

Continuous testing with automatic marking and feedback improves learning and retention.

Multimedia visuals and interactivity anchors key concepts and promotes active engagement.

Detailed student progression and comprehension data allows evidence-based optimization of learning.



Q&A

Thank-you



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