24 May 2018

How Customizing Content using Digital Tools Can Make Education Student Focused: *A Northern Alberta Institute of Technology Case Study*

Mark Schneider
Educational Technology Specialist
Northern Alberta Institute
of Technology

Andrew Rourke
Director, Teaching Solutions Group
Maplesoft

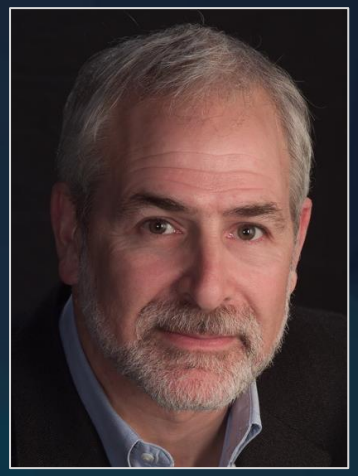
Maplesoft
Mathematics • Modeling • Simulation
A Cybernet Group Company

NAIT

Today's Speakers

Mark Schneider
Educational Technology Specialist
Northern Alberta Institute
of Technology
mschneider@nait.ca

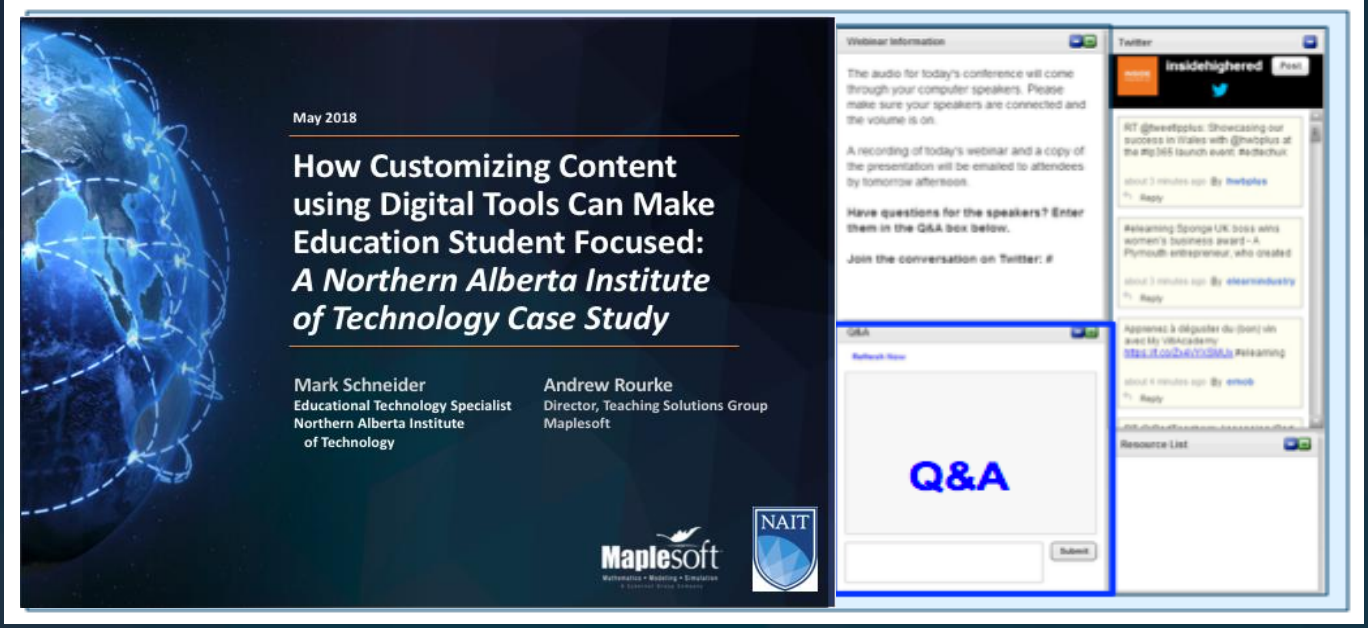
Andrew Rourke
Director
Teaching Solutions Group
Maplesoft
arourke@maplesoft.com



Casey Green
(Moderator)
Digital Tweed Blogger and Director,
The Campus Computing Project
cgreen@campuscomputing.net

Before We Begin

- We are using On24 for today's webinar. Please enter questions in the text field at the bottom of the Q&A Window. *We are monitoring the discussion and will try to bring the Q&A comments into the conversation.*
- We are recording the webinar; the webinar archive and slides will be available later today.



“In the past, universities determined curricular design largely by themselves, assuming that they understood learners’ needs and desired outcomes.”

“In the… future, universities will codesign curricula in full partnership with employers and learners.

[This] means that they will need to sit down with learners to maps out their professional needs and outcomes candidly.”

--Joseph E. Aoun. Robot-Proof. 2017.

Session Direction:

Overview of Maplesoft

Student-Centered Solutions:

- Maple T.A.
- Mobius

Overview of NAIT (Northern Alberta Inst. of Technology)

NAIT Case Study

Q&A

Maplesoft Overview

‘More than 30 years of experience’

- Core technology – Maple – began as a research project in 1980; incorporated in 1988
- Earliest customers were undergraduate mathematics educators and students
- Expanded offering has widened customer base to include other technical courses, high school and 2-year colleges and industry
- Specializing in solutions for STEM education, including testing and assessment and online courseware

Maple T.A.

Origins of Maple T.A. | | Online Education

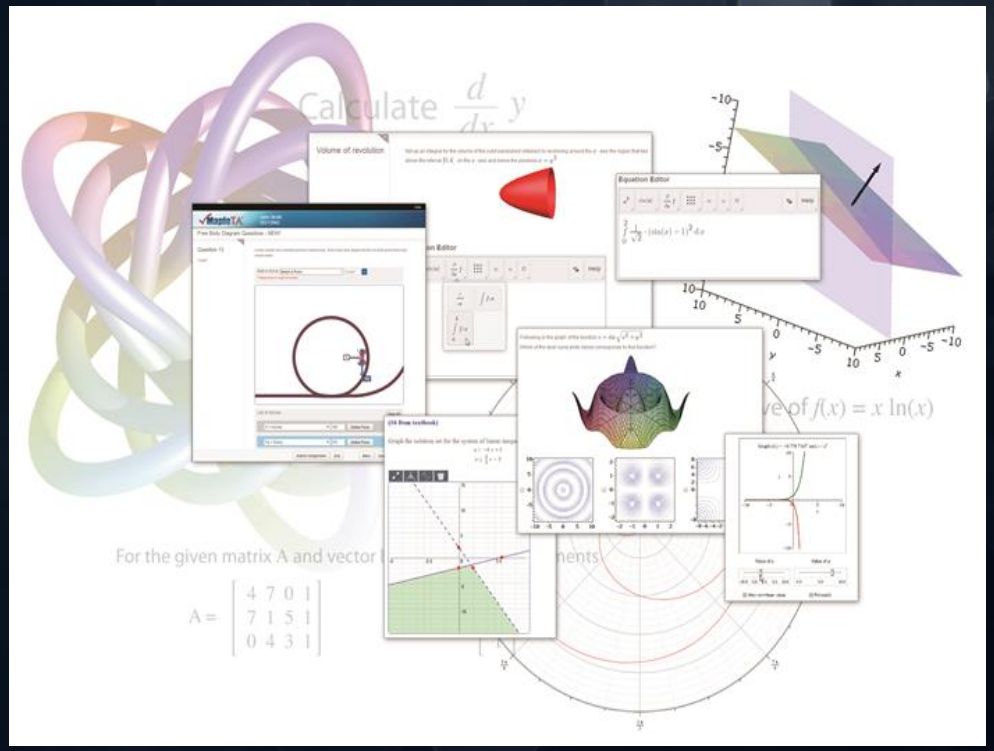
2002: Online Learning 1.0

Maple T.A. is an online testing and assessment system designed around the unique needs of STEM courses

- Designed especially for courses involving mathematics
- Compatible with all online course management environments
- Puts you in control of your testing content

