The Minnesota Online Learning System

A World-First Assessment Platform Powered by Symbolic Computation

Industry: Edtech   **Applications:** Automated Assessment and Grading

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ABOUT

Founded in 1851, the University of Minnesota is one of the most prestigious public research universities in the United States. Serving over 50,000 students, the University of Minnesota prepares students to face and help solve the most complex issues faced by today's society.

The University of Minnesota is a powerhouse of research and discovery with a record of alumni featuring astronauts, Nobel Prize winners and innovators who created the technology that shaped the world around us, including the retractable seat belt, cancer therapies, biodegradable plastics and supercomputers.

THE CHALLENGE

One key area the School of Mathematics at the University of Minnesota wanted to address with the Wolfram Technical Consulting team was the number of first-year students withdrawing from precalculus. Mike Weimerskirch, MathCEP Director of Educational Innovation, trialled an active learning approach using an off-the-shelf platform for homework and quizzes. While the active learning approach worked well, there were several significant issues with their homework and assessment platform.

Poor Student Experience

Students who had used the off-the-shelf platforms faced a number of issues. Some popular platforms charged students for access, making it inaccessible to those waiting on funding.

Offsite administrative support was often slow, resulting in students falling behind on their courses or dropping out of them completely.

> ## 9.3%
> ### Dropout Rate
>
> With off-the-shelf systems, **9.3%** of enrolled students were dropping out of precalculus at the University of Minnesota.

Antiquated Auto-grading

Old-fashioned grading engines forced students to guess how to format their answers in the hope the system would parse it correctly. Even simple operations and common symbols like square roots would require complicated or proprietary syntax.

These limitations meant that teaching staff were forced to create assignments based on the platform's capabilities rather than their students' needs.

Too Many Compromises

Mike needed a platform with much greater accuracy and flexibility, with on-campus administration and support and that would be easy to use by students and faculty throughout the university.

While the University of Minnesota had found alternative off-the-shelf products that could meet some of these objectives, they all required significant compromises, from a lack of long-term vendor stability to requiring faculty to learn new programming languages to requiring significant time and effort troubleshooting errors.
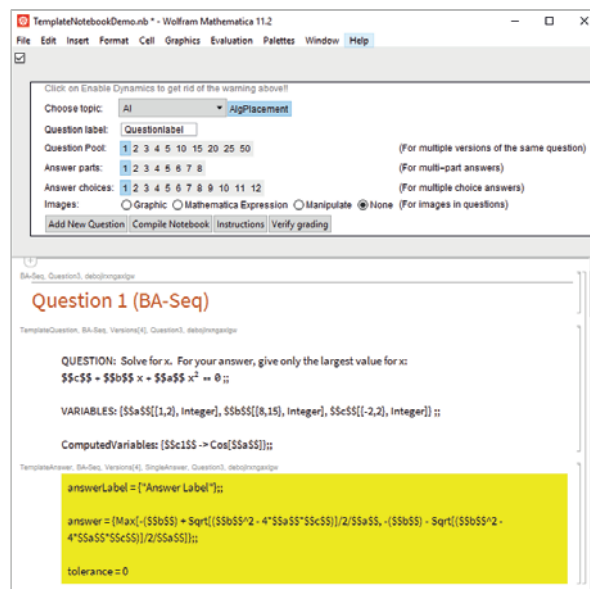
" *Having evaluated a range of online assessment solutions, only through working with Wolfram Consulting Services were we able to achieve the flexibility and quality experience we required. Our new MOLS system enables us to ask the questions we want, that students can answer intuitively and that we can expand out to other topics, without being restricted by the technology.* **"**

— Mike Weimerskirch
MathCEP Director of Educational Innovation,
University of Minnesota

THE APPROACH

Having used the Wolfram Problem Generator, Mike reached out to the Wolfram Technical Consulting team to build a customised solution for the University of Minnesota—the Minnesota Online Learning System, or MOLS for short.

Symbolic Questioning

One of the core elements of the MOLS system is the question and assignment creation system. The Wolfram Technical Consulting team built on their experience with the Wolfram Problem Generator to create a system where university faculty can define questions in a symbolic form using the Wolfram Language.

