



Transforming Testing and Assessment

A collection of Maplesoft customer stories

Discover how educators are using Maplesoft solutions for all their testing and assessment needs.

A Word From Maplesoft's President

Welcome to the Maplesoft magazine, *Transforming Testing and Assessment*.

We at Maplesoft understand that science, technology, engineering, and mathematics (STEM) courses have their own requirements when it comes to automated assessment. Many of us have graded tests and assignments in these courses, and even more of us have written those tests and assignments in the first place, so we are very familiar with the importance of elements such as standard math notation, plotting, free response questions, and the intelligent evaluation of the responses when it comes to STEM assessment. That's why we developed Maple T.A.[™], a powerful online testing and assessment system designed especially for courses involving mathematics.

Maple T.A. provides everything you need to take full advantage of automated assessment in your math-based courses, allowing you to truly assess student understanding in your STEM classes. And because assessment doesn't happen in a vacuum, Maple T.A. can be seamlessly integrated into your online learning infrastructure. It even supports mobile strategies by allowing students to access their tests and assignments from tablets.

Maple T.A. helps instructors teach, students learn, and administrators offer cost-effective strategies for student success. In this collection, you'll read about just a few of the ways institutions around the world are using Maple T.A. to improve learning, save money, reduce drop-out rates, and increase student satisfaction.

Please enjoy this magazine with our thanks for all the passion and support the Maplesoft community has shown to us over the years.

Sincerely,



Jim Cooper
President and CEO
Maplesoft

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University of Waterloo Improves Learning While Saving Money with Maple T.A.

University of Waterloo

The University of Waterloo faced an all-too-familiar problem: increasing enrollment and decreasing budgets. They firmly believe that students need to actively do mathematics in order to learn mathematics, so their courses involve very frequent tests and assignments. Their original approach to handle this workload involved hundreds of teaching assistants and undergraduate graders to help with the grading, but that was simply no longer a viable option due to growing class sizes and reduced budgets for teaching support. As an institution that is renowned for the quality of its mathematics education, staff and faculty at the University of Waterloo were not willing to compromise their students'

learning by reducing the number of graded assignments offered in each course. They had to find another solution.

The University of Waterloo chose Maple T.A. to automate the assessment tasks for many of their mathematics-based courses. Today, Maple T.A. is used to deliver tests and assignments to approximately 9000 students/year, spread over more than 40 courses. Students in the mathematics, engineering, and science faculties use Maple T.A. every day. For example, the first six core courses taken by mathematics students in first and second year all rely on Maple T.A. to deliver regular assignments to students. At times, as many as 800 students use the system at the same time.





After adopting Maple T.A., the university reduced its budget for graders by one-third. Though the savings are substantial, and welcome, the university also views Maple T.A. as an important teaching tool that provides real benefits to the quality of the students' education. Through Maple T.A., students get an opportunity to practice on questions they would normally be left to do completely on their own, and are given instant feedback to show them how to improve. In turn, since the straight-forward questions are handled by Maple T.A., human graders have more time to devote to giving thoughtful feedback on the students' solutions to the more challenging questions that make up the written assignments.

“ ...after moving to Maple T.A., we've found that we can save approximately \$100,000 per year on our grading budget... ”

— Carrie Howells, University of Waterloo

“ We can offer an appropriate number of assignments to our students without being overwhelmed, and students appreciate the improved feedback on all their assignments. ”

— Carrie Howells, University of Waterloo

“Maple T.A. has made a huge difference to us, on many levels,” says Carrie Howells, Instructional Support Coordinator for the Mathematics Faculty Computing Facility. “We can offer an appropriate number of assignments to our students without being overwhelmed, and students appreciate the improved feedback on all their assignments. In addition, after moving to Maple T.A., we've found that we can save approximately \$100,000 per year on our grading budget, which we can use to support activities and programs we couldn't otherwise offer.”

Impressed with the results thus far, the administration has plans to further expand the use of Maple T.A. to include more courses, both inside and outside the mathematics, science, and engineering faculties, on both their main campus and their satellite campus in Dubai. They are also looking at replacing their labor-intensive, logistically complex math readiness testing process, which involves thousands of first year students, with an automated Maple T.A. solution.

Feedback

Recalling that the volume of revolution, about the y -axis, is calculated as

$$V = \pi \int_a^b r^2 dy$$

where r represents the radius of each disk as a function of y , we create the integral

Question

Consider the region in the first quadrant of the xy -plane bounded by the curves $x^2 - y^2 = 3$, $x = 0$, $y = 0$, $y = 4$. When this area is rotated about the y -axis it forms a vase-like structure. Calculate the volume of this vase. **Note: Give an exact answer.**

It would be helpful to draw a picture of the curves above.

$$V = \pi \int_0^4 (3 + y^2) dy$$

$$= \pi \left(3y + \frac{1}{3}y^3 \right) \Big|_0^4$$

$$= \frac{188}{3} \pi$$

Below is a visual demonstration of the surface area of the volume we are creating.

Use of Maple T.A. at Amsterdam University of Applied Sciences Increases Student Pass Rate by 20 Percent

Amsterdam University of Applied Sciences

Driven by low pass rates in mathematics courses, Hogeschool Van Amsterdam (Amsterdam University of Applied Sciences) decided to change their approach to teaching and learning mathematics. Online learning and digital testing were key pillars of this approach, and Maple T.A. was the primary tool they chose to implement this change. They saw immediate results with student pass rates in affected courses going up by about 20% within a span of one year.

Maple T.A. was introduced in the (Applied) Computer Science Program, to which students come with different levels of math knowledge. This created some obvious problems. To solve these, the university revamped the first year curriculum to make sure all students reach the same level by the end of the first year. Use of online assignments, homework, and tests using Maple T.A. strengthened the program. Results from Maple T.A. were then used to create an individual learning path that was relevant and inspiring for each student.



“Students have different styles of learning, and the pace of study differs from one student to the other,” said College Professor Robert Meijeringh, MSc. “The use of Maple T.A. gave us the flexibility to teach accordingly, which was very important because students came from different backgrounds with varying levels of knowledge. With the use of Maple T.A., students got the chance to create their own learning path.”

Maple T.A. is an easy-to-use web-based system for creating tests and assignments, and automatically assessing student responses and performance. It supports complex, free-form entry of mathematical equations and intelligent evaluation of responses, making it ideal for science, technology, engineering, mathematics (STEM), or any course that requires mathematics.

The ability to quickly and easily create questions is what the University staff found most attractive in Maple T.A. – the ability to include open-ended questions and the option to generate variations of questions meant that both the staff and students got a lot of flexibility. Parameterization is a key feature in Maple T.A. that provides each student with an individual set of problems that are algorithmically generated, reducing the likelihood that answers will be copied.