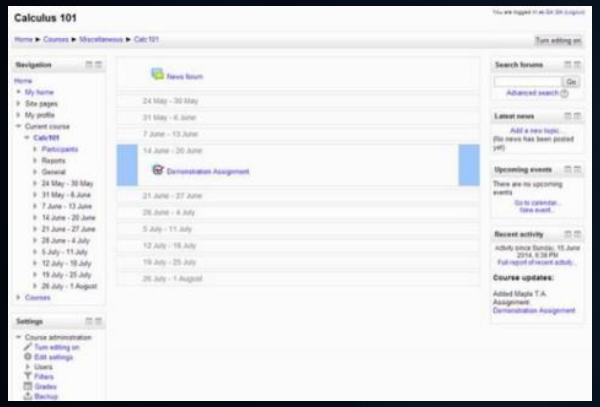
Designed especially for courses involving mathematics

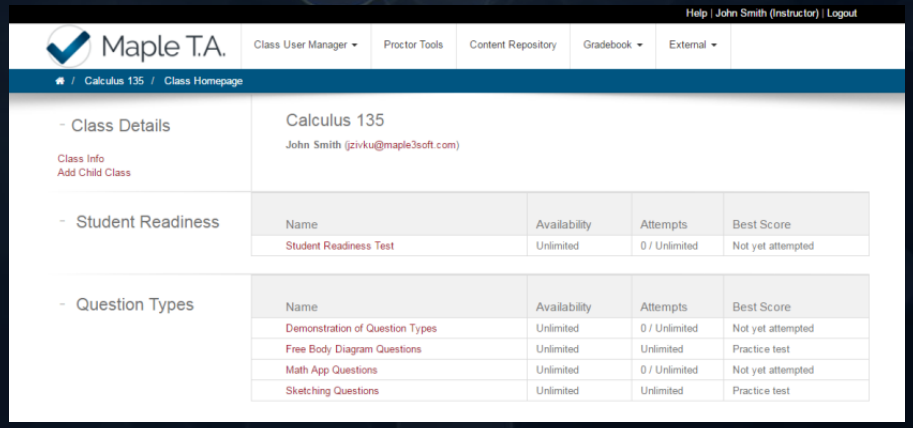
- Standard math notation and visualization tools
- Free-response and open-ended questions
- Intelligent machine-grading of mathematical responses



Compatibility

- Mobile ready: works on any device with an internet connection
- Connections available to Learning Management Systems
  - Initially through open API, now through LTI





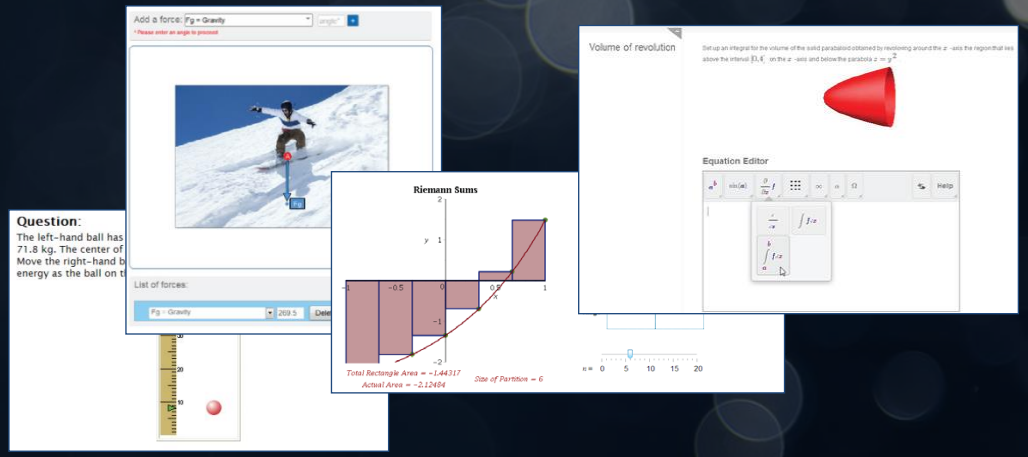
Putting *you* in control of your content

Questions

- Full authoring environment for creation of customized questions/assignments
- 17+ different question types for technical & non-technical courses

Assignments

- Variety of assignment types
- Flexible assignment properties
- Security features



Gradebook

- Reports and analytical tools
- External assignment grades
- Export capabilities

Möbius

Möbius™

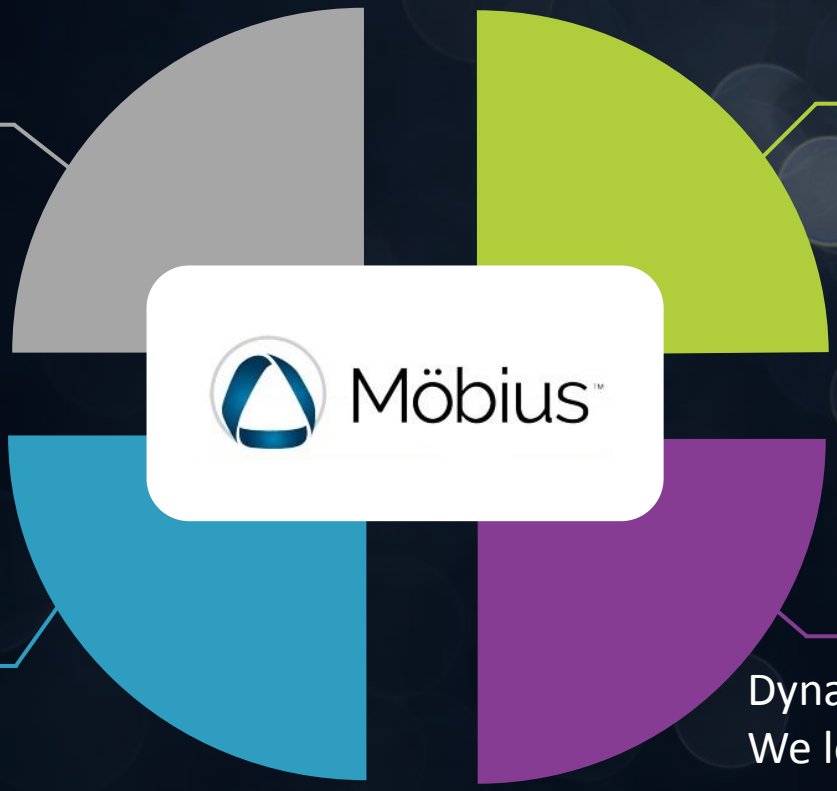
Möbius is a platform for *creating*, *deploying* and *managing* online digital assets for **mathematics**, **engineering** and **science** that focuses on continuous assessment throughout the learning process.

STEM courseware platform for outstanding student outcomes.

A purpose-built STEM education platform providing instructor customized, learner adaptive, experiential learning with real-time testing, measured outcomes, analytically driven course and curriculum evolution and automated administration.

Container for “Modularized Learning Components”

Active Learning – Recall – Interactivity – Application - Assessment



Evaluation
Testing & Analytics
Evaluation of skills

Exposition
Here’s the concept
‘Mathematical storytelling’

Exercises
Real-time Drill & Practice
Test what we know

Exploration
Dynamic Interactive Content
We learn by doing

Fundamental Connectivity

Blackboard

canvas

brightspace by D2L

moodle

Why Mobius?

- Single platform to develop and deploy customized couseware
- Full content authoring environment (‘4 E’s’)
- Save time in course development *and* maintenance
- Increased learning benefits

NAIT – Northern Alberta Institute of Technology

Mark Schneider - LTC

Edmonton, Alberta - Canada

Business

Culinary Arts

Skilled Trades

Continuing Education

Health and Life Sciences

Corporate and International Training

Applied Sciences and Engineering Technologies

Our Focus

Inherent Challenge #1:

Deliver leading-edge courseware that is directly tied to industry.

A coil spring in a car is oscillating according to the equation $h(t) = 5\sin\left(\frac{3\pi}{2}t\right)$, determine how much time elapses between max and min compressions.