One of the key benefits of this approach is in allowing the question creation system to automatically generate variations of the questions in real time, saving faculty time defining questions while providing students with a continuous pool of practice problems.

A custom webMathematica environment, hosted on campus, allows faculty to upload questions to a repository and build out assignments for homework, practice and assessment. With the ability to pull questions from a number of sources, faculty can either use the built-in question repository, reuse previous assignments, upload a set of new questions or a combination of the three.

Improving the Student Experience

With MOLS, students can log in with their university SSO credentials, where they can then view and complete outstanding assignments and see their scores for completed work.

One of the primary benefits of storing questions and answer criteria in a symbolic format is that it allows for a great degree of flexibility in how answers are provided. As the grading system is capable of checking answers based on whether a string of text matches or not, students have the freedom to use algebraically equivalent variations of an answer.

Intelligent Auto-grading

Using the symbolic nature of the Wolfram Language, MOLS administrators can choose when and when not to accept algebraically equivalent answers. For example, possible answers to sample questions:

Reduce the radical $\sqrt{\dfrac{320}{49}}$ to the simplest form.

$\dfrac{8\sqrt{5}}{7}$ **not** $\dfrac{1}{2}\left(2\sqrt{\dfrac{320}{49}}\right)$

Calculate $\dfrac{2}{4}\times\left(4-\dfrac{1}{2}\right)$.

$\dfrac{7}{4}$ or $1\frac{3}{4}$ or 1.75

What is the second derivative of $\sin(2\,x)$?

$-4\sin(2\,x)$ or $-8\sin(x)\cos(x)$ or $2\,ie^{2\,ix}-2\,ie^{-2\,ix}$

Find the integral of $1-2\,x^4$ with respect to x.

$x-\dfrac{2\,x^5}{5}+c$ or $x-\dfrac{2\,x^5}{5}+\text{constant}$

The capabilities of the grading engine also meant that faculty members were able to spend far less time checking for troubleshooting issues. Having a robust, reliable platform provided the university with the confidence to expand MOLS beyond precalculus courses to being the platform of choice throughout the university for their placement exams.

ACHIEVEMENTS

Significant Improvements in Student Retention

Having rolled out the Minnesota Online Learning System, the withdrawal rate on calculus and precalculus courses dropped from 9.3% to just 3.2%. As an onsite, custom-built system, students do not have to pay an external provider to access their assessments, making the courses more equitable and removing students' barriers to entry. Additionally, intuitive answer parsing and grading means students are not challenged by technology and are free to focus on the course content.

Reliable, Robust On-campus Deployment to over 30,000 Students

Having successfully piloted MOLS on calculus and precalculus courses, the University of Minnesota and the Wolfram Technical Consulting team scaled up the deployment to deliver placement exams to 7,000 new students every year, totalling over 30,000 students to date. The online system also allowed the university to rapidly respond to the COVID-19 pandemic by providing a robust remote-learning environment and alternative to paper-based exams.

Fast, Efficient and Flexible Build-out of a Top-Tier Learning Environment

Working with the Wolfram Technical Consulting team allowed the University of Minnesota to create the ideal learning environment without being held back by having to work around a pre-existing platform. With decades of experience with computation, the Wolfram team was able to iterate quickly to achieve the university's vision and create a platform that can be built upon with new topics, new subjects and new capabilities.

MADE POSSIBLE BY WOLFRAM

"When Mike and I were originally discussing this project it was clear that we could make big improvements on what was currently available on the market, but it was only when we got going that it became clear how the symbolic nature of the Wolfram Language could blow everything else out of the water! We were able to build an entirely customised online learning system that provided great flexibility in its questioning and much more intelligent automated grading, all while greatly reducing the amount of administration required. **"**

—Kelvin Mischo
Senior Academic Account Manager

LET'S TAKE YOUR PROJECT TO THE NEXT LEVEL

Find out how the Wolfram Technical Consulting team can jump-start your project with in-depth troubleshooting, code optimisation, custom training or production deployment.

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