“**Student satisfaction went up, with feedback indicating that different options for learning and individual support from teachers were highly appreciated. Not only did the data show improvement, but the overall quality of the student experience improved.**”

– Robert Meijeringh, Amsterdam University

The “anytime anywhere” nature of the web-based tool meant that the students could work in their own setting and at their own pace. Students who took the initiative to learn on their own started with the Maple T.A. exercises. The teachers could then easily grade papers and assignments, providing immediate feedback, urging further exploration and study of the topic. Students who needed more structure to their learning were directed by the teachers, supplemented by testing and assessment in Maple T.A.

“The flexibility in learning proved to be a huge motivating factor for students,” continued College Professor Robert Meijeringh, MSc. “Student satisfaction went up, with feedback indicating that different options for learning and individual support from teachers were highly appreciated. Not only did the data show improvement, but the overall quality of the student experience improved.”

Encouraged by the success of this program, other departments in the university are beginning to adopt the digital testing and learning method. The university is also committed to helping other institutions make use of the power of Maple T.A., by sharing and exchanging question banks and other resources.

The University of Manchester uses Maple T.A. to Assess Student Learning Across a Wide Range of Courses

University of Manchester

Science, Technology, Engineering and Math (STEM) programs around the world are benefitting from the testing and assessment tool Maple T.A., which includes many features designed especially for courses involving mathematics. However, it's not just STEM courses which need a software platform that offers instructors a comprehensive online assessment tool. Academic staff at the University of Manchester, UK's largest campus-based university, use Maple T.A. beyond the traditional STEM courses, in a variety of programs from the Humanities.

Maple T.A. is a powerful online testing and assessment system designed especially for courses involving mathematics. Since Maple T.A. automatically assesses responses, students receive instant feedback on their performance. Compatible with virtually any course management environment, Maple T.A. can be seamlessly integrated into the existing online learning infrastructure.

Maple T.A. first made its entry into the University of Manchester's curriculum in the Faculty of Humanities' mathematics-based programs such as Economics, which, in the first year alone, saw an enrollment of over 2000 students. As the first few courses build the foundation of later concepts and skills, the university required early skills to be thoroughly assessed and firmly established.

Manchester University also required the flexibility to test a wide range of course material without being limited by only certain types of questions, as it offers more courses than any other university in the country. Prior to the introduction of Maple T.A., instructors were restricted to using specific question types such as true/false and multiple choice in tests and evaluations due to the inability of other software programs to offer more than a limited subset of question types.

"The question types we had available to us placed limits on the material we were able to assess," Dr. Leonard Gill, lecturer in Econometric Theory and Applied Econometrics, explains. To properly assess students, Dr. Gill needed to be able to test their abilities to understand and use proper mathematical notation, and interpret mathematical and statistical material on graphs and diagrams. Maple T.A. offers many different types of questions that cover technical and non-technical subjects, including free-response math questions, and sophisticated algorithms for generating hundreds of practice questions based on a template. "The range and flexibility of the questions were critical for us to most effectively assess the students' understanding of the material," Dr. Gill noted. "Maple T.A. gave us assurance that students were completing the courses with the knowledge they needed for upper year courses."



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— Leonard Gill, University of Manchester

The University of Manchester is currently in the process of integrating Maple T.A. into their course management systems, using the Maple T.A. Connector for Blackboard Software to provide easy access to Maple T.A. from within the Blackboard environment. "By integrating Maple T.A. into our course management infrastructure, we will be able to provide a seamless environment for both instructors and students," says Dr. Gill. "Being able to integrate the two will give us the opportunity to take advantage of the power of Maple T.A. while continuing to work within our existing infrastructure."

Maple T.A. has also been integrated into other programs within the Faculty of Humanities, and in other faculties across the university. In Humanities, the School of Arts, Languages and Cultures, the School of Environment, Education and Development as well as the Manchester Business School have all benefitted from using Maple T.A.

Maple T.A. Helps Sustain High Success Rates at INSA-Lyon, France's Leading Engineering School

INSA Lyon

INSA Lyon (the National Institute of Applied Sciences in Lyon), one of the leading engineering schools in Europe, annually graduates 950 innovative and entrepreneurial engineers. INSA Lyon welcomes three-quarters of all its students right out of high school while the other one-quarter enter directly into their third year of study from a variety of other educational programs, resulting in a mix of educational backgrounds and skill-levels among new students.

In order to maintain the high standard of teaching for which INSA Lyon is known, the directors of the undergraduate program placed emphasis on students mastering basic fundamentals as well as calculus in their first year. Calculus was deemed important as it is central to mathematics, chemistry and physics. Placement tests were carried out at the beginning of the year, and a program was put in place to track the progress of first-year students.

The exams consisted of multiple-choice questions and the tests were handwritten. The assessment of such a large numbers of students proved to be a time-consuming and

laborious task. Being an institution that strives for innovation in the field of information and communication technologies for education, INSA Lyon started looking for a testing tool that could ensure more efficient use of its resources.

"When we looked for the right testing tool, we wanted to find a system supporting the assessment of mathematical expressions, a crucial function for us as an engineering school," says Philippe Lonjou, Associate Professor at INSA Lyon. "We found Maple T.A. to be the best option."

Maple T.A., from Maplesoft, is the perfect tool for any course that requires mathematics. It is a comprehensive web-based system for creating tests and assignments, and automatically assessing student responses and performance. It supports complex, free-form entry of mathematical equations and intelligent evaluation of responses, making it ideal for science, technology, engineering, and mathematics (STEM).

A number of features in Maple T.A. were of particular interest to the teaching staff at INSA Lyon. "Maple T.A. allows us not only to assess mathematical expressions, but also to accurately grade different variations of the same question.



We can also see the progress made by the students in various courses and topics, and provide them with additional practice questions they can solve at their own pace,” adds Lonjou.

In the first weeks following their admission to INSA Lyon, students are tested in basic mathematics, physics and chemistry using Maple T.A. Instructors can then quickly and easily identify students who need additional support in specific areas. Students requiring support are provided with a bank of practice exercises in Maple T.A. This allows at-risk students to progress and achieve the necessary level for success at INSA Lyon, while instructors are able to monitor student progress and development in the subject areas.

With 30% of the student population at INSA de Lyon comprised of foreign students, and 25% of students entering their third year directly from varied educational paths, there is a strong need to consolidate their skill levels and knowledge



“ ...Maple T.A. has proved to be a valuable resource for us. Time usually spent assessing and evaluating students is now used to enhance and improve our question databases...”