Voltage in an AC circuit oscillates according to the equation $V(t) = 120\sin(160\pi t)$ determine how much time elapses between two consecutive neutral readings.

Solution #1:

Use authoring tools that allow instructors to sort, create and modify content.

Northern Alberta Institute

Secure | https://nait.mapleta.com/nait/qbeditor/AddQuestion.do?editMode=Inline&uid=ac30eae6-35eb-43f5-ac20-4d6f8b7bab57&classId=208

Apps | delete results | Northern Alberta Ins | dlo questions | emily | Menti-Interactive pr | Authentic Assessme | furnace info | Virtual House | UsenetServer | Sign

Help | Mark Schneider (Instructor) | Logout

Maple T.A. NAIT

Class User Manager | Proctor Tools | Content Repository | Gradebook | External

/ MTH 1247 POWER ENG. - MATHEMATICS / Question Designer

- Question Name

Voltage AC Circuit Sinusoid Motion

- Question Text

Source | Equation Editor | Response Area | Paragraph | Font | 14

The voltage in an AC circuit is oscillating according to the equation: $V(t) = 120 \sin(120 \pi t)$, where $V(t)$ is measured in volts and t is measured in milliseconds.

Determine how much time elapses between two consecutive neutral readings.

Numeric with Units

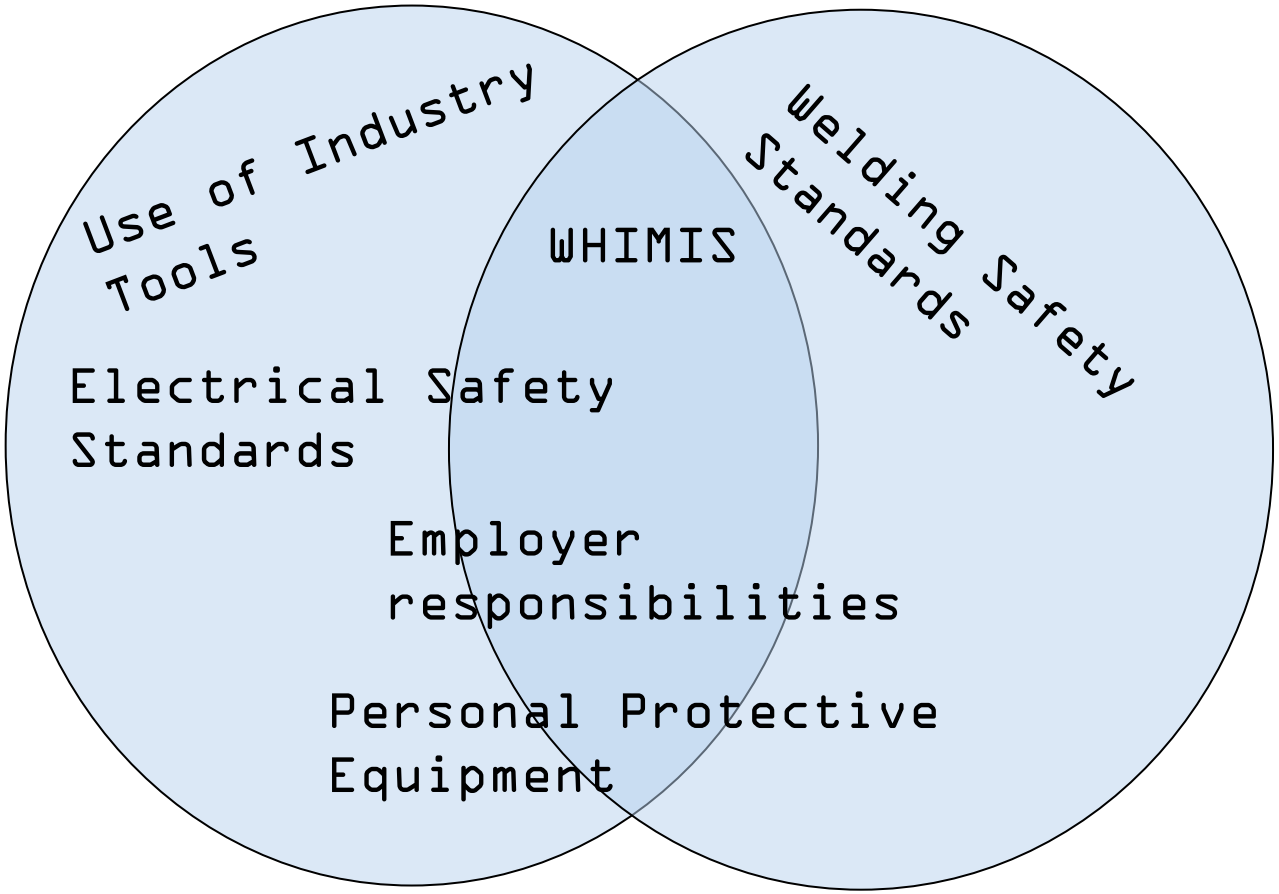
Save & Close | Save | Preview | Cancel

8:33 AM
2018-05-22

Inherent Challenge #2:

Minimize the duplication of workload when developing courseware.

Safety Course



Safety Course

Solution #2:

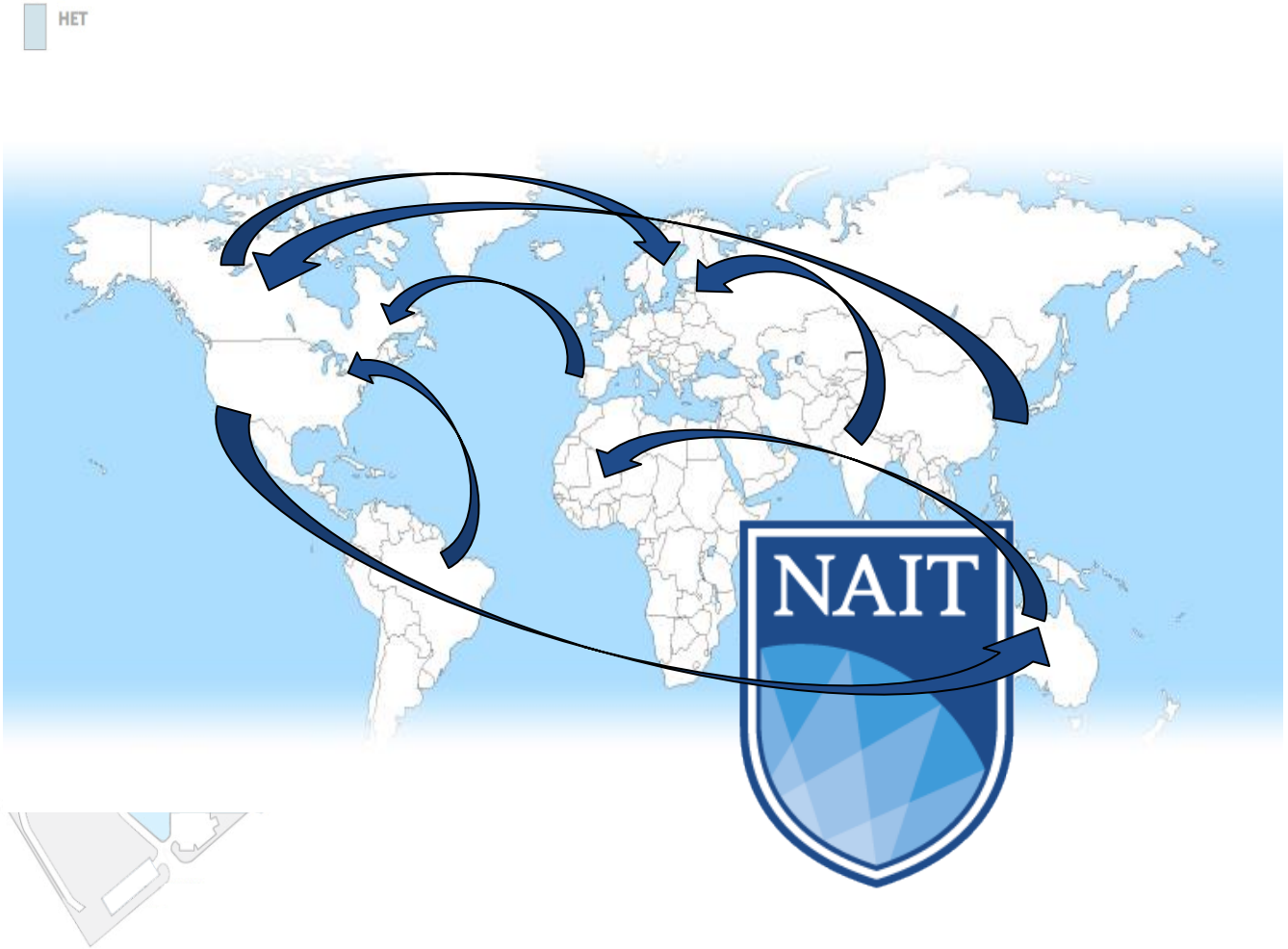
Use authoring tools that facilitate the seamless sharing of content.