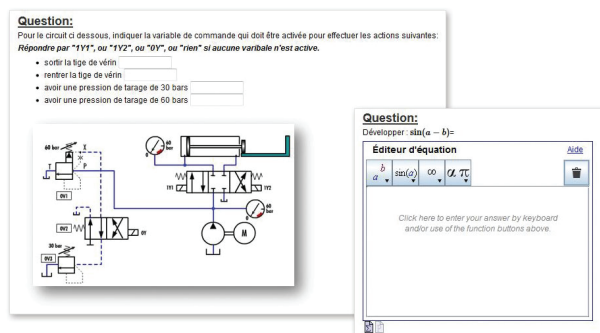
– Philippe Lonjou, INSA Lyon

base and bring them to the level required to be successful at the university. Instructors realized the full potential of Maple T.A. to help bridge the important knowledge gap among this population and effectively equip them for their studies at INSA Lyon.

“Maple T.A. has proved to be a valuable resource for us,” says Lonjou. “Time usually spent assessing and evaluating students is now used to enhance and improve our question databases.”

Thousands of questions are freely available for use in Maple T.A. Instructors can also create their own question database as well as customize the questions depending on their classes.

Based on experiments in the first year’s curriculum and in the undergraduate program, a team of teachers plan to develop a website on behalf of the Department of Mechanical Engineering Design to help students from various backgrounds further develop their knowledge in the areas of technical sciences, design and mechanical engineering calculation.



Student Grades Improve After Implementation of Maple T.A. at Shanghai Second Polytechnic University

Shanghai Second Polytechnic University

Increasing class sizes and more options for finding answers to math questions online provided significant challenges to the faculty at the Shanghai Second Polytechnic University. More students meant more time and money spent on grading papers and better access to mathematics on the internet meant an increase in student cheating. The faculty and management were looking for ways to make their testing system more efficient when they were introduced to the testing and assessment tool, Maple T.A., from Maplesoft.

“With the practice and testing options in Maple T.A., the students’ grades improved. It also brought back the students’ enthusiasm for learning by helping them understand concepts better.”

— **Wu Luo**, Shanghai Second Polytechnic University

What started off as a pilot project in the Calculus course has now turned into a key project across the entire university. The university has now integrated Maple T.A. into its testing and assessment system for over 2200 students.

Maple T.A. is an online, anytime, anywhere testing and assessment tool. Students can do their assignments, or take tests, based on custom questions prepared by the instructor. The results are automatically graded by Maple T.A., providing immediate feedback to students and teachers. The algorithmic nature of the questions enables students to practice with several questions and understand the concept thoroughly. The simple and easy to use interface of Maple T.A. enables students to do their work without spending time



learning the tool. Additionally, the Maple T.A. Proctored Browser means students can't access other websites or programs while using Maple T.A., significantly reducing their ability to cheat using online sources.

“The enormous benefit that Maple T.A. can bring to the teachers and the students is obvious once you see how the tool works,” says Professor Wu Luo, Shanghai Second Polytechnic University. “We saw instant results when we introduced Maple T.A. in our calculus courses. With the practice and testing options in Maple T.A., the students’ grades improved. It also brought back the students’ enthusiasm for learning by helping them understand concepts better. The fact that we are able to use technology to avoid copying and cheating in assignments and tests is a big bonus.”

Before the broader implementation of Maple T.A., Professor Wu Luo set up a pilot class in the calculus course for one year, to test the tool. During the year, 50% of the students in the pilot class completed assignments and took tests using Maple T.A. The other 50% did not use Maple T.A. To the university's surprise they found that in the final examination, the group that used Maple T.A. scored 12% higher than the rest of the class on the same exam.

This staggering success was noticed by many in the Shanghai education system. Apart from other professors and department heads within the Shanghai Second Polytechnic University, the Dean of the Liberal Arts College of Shanghai Maritime University, and several professors from the Shanghai Business School became interested in Maple T.A. and expressed their desire to hear more about it.

Riding on the initial success of the pilot test, Professor Wu expanded the use of Maple T.A. to other classes. With the help of a few students, he also started to develop a mathematics question bank within Maple T.A., which, when completed, will serve as a resource for other teachers in their assignments and tests.

“When we complete the questions bank, all math teachers will benefit,” said Professor Wu. “Teachers will be able to pick questions as they need to, saving a lot of time. Maple T.A.’s automatic grading capabilities will also save the university a large budget on grading. Moreover, the tool is very easy to use, letting both teachers and students get started quickly.”

Having seen the success of the Mathematics department in improving the quality of teaching and learning, other departments at Shanghai Second Polytechnic University, including the Physics department, have also started implementing Maple T.A. in their courses.

Using Maple T.A. Improves Final Test Results of Engineering Students

Polytechnical Institute of Noordelijke Hogeschool

The Polytechnical Institute of Noordelijke Hogeschool Leeuwarden in Holland (NHL) introduced a collection of online math exercises using Maple T.A. Since then, 95% of the engineering students who regularly evaluated their math knowledge with Maple T.A. online exercises passed with significant improvement in their final scores. Many of the students who did not regularly test their skills using these exercises failed the course.

They say *practice makes perfect* and students at NHL have proved it right. Students who regularly used these exercises to test their knowledge and practise concepts they found challenging showed significant improvement to their final test results.

Each exercise is designed to be solved in 15 minutes and includes 5 questions. Students have the option of trying exercises in a particular topic as many as four times. The randomization of Maple T.A. is one of its biggest strengths – students never get the same tests or exercises, which helps them to practice new problems each time.

“Students love that they can take these exercises on their own time, in the convenience of their own homes and at their own pace.”

– **Metha Kamminga**, Polytechnical Institute of Noordelijke Hogeschool

Maple T.A. also offers a wide range of question types, including the ability to have multiple response areas in a single question and to ask open questions that are graded for mathematical equivalency using the Maple engine. The variety of question types, along with the randomization capabilities of the system, provides a rich environment that enables the use of advanced questions to truly test a student’s knowledge level. The objective of the exercises is to get more than 80% of the answers right. If a student fails after four attempts, it is an indication they should seek help on their basic theoretical knowledge of the concepts presented.

The implementation of Maple T.A. at NHL was spurred on by math teacher Metha Kamminga. “We wanted to implement



a flexible system that gives students the desire to work with math. Today, 95% of the students succeed in the final tests if they have done the exercises regularly during the year. Results of the final tests were very disappointing previously, but have now improved significantly. Students love that they can take these exercises on their own time, in the convenience of their own homes and at their own pace. What’s more, they get immediate feedback too. This can be very inspiring and motivating,” Kamminga says.

In the beginning, Kamminga had to build a few extra exercises to teach students how to enter a math formula correctly. But Maple T.A. contributes to teaching them the rigorous syntax of math in a precise fashion, and students have quickly adopted the system. They appreciate the possibility to get graded again and not being dismissed at the first mistake on an exercise. With each passing trial, they get better.

“Building the exercises, I particularly appreciated the simple interface of Maple T.A. and the personalization capabilities of the test. With these tests, each student gets personal attention in areas where they need it and they feel like they are well looked after,” adds Kamminga. “Before Maple T.A., this was done with paper tests and my Sunday mornings were spent correcting too many paper exercises. The system is now fully automated. Furthermore, we have created a participative teaching system. I am now like a “virtual teacher” who is always around the students when they work, but I get my Sunday mornings free!”

Analysis also showed that Kamminga was able to move faster in her course and cover wider and deeper topics with the vast amount of time now saved. At the same time, students are also well prepared to take on new challenges since they have rigorously practiced these Maple T.A. exercises.

Maplesoft Solutions

Testing and Assessment for Courses Involving Mathematics



Maple T.A. is a powerful online testing and assessment system that allows instructors to truly assess student understanding of math-based concepts, making it ideal for science, technology, engineering, and mathematics (STEM) courses.

- **Designed especially for courses involving mathematics**

Science, technology, engineering, and mathematics (STEM) courses have their own requirements when it comes to automated assessment, and Maple T.A. was designed specifically to meet those needs. Offering standard math notation, sophisticated plotting, free-response math questions, intelligent grading of responses, and more, Maple T.A. provides everything you need to take full advantage of automated assessment in your math-based courses.

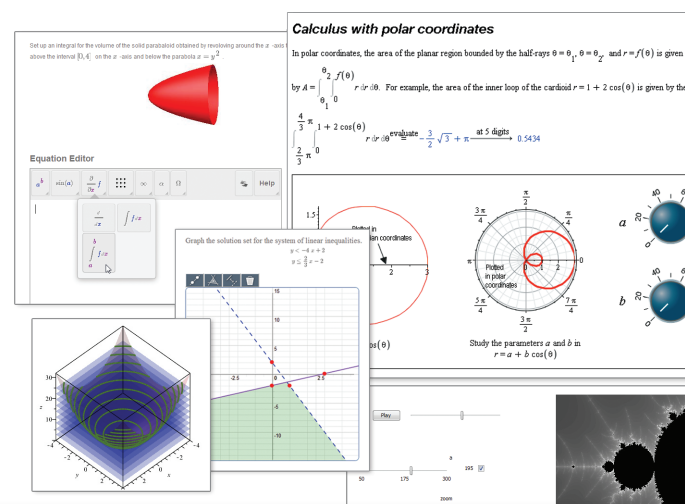
- **Compatible with virtually any online course management environment**

From augmenting a standard course management system to providing automated assessment for a custom-built MOOC, Maple T.A. can be seamlessly integrated into all your online offerings. Maple T.A. can be integrated with Blackboard®, Moodle™, and more, offering single sign-on, a consolidated gradebook, and easy access to all student assignments regardless of where they were created.

- **Mobile-accessible**

Today's students expect mobile access to all their course materials, including tests and assignments. Whether you are developing a full mobile strategy or simply giving students a way to do homework from the campus coffee shop, Maple T.A. provides a tablet-compatible assessment environment that works with iPad®, Android™ tablets, and more.

To learn more:
www.maplesoft.com/mapleta



for Online Education

Online courseware environment that puts **STEM first**



Möbius is a comprehensive online courseware environment built around tools that focus on science, technology, engineering and mathematics (STEM). It is built on the notion that people learn by doing. Engaging visualizations, complex simulations and powerful assessments can be woven throughout the entire learning process to help your students solidify their knowledge.

Moving courses online is challenging at the best of times, but is particularly difficult when it comes to STEM courses. Maplesoft has years of expertise in technical education, and has both the experience and technology to help you meet the particular challenges of math-based courses in an online environment.

Whether you want to provide a textbook-agnostic fully online course, a textbook-specific supplement, or anything in-between, Möbius has the tools that will allow you to make your vision a reality and deploy it to your students.

Truly Integrated Assessment

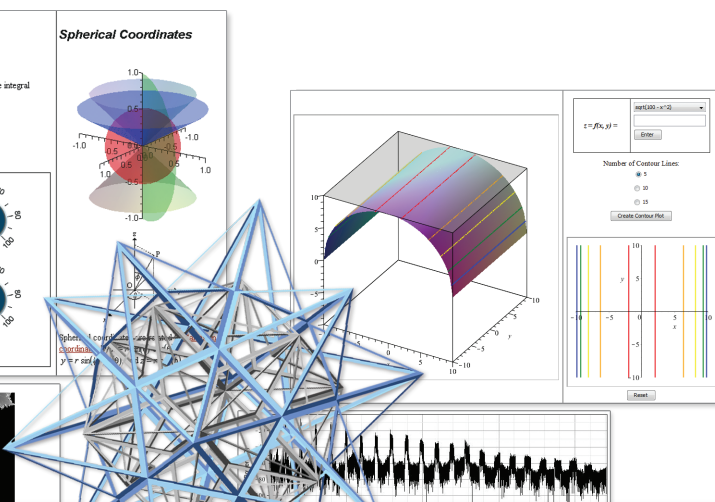
By integrating powerful and dynamic assessment tools *directly into the learning materials*, Möbius helps you give your students immediate feedback that keeps them engaged and productive.

Everything You Need

Möbius is built to use natural notation, to understand mathematical concepts and to produce engaging visualizations. These capabilities are directly integrated into Möbius, providing the tools you need to construct and deliver your entire course – from lessons to narrated lectures to assessments – in one place.

Your Content, Your Rules

Möbius is a flexible platform that supports traditional online courses, open-access courses, formative testing, placement testing, independent learning, and flipped or blended classrooms. Best of all, your course content belongs to you, leaving you in full control.



To learn more:
www.maplesoft.com/mobius

Use of Maple T.A. at the University of Guelph Reduces Drop-out Rates by More Than 10%



University of Guelph

The University of Guelph in Ontario, Canada is a long-standing user of Maplesoft products such as Maple, a technical computing and documentation tool, and Maple T.A., an online testing and assessment solution. Recently, faculty and staff at the University of Guelph embarked upon an experiment to statistically determine the impact on students of using Maple T.A.

An undergraduate Mathematical Economics class was chosen for the study, with one half of the students being randomly assigned to use Maple T.A., and the other half to use conventional tools. The final grade for all students were split as follows: 30% from their midterm, 50% from the finals and the remaining 20% from assignments and quizzes using Maple T.A. or other tools depending on the group the student was in. Apart from analyzing the final exam scores, a survey was also conducted to determine the students' qualitative impressions, preferences and attitudes. The students' preference for the Maple T.A. group was evidenced by the majority of the group preferring to stay in their assigned group, while half of the conventional group wishing to be assigned to the Maple T.A. group.