Blackboard

moodle

brightspace by D2L

canvas



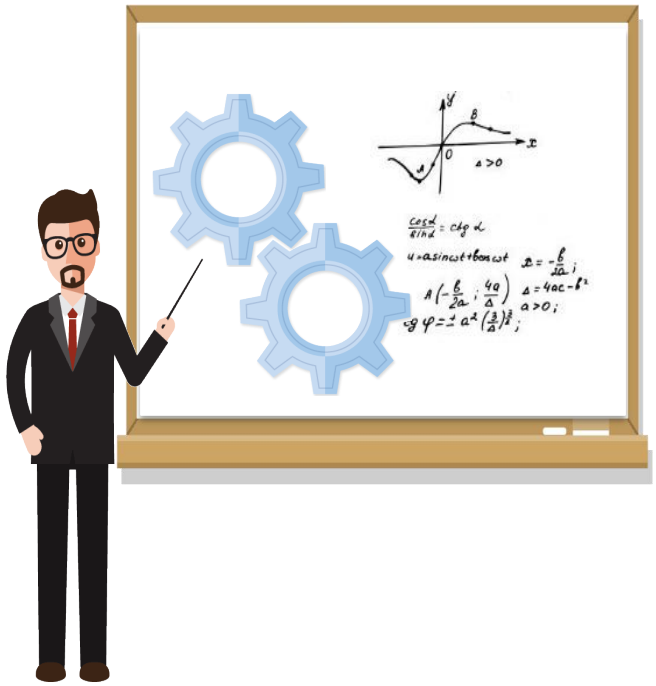
NAIT

Maple T.A.™

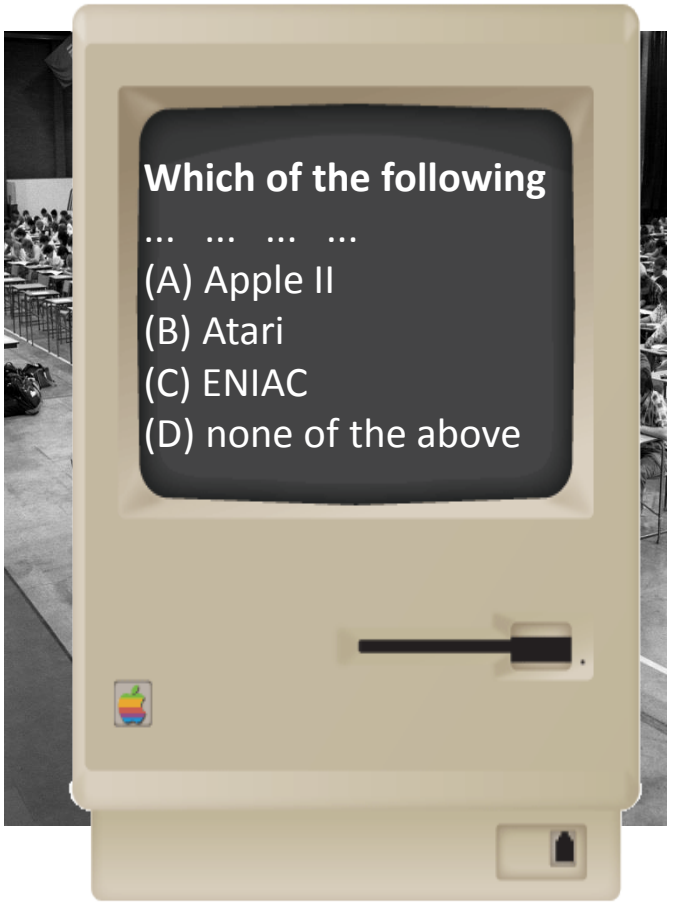
Inherent Challenge #3:

Other constraints pertaining to online authoring.

Lectures

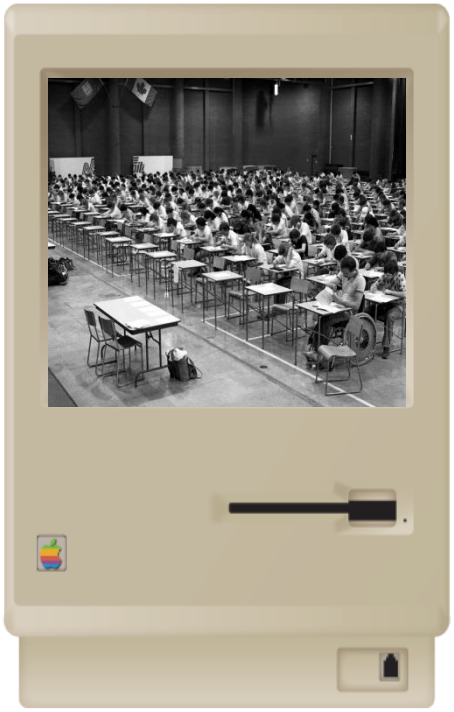


Assessments



Solution #3:

Use authoring tools that deliver dynamic content with a simple to use interface.



Solution #3:

Use authoring tools that deliver dynamic content with a simple to use interface.

Maple T.A. NAIT

Insider Higher Ed. Assignment DEMO

Question 5

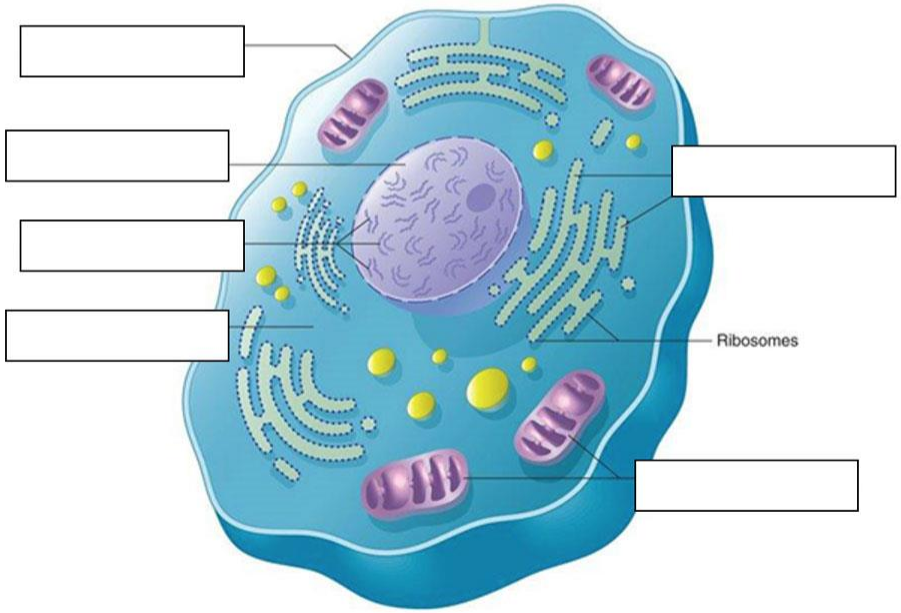
1 point

How did I do?