More significantly, results showed a lower drop-out rate in the Maple T.A. group (9%), with the students that dropped being the ones that had the lowest GPA scores. However, in the conventional group the drop rate was higher (20%), and students with a spectrum of GPA scores dropped the course. "The lower drop-out rate and the quality of the students who dropped out indicate that students who used the Maple T.A. tests and assignments had a better understanding and grasp of the subject than the other students," said Dr. Asha Sadanand, Professor in the Department of Economics and Finance, University of Guelph. "More students in the Maple T.A. group said they liked the course compared to the conventional group. To me, this shows a boost in the students'

confidence levels through the use of tools like Maple T.A., which let students learn at their own pace and time."

Maple T.A. is an easy-to-use web-based system for creating tests and assignments, and automatically assessing student responses and performance. Because Maple T.A. is powered by Maple, it offers features especially suited for assessment in technical courses. Through Maple T.A., students get an opportunity to practice questions they would normally be left to do completely on their own, and are given instant feedback to show them how to improve.

"Besides being an excellent learning tool for students, Maple T.A. is a wonderful aid for teachers too," continued Dr. Sadanand. "We saved significant amounts of time in marking tests and assignments, freeing instructors' and Teaching Assistants' time to do more productive work. We can now offer more tutorials, small group interactions and even provide more personal attention to students, which was limited due to time constraints. The technology in Maple T.A. also helps us to delve deeper into the students' thought processes and see how they approach their problems and assignments."

“ Besides being an excellent learning tool for students, Maple T.A. is a wonderful aid for teachers too. We saved significant amounts of time in marking tests and assignments, freeing instructors' and Teaching Assistants' time to do more productive work. ”

— Asha Sadanand, University of Guelph

Powerful, algorithmically-generated questions in Maple T.A. turn one question template into hundreds or thousands of similar questions, providing individual homework assignments and lots of practice questions for students. "This is one of Maple T.A.'s biggest strengths," commented Dr. Sadanand. "It is a time-saver and an extremely useful tool for students and teachers."

Encouraged by the results she found, Dr. Sadanand and her team at the University of Guelph are planning to roll out Maple T.A. to new programs and courses.

Maplesoft's flexible and efficient digital placement test system used by the University of the Virgin Islands

University of the Virgin Islands

Until a few years ago, the University of the Virgin Islands had a placement test system that used paper and pen tests. The school administration particularly liked the richness of the data that paper tests provided. That is, until they were introduced to online placement testing through Maplesoft's digital testing solution, the Maple T.A. MAA Placement Test Suite (PTS).

“The gains we have made in terms of efficiency and flexibility are enormous. More importantly, our tests are now much less time consuming, while giving us the flexibility to customize them to our own needs, and those of the students.”

— Dr. Celil Ekici, Assistant Professor of Mathematics

PTS enables universities to place incoming students in the right mathematics courses quickly and painlessly using the renowned Mathematical Association of America (MAA) placement tests offered online exclusively through the Maple T.A. testing environment. Correct placement ensures higher success rates for students. Students are more satisfied with the education they are receiving, and instructors can focus on teaching the course instead of dealing with ill-prepared students.

“We are very pleased with the Maple T.A. MAA Placement Test Suite,” said Dr. Celil Ekici, Assistant Professor of Mathematics. “We like both the content and the tool. We are very happy with the quality of the questions created by the MAA, and the technological tools provided by Maplesoft. We like the quality of the customized experience provided by the Placement Test Suite.”

Before a test can become an MAA standard or calculator-based placement test, it is first administered at select institutions. The results undergo detailed analysis, with modifications and further trials as required. MAA placement tests have high credibility as they have been either constructed by college faculty members, or piloted at various universities over the last three decades.

PTS also gives universities the ability to access the questions ahead of time, and edit them, if they so wish. They can modify the content, change questions around, as well as do detailed analysis. This level of transparency is unique to the Maple T.A. MAA Placement Test Suite.

“One aspect of PTS that we really appreciate is that we can choose a test that is most relevant to the particular course we are trying to accurately place the students in,” said Dr. Ekici. “With other packages that we evaluated, we couldn't see the question in advance, which was a major concern. With PTS, we can select questions that are aligned perfectly with the courses we offer. The level of customization is very high in PTS – we actually took questions from five different tests and created two, which helped us create tests very specific for our courses.”

Because of the power of Maple T.A., students can practice several times before the test, getting instant feedback on their performance. Teachers can use the system to track students' performance, analyze data and arrive at trends. This helps them customize lessons and instructions based on the students' performance. “The data we can obtain by using this system is very powerful,” said Dr. Ekici. “We plan to improve our analytics by creating student profiles to track their performance in key skill sets we identify. The teachers will then use the data to create customized lessons for the classroom that will take the students' skill level into consideration.”

Dr. Ekici and the University team are pleased with how the Maple T.A. MAA Placement Test Suite has transformed their placement testing. “The gains we have made in terms of efficiency and flexibility are enormous. More importantly, our tests are now much less time consuming, while giving us the flexibility to customize them to our own needs, and those of the students.”



Maplesoft Technology Used to Revolutionize Learning at Delft University of Technology in Netherlands

Delft University of Technology

Delft University of Technology (TU Delft) in the Netherlands is taking leadership in transforming learning through the use of technology. Its ambition is to eventually offer fully digitalized degree programs and it believes that digital testing and assessment can play an important role within this process. It turned to Maplesoft's online testing and assessment suite, Maple T.A., to be a partner in this journey of transformation.

The motivation

"Given the current economic climate, we can no longer justify the length of time that students take to complete their studies," said Drs. Paul Rullmann, Vice President, Education, Executive Board, TU Delft. "For this reason, we recently launched a project aimed at using technology to achieve drastic improvements in the pass rates in our programs. For example, providing timely feedback to students regarding their learning progress is one area of focus. We believe that assessment is at the heart of the educational process and that digital testing, through systems like Maple T.A., can play an important role."

In addition to the objective of addressing low pass rates, there are at least two other reasons for the focus on digital testing. First, student enrollment is increasing each year, even as funding from the government is decreasing. This poses organizational challenges including overcrowded classrooms, high teaching workloads, and tight teaching schedules. Digital testing can help to organise testing more efficiently for a larger number of students. Maple T.A. also provides anytime anywhere testing, providing the ability to take tests digitally, even from remote locations. This makes it very attractive especially to international students.

Regular and repeated testing produces the best learning results because progressive monitoring offers the possibility of making adjustments throughout the course. Parameterization is a key feature in Maple T.A. that provides each student with an individual set of problems, reducing the likelihood that answers will be copied. When testing takes place digitally, questions can be easily reused, feedback can be automated and the results can be analyzed more quickly.