Drag the correct label onto the diagram below:

cytoplasm | mitochondria | cell membrane

chromosomes | nucleus | endoplasmic reticulum



Solution #3:

Use authoring tools that deliver dynamic content with a simple to use interface.

Maple T.A. NAIT

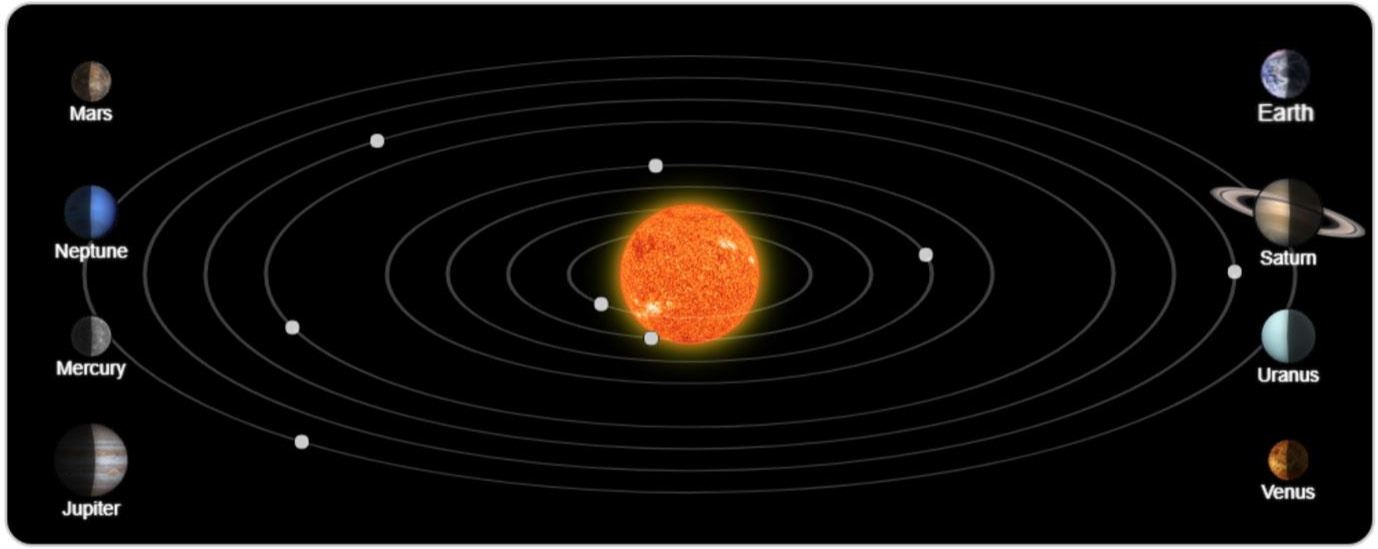
Insider Higher Ed. Assignment DEMO

Question 10

1 point

How did I do?

Drag and drop each planet into the correct orbit around the sun.



Solution #3:

Use authoring tools that deliver dynamic content with a simple to use interface.

Maple T.A. NAIT

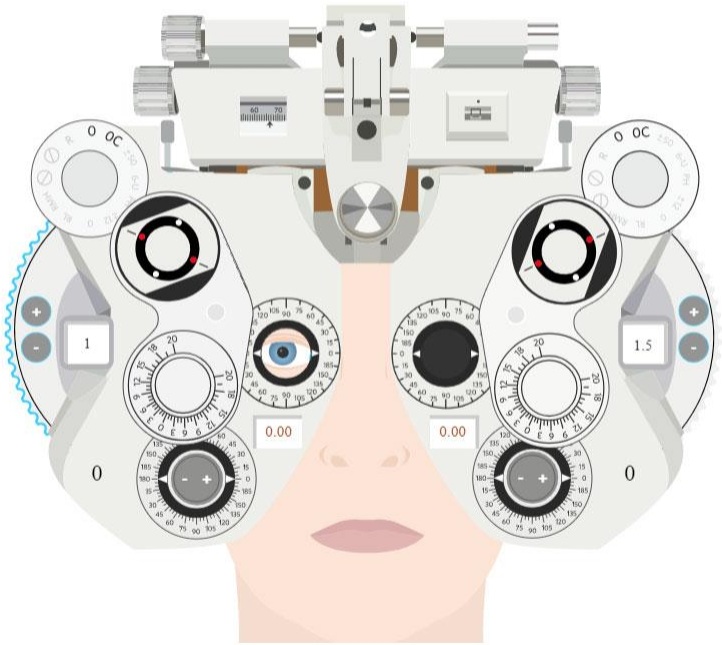
Insider Higher Ed. Assignment DEMO

Question 12

1 point

How did I do?

Use the interactive phoropter to answer the following questions about Patient 1



The right eye of Patient 1 can be described as (Click for List)

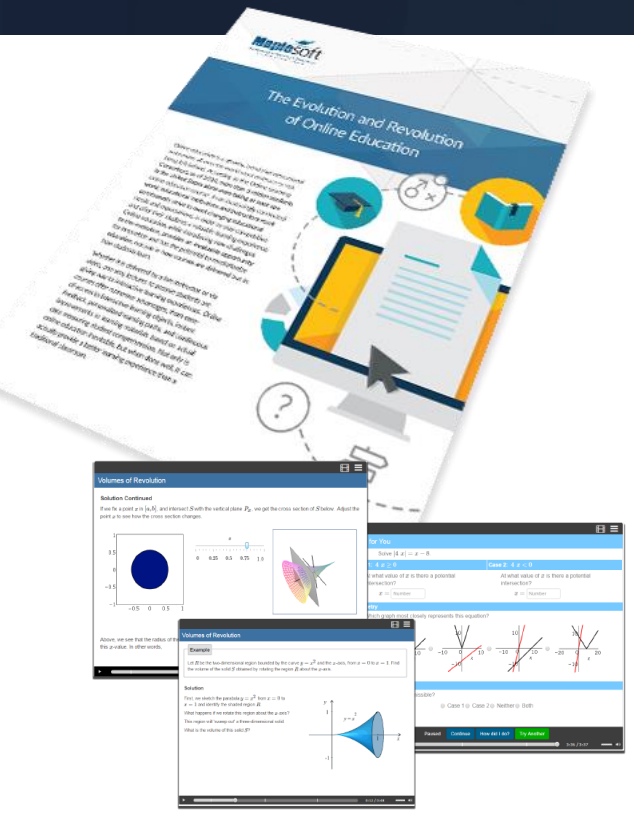
Submit Assignment | Quit | Back | Question Menu | Next

In Summary:

Key factors for developing student-focused assessment content.

- Constantly revise and stay on the leading-edge of customizing courseware that is directly tied to industry.
- Share content with colleagues on an institutional and global level.
- Author content that epitomizes student engagement.
- Pay attention to Universal Design for Learning principles.

Resources and References



- **Whitepaper:** The Evolution and Revolution of Online Education
- **Whitepaper:** Your Online Students Aren't Paying Attention!
- **Whitepaper:** Are you Failing Your Students without Realizing it?
- **Case Study:** Instructor uses Möbius to enhance learning for first-year engineering students at the University of Birmingham
- **Case Study:** Perimeter Institute Uses Möbius in Physics Camp for High Achieving Students
- **Case Study:** German Professor Uses Möbius to Foster Curiosity and Accelerate Learning Among Students

Maplesoft
Mathematics • Modeling • Simulation
A Cybernet Group Company

NAIT

Questions?

www.maplesoft.com/OnlineLearning

www.nait.ca

Maplesoft
Mathematics • Modeling • Simulation
A Cybernet Group Company

NAIT

Today's Speakers

Mark Schneider
Educational Technology Specialist
Northern Alberta Institute
of Technology
mschneider@nait.ca

Andrew Rourke
Director
Teaching Solutions Group
Maplesoft
arourke@maplesoft.com

THANK YOU!

www.maplesoft.com/OnlineLearning

www.nait.ca

Maplesoft
Mathematics • Modeling • Simulation
A Cybernet Group Company

NAIT

German Professor Uses **Möbius** to Foster Curiosity and Accelerate Learning Among Students

As trends in education continue to shift towards online learning, instructors are searching for tools to facilitate this transition for their students and to take advantage of the convenience and accessibility that online teaching solutions offer. An engineering professor at Hochschule Bremerhaven in Germany, Matthias Kniebusch was looking for online solutions to accelerate the development of skills in his engineering students, specifically for a new undergraduate program in wind power technology. He was introduced to Möbius, the online courseware platform from Maplesoft, and was immediately impressed with its ease-of-use and interactive qualities.