TU Delft selected Maple T.A. as the centrally supported package for digital assessment. "Though Maple T.A. is specialized in mathematics, evaluating calculations and formulas, it also supports more common question types like multiple choice, multiple selection, fill-in-the-blanks and hot spot," said Ir. Meta Keijzer-de Ruijter, project manager, digital testing, TU Delft. "Extensive ways to randomize questions and build in test analysis were key features that appealed to us. In other similar software randomization options are limited, the use of (mathematical) formulas is restricted to question design, and an extensive test analysis module is lacking."

Testing as a diagnostic tool

At TU Delft a math entry test using Maple T.A. is obligatory to all first-year students to assess the required level of math. On a yearly basis 1500 to 1700 students take the test. Students that fail the test are offered a remedial course in which students receive explanations and complete exercises, under the supervision of student assistants.

The use of Maple T.A. facilitates this process without placing an additional burden on the teacher. When the practice tests and the associated feedback are placed in a shared item bank in Maple T.A., teachers are able to offer additional practice materials to students with little effort.



“By sharing the question bank amongst different lecturers, the creation of weekly assignments in Maple T.A. is quite simple and efficient; lecturers can monitor their students’ work and students tend to keep up more often,” said Ir. Roel Schipper – Lecturer, Faculty of Civil Engineering and Geosciences, TU Delft.

“It makes it considerably easier on the teachers to be able to use a variety of question types (numerical, multiple choice, multiple answer and fill-in-the-blank), thus creating a varied test. The possibility of entering extensive feedback in Maple T.A. is extremely useful. I definitely see potential providing international students with a better picture of our master’s degree program. They can take the test in their own countries and receive feedback on the gaps in their knowledge, as well as on the level of English that is expected of them. They come better prepared.”

Each semester, the English test is taken by approximately 200 students and 50 PhD candidates. This test consists of one hundred ‘fill-in-the-blank’ (semi-open) questions and two short essay questions, in which students are required to formulate their reasons for their program choices or research topics. The burden associated with marking these tests used to be enormous. It took four lecturers working full-time for two days in order to mark the tests and report the results to participants in a timely manner. Moreover, the number of participants was increasing. “The digitization of the placement test saves us considerable time,” said Ir. Keijzer. “The hundred fill-in-the-blank questions are now marked automatically, and we no longer have to decipher handwriting for the open questions. It is no longer necessary to divide the task of reviewing student motivation texts amongst the lecturers in advance.”

Testing as a monitoring tool

By offering regular homework assignments and analyzing the results, lecturers gain better insight into the progress of students and the topics that students perceive as difficult. Lecturers can use this insight to decide whether to repeat particular material or to offer it in another manner.

Calculus is a first-year course in all of the Bachelor’s degree programs at TU Delft. The required level varies by faculty, but the subjects overlap. In the calculus course, it is important for students to get a lot of practice. Preparing and reviewing practice tests comprises an important, yet time-consuming, part of the task of lecturers, especially given the increasing number of students. The overlap in curriculum provides opportunities for collaboration. The introduction of Maple T.A. ensured that this cooperation was actually realized.

“When Maple T.A. became available campus-wide, it soon became apparent that it would be very simple to collaborate



in order to create an item bank that could be called up within each course. This offered a fine opportunity to start collaborating efficiently as a faculty, in addition to exchanging assignments digitally and compiling and re-using tests,” continued Ir. Keijzer.

“The nice thing about Maple T.A. is that it is relatively simple to enter exercises. Feedback can be limited to the correct answer, a reference to the required reading or even the step-by-step solution method. This makes Maple T.A. particularly well-suited for offering practice materials to students.”

Testing as qualification

Since the assessment of the student’s ability is so heavily dependent upon qualifying tests, it is extremely important for the test to be completed under controlled conditions. In Maple T.A. it is very simple to generate multiple versions of the test or test questions without increasing the burden of review, as the test scores are revealed immediately. In addition, the Education and Examination Regulations (EER) specify that students should be able to view their results after the examination, with or without feedback. With digital tests like Maple T.A., this is easily done. The lecturer has the flexibility of deciding which information in the system is released to the student at what stage.

Digital testing is a current topic of attention not just at TU Delft University; it occupies a prominent position on the agendas of many institutions in Europe and elsewhere. These institutions are intensively involved in improving, expanding and advocating the positive results from digital testing and digital learning experiences.

Maple T.A. Transforms High School Teacher's Impression of the Use of Technology in Mathematics



University of Guelph

When high school teacher Kevin Conway was a student, he enrolled in a first year calculus class at the University of Guelph, Canada. Up to that point, his experience with math classes was similar to many other students: the instructor would stand in front of the class, write down problems on the chalkboard, and students would make notes and check their work. However, on his first day of first year calculus, Kevin and his classmates were in for a surprise that would transform their impression of using technology in math education.

During his first class, the calculus professor announced that Maple T.A., Maplesoft's advanced testing and assessment tool for any class involving mathematics, would be a heavily used tool in the course. Students would be able use it for efficient study and practice, and the professors would use Maple T.A. for automatic grading of assignments and tests.

Kevin was not convinced using such a tool was the best use of his time. "I was skeptical when I first heard we would be using an online testing and assessment tool," Kevin explained. "I didn't think there was any room in a math class for technology. I was unable to see how Maple T.A. would fit into the course. I certainly didn't trust a computer program to mark my tests, and I was so used to learning math on a chalkboard that anything else seemed less trustworthy." Despite Kevin's reluctance, though, he soon discovered first-hand the impact that Maple T.A. can have on students' success in mathematics. The tests were designed to have students study and learn the material presented in the class during the week. This allowed him to be more prepared for midterms and exams.

A few days before the first test, the professor informed the class that he was making use of a unique feature in Maple T.A. that allowed the students to take the test online as many

times as they wished. The professor explained that he had chosen to do this – having also the option in Maple T.A. to set the test to a one time use - so students can learn from their mistakes each time and hone their understanding of the concept. This would give the students a very good chance to earn a perfect grade! "As a student who aims to achieve the best possible grade, this aspect of Maple T.A. was very appealing to me," continued Kevin. "By being able to take the test again and again, I was able to learn the concept better, identify where I went wrong, and fix my mistakes. This feature quickly made Maple T.A. a popular asset with students."

Maple T.A. reinforces and solidifies students' understanding of new concepts learned in class without the added pressure and anxiety of performing poorly on in-class tests. Students can more effectively study the material at their own pace and in their own time. Kevin noted, "Student success begins with opportunities to learn and grow both in the classroom and outside the classroom. Students need to be able to take risks without the fear of a bad grade showing up on their paper. Maple T.A. makes this a real possibility by being an engaging assignment tool and assessment method."

“As a student, I found Maple T.A. to be a phenomenal learning tool.”

– Kevin Conway, University of Guelph graduate

Reflecting on his own risk-taking, Kevin notes, "I was able to explore mathematics in ways I never thought possible prior to using Maple T.A. As a student, I found Maple T.A. to be a phenomenal learning tool. It inspired in me a curiosity to dig deeper, explore other concepts, and experiment with the 'what-ifs' of math."

Kevin's love and enthusiasm for math grew as he advanced in his academic program of choice. When he graduated, he decided to become a teacher in the hope of getting his own students just as enthusiastic about mathematics. Currently a high school teacher, Kevin recommends using Maple T.A. to show students that mathematics is much easier than they think. "I believe Maple T.A. will teach students that math is much more than a chalk and blackboard type of subject. I believe students will begin to have their own 'ah-ha' moments and as a result, their impression of mathematics will be transformed!"

University of Canterbury Uses Maple T.A. to Deliver Innovative Math Courses Online

University of Canterbury

Being innovators paid off in a time of real need for the University of Canterbury, based in Christchurch, New Zealand. The University was one of the first institutions in New Zealand to adopt and utilize Maple T.A. to deliver their mathematics based course material and was quick to realize that they could use the software to avoid any disruption to their classes following a sizeable earthquake in Christchurch on February 22, 2011.

The 6.3 magnitude earthquake struck Christchurch on the second day of semester one. While there were no injuries on campus, the university was evacuated and time was needed to investigate and remediate damaged buildings.

Phillipa Williams, from the Department of Mathematics and Statistics, used Maple T.A. to create weekly online modules to support student learning. The previous year, Maple T.A. had been used primarily for summative assessment, measuring the progress of student learning. Since the success of the weekly online modules, the faculty has used Maple T.A. as a core formative assessment tool.

Students used home computers/laptops for online sessions and assignments, working through each of the online modules. Maple T.A. proved to be a perfect tool to help both students and teachers because its web-based interface promotes learning anytime, anywhere.

Maple T.A. provided several key advantages to the University of Canterbury in meeting their mathematics based course learning objectives:

- Increased opportunity for students to interact with course content, providing instant feedback for better understanding of the concepts
- Provided a structured means for students to use their independent study time effectively, helping them achieve better results
- Students with a weak grasp of basic math skills used online practice and assessment to improve their mastery
- Reduced tutor marking loads considerably

- Addressed cheating issues compared to hand-written assignments

Maple T.A. is supported by Maple, which is the world's most powerful mathematical computation engine. Maple commands can be used in both question generation and in marking code, resulting in more searching and sophisticated questions that assess higher level thinking.

"The depth of questions possible with Maple T.A. and the Maple engine is what I consider its biggest strength," said Williams. "Maple T.A. can randomize algorithmic variables, so that students can have multiple attempts at a quiz and see varying problems of the same type each time." Williams said that "students were quick to start doing these learning modules, and were very positive about having something to work on soon after the earthquake. We received a lot of favorable comments about the modules when speaking to students, and through emails."

“The depth of questions possible with Maple T.A. and the Maple engine is what I consider its biggest strength.”

— Phillipa Williams, University of Canterbury

To obtain more formal student feedback, the university conducted surveys in the last week of lectures. Overall, more than 80% of students from three large first-year courses thought that Maple T.A. was a valuable aid to their learning. The most interesting initial finding is a significant improvement in results for weaker students. The pass rate for these students went up in 2011, compared to the previous two years.

"With the help of Maple T.A., we delivered our full academic program in 2011 and were able to achieve student learning outcomes," said Williams. "We are definitely going to continue using Maple T.A. as a core formative assessment tool."



Chalmers University of Technology Adopts Maple T.A. Across Entire Campus

Chalmers University of Technology

Since 2008, The Department of Mathematical Sciences, a joint department between Chalmers University of Technology and the University of Gothenburg in Sweden, has been using Maple T.A. to deliver, administer and grade mathematics courses. What started as a tool to deploy online summer courses turned into a technology to teach and grade parts of several mathematics courses year round. The benefit of using Maple T.A. was so evident that the university recently adopted Maple T.A. for all 15,000 of its students and staff.

Maple T.A. is a testing and assessment system that supports complex, free-form entry of equations and intelligent evaluation of responses, making it ideal for science,

technology, engineering and mathematics (STEM) education. It offers an advanced authoring environment that lets professors create high quality, custom content easily, and it does the marking automatically, making it simple to analyse the results.

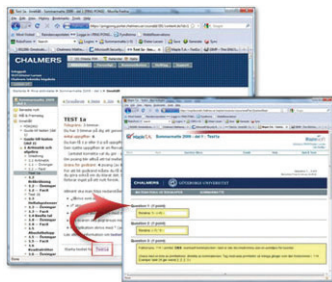
The original use of Maple T.A. at the Department of Mathematical Sciences was to deploy online summer courses designed to help new students get their math up to speed before commencing their studies at the two distinguished universities. That project has been a huge success, with around 1,600 participating students answering thousands of online questions each summer.

According to Tommy Gustafsson, Director of Studies at the department, that first course was the beginning of an



evolution in the way mathematics is taught at Chalmers. “We have integrated the Maple T.A. system into an online learning platform called Ping Pong,” he explains. “This allows students to access a variety of learning resources from text to videos; and to send questions to mentors, usually older, more capable students, when they get stuck. When they saw how well the approach worked with the summer course, a few teachers here started to develop materials to support some of the courses we teach as part of our degree programs, like calculus and linear algebra.”

The degree courses are more advanced than the original summer courses, with thousands of questions and some complex topics, but it is a testament to the ease of use of the Maple T.A. system that the teachers were able to create the materials they needed. “Today, many teachers across the department use the system,” explains Gustafsson. “They often create assignments for their students by picking up questions from other courses, and modifying them a bit. That shows just how easy the system is to use and its adoption is spreading through the department like ripples on a pond!”



The growing popularity of the system created challenges for the department’s IT function, however, which originally hosted the Maple system on its own servers. “It was getting hard for us to get all the support we needed to keep expanding the system and those problems were compounded last year when staff changes meant our IT function lost a lot of relevant expertise,” Gustafsson explains. “We were advised to host the system on Maplesoft’s servers in Canada.”