Kniebusch bases his teaching on the belief that instructors need to foster curiosity in their students and challenge them to expand and strengthen their knowledge base. In his opinion, traditional lectures are not the most effective method to achieve this. "We need to ask ourselves 'What do students need? What do we want them to have?'" he said. "We should help to guide their way of looking at the world. I like my blackboard, but a teacher has to bring more to the classroom; you have to bring life to the students, and technology is one way of doing that."

Kniebusch is excited about how technology has developed recently. Five years ago, Kniebusch tried to develop an eBook for a mathematics course on differential equations, but was unable to realize his vision because the technology platform he was working with did not have mathematical capabilities. He recently visited the University of Waterloo where he was introduced to Möbius by Dr. Steve Furino, Associate Dean for Undergraduate Studies in the Faculty of Mathematics. "When he showed me Möbius, I said 'this is what I wanted to have five years ago!'" said Kniebusch. "Now we have it!" Kniebusch is a strong believer in the capabilities Möbius provides; he now uses it extensively to deliver courses and engage his students. Based on his experience at the University of Waterloo, he encourages different groups and institutions to work together to develop content, in order to bring different perspectives and areas of expertise together with the goal of discovering the most effective learning solutions.

Interactive programs are a point of emphasis for Kniebusch and Möbius has features that allow him to better connect with his students. In Möbius, students can engage with materials, work through different possibilities and factors to solve problems, visualize their work and receive detailed feedback to ensure they understand the full process. "Interactivity like this is difficult to find, as many universities present materials as interactive when that's not actually the case," he said. "A lot of universities present an interactive table of contents, but behind that you find a series of PDFs. That's not interactive." Möbius comes with several interactive features that help explore STEM concepts, **interactive narrated lectures** that incorporate exploration and self-assessment elements, engaging visualizations, **assessment questions** that are automatically graded, and much more.

One key aspect of interactive learning solutions is the ability for students to receive feedback so they can work through assignments on their own and learn the processes. Students need detailed feedback to keep them from getting lost when it comes to complex subject matter, Kniebusch said. This leads to another valuable aspect of online learning: accessibility. Modern students need to be able to access materials in different locations and on different devices, so they can work on assignments and problems wherever they are. When Kniebusch began using Möbius with his students, he was surprised they were able to work through problems using mobile devices. "I was astonished to see 80% of my students take out their smartphones and try to work on it," he said. "That is the accessibility we need."

As Kniebusch looks towards the future, he believes we need to reassess the traditional approach in classrooms. "We need to rethink how we bring knowledge to students, create competencies and build skills," he said. "There is a need for real interactive content. Not just good content; it must be interactive to create that curiosity. That's the point. Thanks to Maplesoft, we are developing that content."

Maplesoft

www.maplesoft.com | info@maplesoft.com • Toll-free: (US & Canada) 1-800-267-6583 | Direct:1-519-747-2373

Challenges and Solutions in Automated STEM Assessment

Maple T.A.™

Online testing and assessment has opened up great opportunities for the modern educator. Good automated assessment tools can help consolidate student understanding, support self-directed learning, give instructors more time to focus on other teaching tasks, make it easier to manage growing class sizes, and much more. While these systems are of tremendous use in some subjects, initially their benefits were not readily available in science, technology, engineering, and mathematics (STEM) courses, because the assessment systems could not meet the specialized needs of these subject areas. However, a system is available today that provides the benefits of automated assessment to STEM instructors and students. This article examines how Maple T.A.™, the online testing and assessment system from Maplesoft™, enables STEM educators to fully leverage automated assessment in meaningful ways.

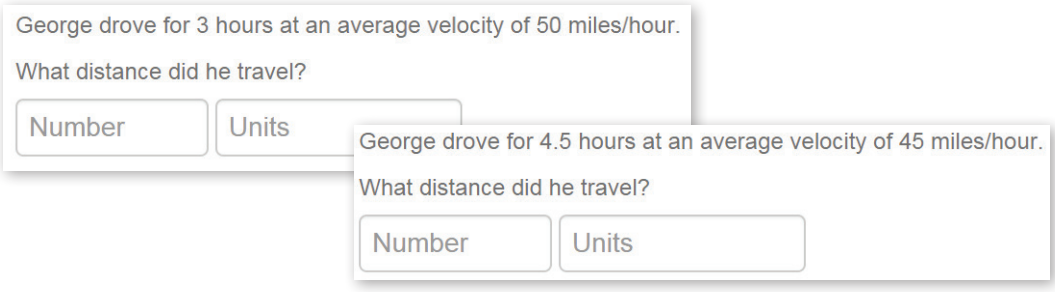
Advantages of Online Automated Assessment Tools

There are many advantages to using online automated assessment tools that benefit students, instructors, and institutions.

One of the most obvious advantages is that students get instant feedback on their assignments. While students are still actively engaged in learning the material, they can find out if they understand it as well as they think they do, and take corrective action immediately if they don't. Instant feedback helps students know what they know, so they can focus their studying, feel confident in their abilities, and solidify their conceptual foundations before moving on to new topics.

Another important benefit offered in many systems is the ability to generate many similar questions from a single question template. Using this feature, instructors can give students lots of opportunities to practice, without going to the effort of producing and grading extra assignments. In addition, because each student can be given a different version of the same question, these systems limit cheating while encouraging productive collaboration. Instead of sharing answers for their assignments, students discuss the process of finding the solution, and then each student does their own work to answer their individual question.

For instructors, automated assessment means they spend less time marking assignments and more time on other aspects of the course. Time formally spent on producing answer keys for markers, grading stacks of assignments, and manually entering marks can now be spent on enriching course materials, providing individual assistance, developing enrichment questions, or anything else the instructor wants to do but rarely has the time for. Without the demands of manual grading, instructors also have the luxury of offering exactly as many assignments as they



Some automated testing systems can generate questions from question templates, which can be used for extra practice and to ensure that each student sees a different version of the question.

feel the course needs to reinforce the course material, without being limited by the number of available teaching assistant hours or their own time constraints.

In addition, students are not the only ones who benefit from instant feedback on tests and assignments. Instructors, too, can look at the results immediately after the assignment is due. If they find that the majority of the class had problems with a particular concept, they can provide a review of that material in the next lecture, before moving on. Identifying and correcting conceptual misunderstandings immediately makes life much easier for both students and instructors.

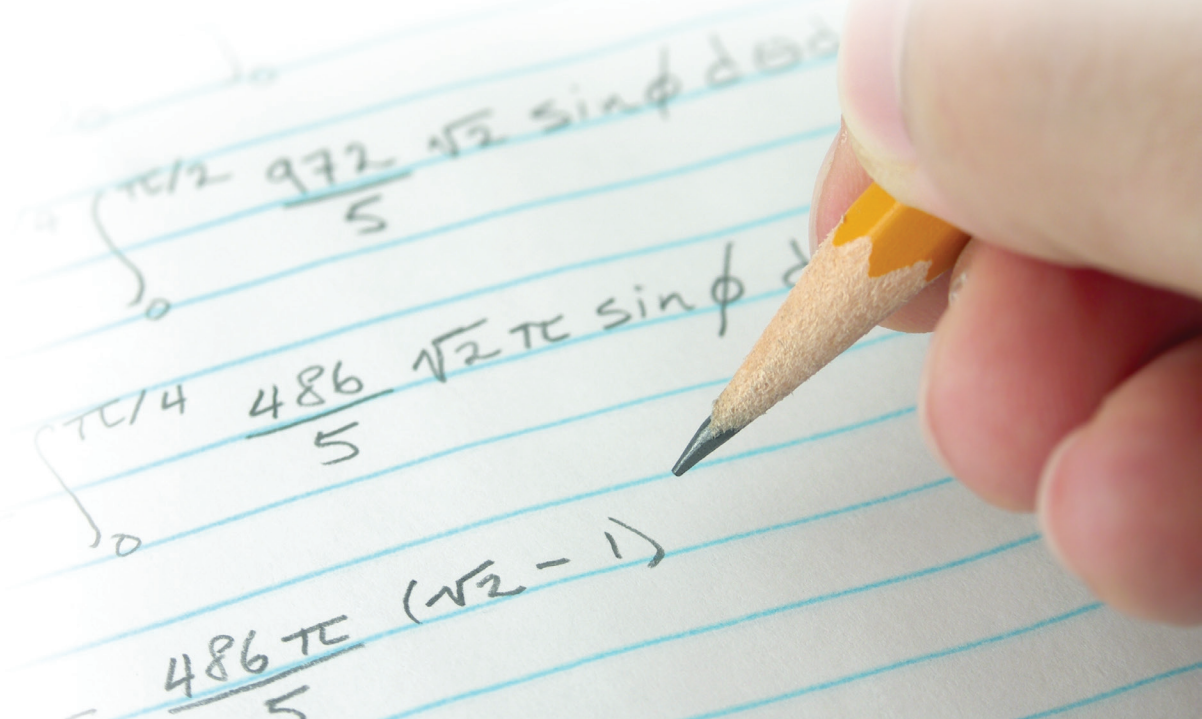
For the institution, automated testing tools offer very practical advantages – no more photocopying and distribution of assignments and tests, no disputes over lost assignments, no need for massive "grading parties" for large-scale testing. Of particular value for many institutions is that the logistical nightmare of placement testing can be completely eliminated. Students can complete their placement tests from home, long before they arrive on campus, so class sizes, instructors, and room assignments for each section can be settled well in advance of the first week of classes. In addition, institutions can save money on their grading budgets, as they reduce the need for teaching assistants while still maintaining their high standards of education and student success.

Challenges for STEM Education

Unfortunately, all these benefits have not been so readily available for STEM education, because STEM has specialized needs and requirements that most automated assessment systems cannot handle.

Even something as simple, and as fundamental, as using standard mathematical notation is a significant challenge. Properly displaying mathematical notation in the question is one problem, and providing a means for students to enter their answers is another. If the math itself doesn't look right, students will make mistakes reading the question and entering their answers, and those mistakes will have nothing to do with their understanding of the mathematics itself. As a result, students are frustrated, instructors frequently have to adjust marks manually to account for "syntax errors", and neither students nor instructors receive completely reliable feedback from their assignments.

Then there is the problem of what types of questions the system supports. Standard question types like multiple choice, fill-in-the-blank, and numeric response simply cannot properly assess student understanding in a technical course. On paper-based tests, questions are typically free-response, where there are no constraints or hints to what the solution might look like, and the answer is



often a mathematical equation or formula. Most automated assessment systems do not support this kind of open-ended mathematical response question.

And if they do provide a mathematical free-response question type, that leads straight to the problem of mathematical equivalency. Students can take different paths to the correct answer that result in mathematically correct, but different, answers. For example, $x + y + 1/2$ is the same as $\frac{(1+2y+2x)}{2}$, $\frac{\sin(x)}{\cos(x)}$ is the same as $\tan(x)$, and $1 - \sin^2(x)$ is the same as $\cos^2(x)$. If the system can only accept a single correct answer, or even one of a fixed list of possibilities, other equivalent responses will be marked wrong. The student will be forced to spend unnecessary time and energy converting their answer to a particular format, or worse, told they got the answer wrong even though they didn't. This problem is infinitely worse in the case of open-ended questions. There are many meaningful assignment questions that have many *different* correct answers – sometimes even infinitely many. There is no way for an instructor to provide a list of all possible correct answers, in all possible variations, to such questions. The issues related to mathematical equivalency and open-ended questions are much less of a problem with human graders, who understand the mathematics and can validate an unexpected response, but they are extremely challenging problems for automated systems.

To be truly effective for a STEM course, an automated assessment system needs to be able to handle the display and input of standard mathematical notation, support free response questions, correctly grade questions with more than one correct answer, and handle mathematical equivalency. Since most assessment systems do not have these abilities, STEM instructors have been left out, or even worse, forced to endure inadequate testing systems that did not allow them to properly assess their students' understanding.

The Maple T.A. Solution

Fortunately, there is an automated assessment tool that meets the needs of STEM education. Maple T.A., from Maplesoft, is an online testing and assessment system designed especially for mathematics, making it ideal for science, technology, engineering, and mathematics courses. Maple T.A. is based on Maple™, the well-known mathematics software. With the power of Maple behind it, Maple T.A. has all the mathematical knowledge it needs to handle STEM assessment.

Mathematical Notation

Math in Maple T.A. looks right. Questions use standard mathematical notation, from exponents and subscripts to integrals, square roots, and matrices. Students do not have to interpret the mathematical notation in the question, with the inherent risks of misinterpretation. They just read it.

Maple T.A. includes a math equation editor that allows students to enter their response using the same notation they would use on paper. No special syntax is required. Students use palettes, menus, and standard keyboard shortcuts, such as "/" to enter a fraction, to enter their response. They can immediately verify visually that their response is what they intended, because they are using familiar notation.

$$\frac{\sin^2(x) - 1}{2} = -\frac{1}{2} + \frac{1}{2}\sin^2(x) = -\frac{1}{2}\cos^2(x)$$

The problem of mathematical equivalence, where there are many different ways of expressing an answer correctly, is one of the many challenges facing automated assessment systems when it comes to STEM education.

Mathematical Equivalence

If the instructor chooses, Maple T.A. can automatically compare a student's response to the correct answer while taking into account mathematical equivalence. The author of the question only needs to provide one form of the answer, and Maple T.A. will determine if the response is equivalent or not.

Open-Ended Questions

Not only can Maple T.A. handle mathematical equivalence, but it can also apply the same kinds of mathematical tests that a human grader would do when evaluating a response to an open-ended question. For example, Maple T.A. can ask "Give an example of a function that has a minimum at $x = 1$", and then take the student's response, find the derivative, and evaluate it at $x = 1$ to see if the value is zero.