Earlier this year, Gustafsson and his colleagues agreed to make the change. “At first we were a bit nervous about doing it, because servers in Canada seemed like they were a long way away,” he recalls. “But I have to say that our initial fears proved unfounded. The user experience runs just as smoothly as it did when we hosted the system here and the change process when we upgrade to new versions of the software has been seamless.” The support team

has been responsive too, despite the great distances and time zone changes involved. “In fact, the time difference has proved quite beneficial,” says Gustafsson. “If we have an issue or a change request, we can send an email at the

“ We are also beginning to use Maple T.A. as a learning platform in its own right. For example, we associate instructional videos with questions so students can hear the teacher’s voice and watch what he does as he solves a problem on paper. ”

– **Tommy Gustafsson**, Chalmers University of Technology

Students react extremely positively to the Maple T.A. system too. “We often use the system for quizzes that students can take to receive points towards their final exam. They are extremely fond of those,” notes Gustafsson. “We are also beginning to use Maple T.A. as a learning platform in its own right. For example, we associate instructional videos with questions so students can hear the teacher’s voice and watch what he does as he solves a problem on paper.”

end of the day and it is normally done by the next morning. Some of our students think we work right through the night!”

The success of Maple T.A. in the Department of Mathematical Sciences has attracted the attention of other departments too and Chalmers has recently extended its access to the system by acquiring a site-wide licence for all of its 15,000 students and staff.

Maple T.A. Successfully Refreshes Math Skills at the Vienna University of Technology

■ Vienna University of Technology

After high school, many graduates take advantage of their new-found freedom to seek employment or travel before continuing their formal education. When they return to their studies, they often come to the realization that they have not retained enough knowledge from high school to thrive at university. Professors at the Vienna University of Technology (Vienna UT) noticed in particular that many of these students were not prepared to pick up their mathematics studies from where they left off in high school. In addition, students joining the university came from different backgrounds with different levels of knowledge.

At Vienna UT, university-level mathematics courses are essential for programs such as Engineering, Economics, Computer Science, Physics, and Urban and Regional Planning. Proficiency in high school mathematics is expected of all students in these programs. To help the students whose math skills were not at the required level expected of high school graduates, the research group of Prof. Breitenecker at Vienna UT developed a refresher course that would be offered in the weeks leading up to the start of the semester, with the goal of raising students' mathematical proficiency. This optional course would cover topics that were most essential to the programs participants were enrolled in. A diagnostic test at the



beginning of the course identified concepts that demanded closer attention and steered the direction of the course for each student.

Since the course was held over a short period of time, the resources were simply not available to design and grade exercises for a large number of participants, let alone return results in time to provide effective feedback. In order for the refresher course to be most effective, a web-based assessment system with automatic grading capable of handling mathematics was crucial. This is where Maple T.A. became an important tool for Vienna UT. "After a long period of testing different environments in commercial and open software we made the decision to choose Maple T.A. because of its powerful algebraic possibilities and the randomization feature," noted Andreas Körner, Lecturer at Vienna UT. "The grading function, especially the automatic and prompt feedback to students, was also important. The ability to create customized grading routines helped us to develop content that reinforced the instructional nature of the courses. We invested time and effort in creating examples and tests, and with that we now have a system of assessment that is efficient, one that offers students a flexible way of completing tests, and instructors a smooth administration of lectures."

“ Maple T.A. made it possible to bring students closer to a level of mathematics necessary to successfully pursue their area of study. ”

— **Felix Breitenacker**, Vienna University of Technology

Maple T.A. is a powerful online testing and assessment system designed especially for courses involving mathematics. It offers features such as standard math notation, sophisticated plotting, free-response math questions, and intelligent grading, allowing instructors to truly assess student understanding of math-based concepts. Because it is designed especially for courses involving mathematics, it is particularly suitable for use in science,

technology, engineering, and mathematics (STEM) courses. In addition, Maple T.A. is compatible with virtually any course management system, including Blackboard and Moodle, so it can be seamlessly incorporated into existing course infrastructure.

Following each session of the refresher course at Vienna UT, students could go to Maple T.A. to begin practicing what they learned immediately. Whenever students encountered problems they could not solve, they received hints and feedback in Maple T.A. that helped them work through the problem on their own. This feedback allowed students to refine their skills and ultimately master the concept without depending on a professor or teaching assistant. "Maple T.A. is an asset to staff and students especially during the refresher course," Stefanie Winkler, Assistant, Vienna UT noted. "A large amount of students can work independently without generating more administration work."

A comparison of the results from the diagnostic test held at the start of the refresher course and the final test showed vast improvements in students' grades. The majority of students failed the diagnostic test at the start of the course. However, by the end of the course, results showed a significant shift: most students scored 70% or higher. Over the last few years, students' test results have continued to reflect the same trend. "Since 2008 when we began the course, these test scores show a consistent increase in students' mathematical skills year after year. Using Maple T.A. in our refresher course has been very useful. Maple T.A. made it possible to bring students closer to a level of mathematics necessary to successfully pursue their area of study," Prof. Felix Breitenacker commented.

Since the refresher course was first offered to Electrical Engineering students in 2008, the program has been expanded to seven different fields of study. Maple T.A. has also been adopted into other courses at the Vienna UT, and students' exams are now beginning to be administered online using Maple T.A. in some engineering courses.

Questions developed by the Vienna UT team, covering math topics such as Integral Calculus, Linear Functions, Vector Analysis, Differential Calculus, and Trigonometry, have been added to the Maple T.A. Cloud, making them available to all users of Maple T.A.

About Maplesoft

Maplesoft, a subsidiary of Cybernet Systems Co., Ltd. in Japan, has over 20 years of experience developing products for technical education, offering a solution that applies to every aspect of academic life. Its product suite reflects the philosophy that given great tools, people can do great things.

Maplesoft's core technology is the world's most advanced symbolic computation engine, which is the foundation for all of its products, including Maple, the technical computing and documentation environment; MapleSim, the advanced system-level modeling system; and Maple T.A., a web-based system for creating and assessing online tests and assignments.

Maplesoft also introduced a fundamental shift in technical education through its Clickable Math™ and Clickable Engineering™ initiatives. The idea behind this shift is to create technology that will allow students and teachers to focus on the concepts, not the tool. These initiatives deliver powerful mathematics through visual, interactive point-and-click methods in Maple, while the intuitive physical modeling environment of MapleSim helps teachers to quickly demonstrate the connection between modeling concepts and the underlying mathematical theory.

Over 90% of advanced research institutions and universities worldwide, including MIT, Stanford, Oxford, the University of Waterloo, TU Wien, the University of Notre Dame, the NASA Jet Propulsion Laboratory, and the U.S. Department of Energy, have adopted Maplesoft solutions to enhance their education and research activities. In industry Maplesoft's customers include Ford, Toyota, Cleveland Golf, the Canadian Space Agency, Motorola, and DreamWorks, covering sectors such as automotive, aerospace, electronics, defense, consumer products, and entertainment.

About Cybernet Systems Co., Ltd.

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