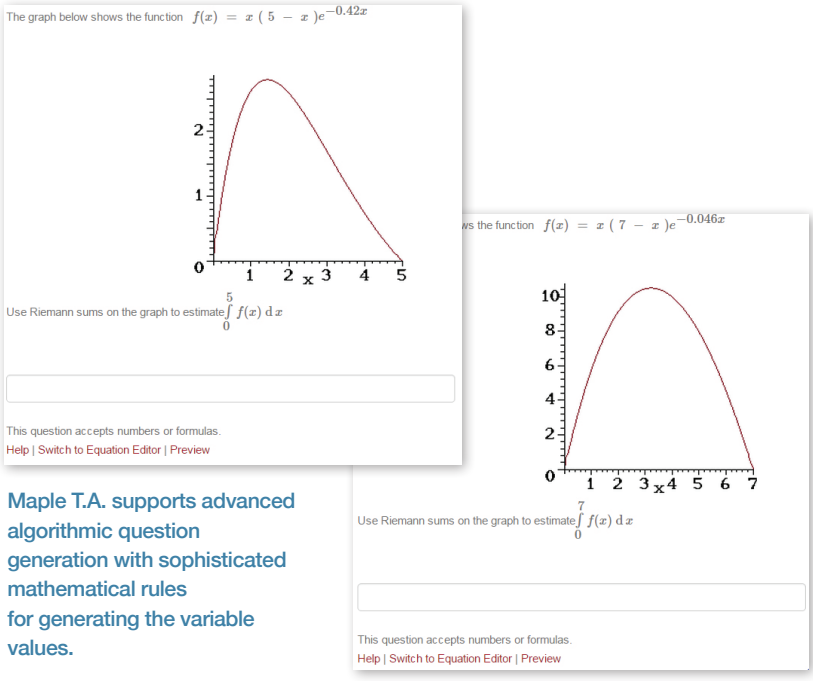
Flexible Algorithmic Questions

Algorithmic questions allow instructors to create a single question template, and then generate many different instances of the question by providing different values for one or more variables in the question template. Because of its inherent understanding of mathematics, Maple T.A. provides great flexibility when it comes to defining such questions. Instructors can set complex conditions for the variables in the question template, such as "a is a positive integer less than 15, b is a integer such that $-30 < b < 30$, b $\neq 0$, and b is not divisible by a". In addition, since Maple T.A. understands mathematics, the variable in the question could be a more sophisticated mathematical object, such as "a prime number less than 100" or "a nxn matrix with integer entries all of absolute value less than 20, where $n = 2$, 3, or 4".

Other Maple T.A. Advantages

As a comprehensive online testing and assessment system, Maple T.A. provides many useful abilities in addition to those specifically designed to support STEM education, including:

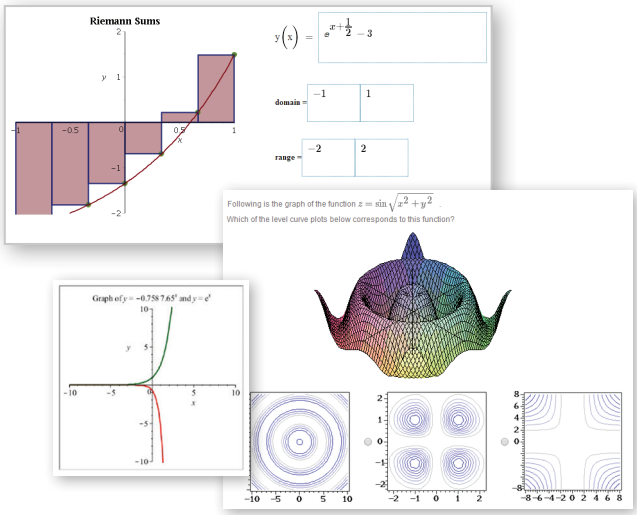
- Adaptive assignments and questions
- Flexible partial grading
- Full-featured gradebook, including reports and analytical tools
- Flexible assignment properties
- International language support
- Support for mobile devices
- Compatibility with virtually any course management environment, including Blackboard® and Moodle™



Maple T.A. supports advanced algorithmic question generation with sophisticated mathematical rules for generating the variable values.

Visualization

Visualizing functions, relations, and data is an important aspect of most technical subjects, and Maple T.A. makes it easy to include a huge variety of customizable 2-D and 3-D plots in assignment questions. The plots are created right inside Maple T.A., so there is no need to turn to other software to create the visualizations. In addition, the plots themselves are not just fixed images. They are generated as needed by Maple T.A., which means that for algorithmic questions involving plots, each version of the question can include a different plot.



Maple T.A. has built in support for a large variety of customizable 2-D and 3-D plots, which will change automatically if the question is algorithmically generated.

Maple T.A. also lets instructors ask questions that require a student to sketch a graph in response, so they can test a student's understanding of these fundamental ideas without having to resort to pencils and paper. Graph sketching questions are graded automatically by Maple T.A.

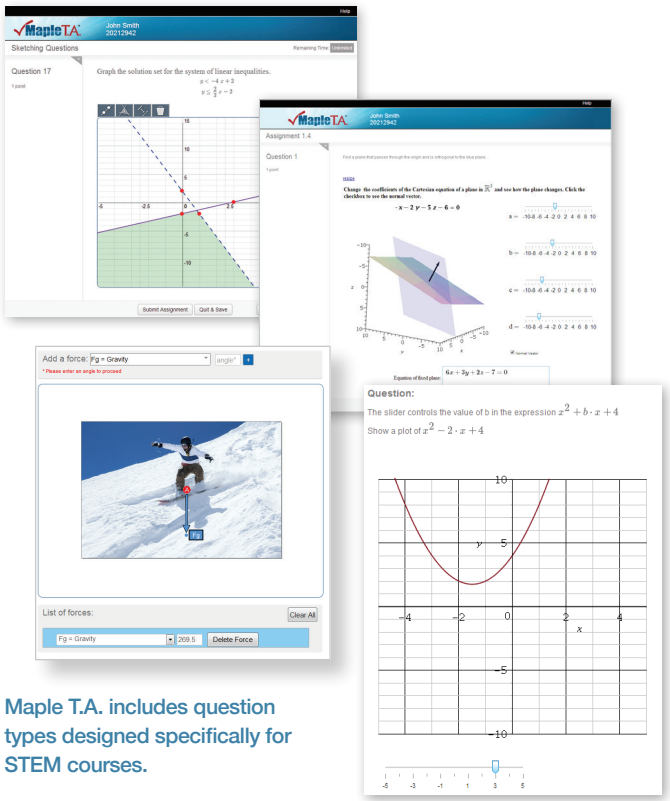
Mathematical Knowledge

Because Maple T.A. has Maple behind it, Maple T.A. can grade questions that rely on virtually any area of mathematics. Maple T.A. can be used in calculus, algebra, statistics, physics, chemistry, differential equations, economics, and many other topics.

Questions Types for STEM

In addition to the standard multiple choice, true/false, and numeric response style of questions, Maple T.A. includes many question types designed specifically for STEM courses. Examples include mathematical free response, numeric questions that handle a margin of error, graph sketching, free body diagrams, questions that handle units, and chemical formula questions.

Maple T.A. also supports Math App questions, where the body of the question is an interactive application the student can use directly inside Maple T.A. Math App questions are based on Maple documents, so instructors can provide a wide range of interactive applications. For example, Math App questions can provide students with specialized calculators, ask them to manipulate parameters until they have found the desired solution, or give them interactive plots to explore and answer questions about. As required, Maple T.A. will examine what the student does with the application, such as looking at the final position of a slider that controls a plot, and automatically grade the interaction.



Maple T.A. includes question types designed specifically for STEM courses.

Question Content

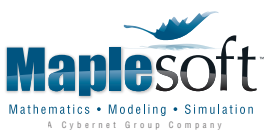
Thousands of Maple T.A. questions are freely available to instructors for use in their own tests and assignments. These questions were created and shared by educators who used them in their own courses. Questions can be used as-is, or they can be customized as required. Question content is available for a variety of STEM subjects, including calculus, precalculus, algebra, physics, engineering, statistics, differential equations, and chemistry.

Maple T.A. provides a comprehensive set of authoring tools for both content customization and the development of new questions. These tools include a mathematical equation editor, powerful algorithm design tools for creating question templates, and a step-by-step question designer that walks the author through the creation of a wide variety of both STEM and non-STEM question types.

Conclusion

Automated assessment provides many advantages to instructors, students, and institutions. However, due to the special requirements of science, technology, engineering, and mathematics education, many assessment systems simply cannot meet the needs of these courses. Fundamental issues such as the display of standard mathematical notation, the possibility of many correct-but-different answers, and mathematical equivalency make most assessment tools inadequate for STEM courses. Maple T.A., the online testing and assessment system from Maplesoft, was designed especially to take into account the needs of mathematical assessment. It handles all these issues, and provides many additional features to support STEM education. With Maple T.A., STEM educators can finally take advantage of the benefits of automated assessment.

Interested in learning more about Maple T.A.?
Visit **www.maplesoft.com/mapleta.**



www.maplesoft.com | info@maplesoft.com