



Technology Across the Curriculum

at George Mason University

Surrounded as it is by such northern Virginia neighbors as Dominion Semiconductor, Oracle, MCI WorldCom, and AOL, George Mason University has significant external motivation to produce graduates who can function effectively in a high-tech environment. Some corporate leaders and Virginia legislators fretted that we were graduating “too many history majors and not enough engineers.” However, the literature on workforce development and our own conversations with CEOs and human resources officers convinced us that producing more engineers would not necessarily be the right answer by itself for our region or our students.

We have an excellent and innovative School of Information Technology and Engineering that does, in fact, produce many well-trained technical specialists, including, among others, engineers.

However, our largest undergraduate program—10,000 students—is the College of Arts and Sciences. And many businesses want the skills that come with a liberal arts education, provided that these graduates can also handle technology well. So, we thought, why not graduate history majors who are fluent in technology? The governor and the legislature agreed with our proposal. And thus in 1998, by leveraging some additional state funding and some existing university resources, was born George Mason University’s Technology Across the Curriculum (TAC) program.

The TAC Program in Brief

The TAC program is an ongoing collaborative effort between the College of Arts and Sciences (CAS) and the Division of Instructional Improvement and Instructional Technologies (DoIIIT) to ensure

that liberal arts graduates achieve a high degree of fluency in information technology. The program starts from a core of 10 technology goals, developed in cooperation with faculty and business partners (see sidebar). The core goals provide a framework for the systematic integration of technology skills across degree programs through general education courses, courses in the major, and specific courses in one of several IT minors. Faculty and academic department proposals emphasize student learning rather than faculty use of technology and include assessment measures. In partnership with the IT unit, students and faculty receive training, mentoring, and appropriate facilities to support the integration of technology throughout the instructional program.

An additional part of the TAC program is the development of IT minors. The School of Information Technology

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and Engineering (IT&E) has developed minors in information technology (IT), computer science, and data analysis, and CAS is working with IT&E on the development of elective courses for the IT minor and on promoting it to liberal arts students. CAS has developed four other technology-focus minors, in electronic journalism, telecommunications, geographic information systems, and multimedia (with the Institute of the Arts).

Programmatic Concerns

In constructing this program, we had three main concerns:

- to ensure that the technology was well integrated with the academic content and focused on student learning;
- to set up a programmatic rather than an episodic approach to the integration of technology; and

would not work. The separate-course solution would also not engage a range of faculty in the process. Our program had to motivate faculty from a range of disciplines to rethink their courses so as to determine where technology could be used to achieve their learning goals better.

Our second concern arose from experiences at George Mason in which faculty members, with or without support, had been incorporating technology into their courses. These efforts involved individual faculty and individual courses typically developed in isolation from what any other faculty member might be doing. There was no plan for what technologies should be taught in what courses, no system for moving students from basic-level skills to more advanced ones, and little or no departmental-level discussion about what technologies

program, planning for their support needs was a major component of the development process.

Identifying Technology Goals

As we developed the program, one of the key steps that enabled us to address the three concerns just detailed was identifying the specific technology goals that became the building blocks of the program. First, we surveyed faculty about what technologies they were already using in their classes. Then CAS engaged its faculty in a dialogue about how the information technology revolution has changed the way scholarly research is done in the majors and has changed the requirements in the professions that their students enter.

After a series of presentations, discussions, surveys, and focus groups, faculty reached consensus on the basic and

Liberal arts graduates will be technology fluent, thanks to a creative partnership between a university IT division and the College of Arts and Sciences

- to provide adequate support for students and faculty to use technology as a problem-solving and product-creating tool for learning.

While the workforce needs dictate that our graduates have strong technology skills, the teaching of technology per se is not the mission of CAS. Because we are not a training school but an institution of higher education, the focus of any curricular development involving technology could not be on technology skills themselves, but on the use of technology as a tool for learning. The technology goals had to be subsumed by the content. Addressing this concern posed an interesting challenge for us. It meant that simple answers to the workforce shortage, like requiring students to take separate skills courses in specific technologies,

were most important for the department's majors. With TAC, we wanted to find a programmatic way to incorporate technology into our courses.

Finally, we were aware that support is often a make-or-break issue for the integration of technology. Faculty need to learn new technologies in order to integrate them effectively in their teaching. But beyond that, faculty—particularly faculty teaching in the arts and sciences—do not want to give up class time for direct instruction in the use of technology. Our surveys of faculty about the use of technology made it quite clear that they expected students to learn the basic technology applications outside of class so that they could build on that knowledge in class. Since we hoped to reach thousands of students a year with this

advanced technology skills needed in today's world by students in order to be successful in their course-based learning, their major fields of study, and in their first jobs after graduation. The specific goals include:

- Electronic collaboration
- Electronic document creation
- Electronic presentations
- Use of electronic tools for research and evaluation
- Use of spreadsheets to manage information
- Use of databases to manage information
- Use of electronic tools to analyze quantitative and qualitative data
- Use of geographic information systems for handling spatial data
- Familiarity with legal, ethical, and security issues

- Working knowledge of IT platforms

For each of these technology areas, faculty and information technology staff members defined basic and advanced skills. For example, in the use of spreadsheets, basic skills include organizing data in worksheets (formatting ranges, columns, rows; multiple worksheets), formulas, column totals, lock columns, absolute/relative cell addressing, link data, import/export data, simple graphing (pie chart, line graph, histogram, labels) and understanding the full range and appropriate applications of spreadsheets. Advanced level skills include macros, pivot tables, filters, statistical functions, logical functions, Visual Basic programming, and object linking and embedding (OLE) between applications (word processor, dbase, browser).

The dialogue and the dual emphasis on course-based learning and academic majors were crucial factors in elevating the program from one that was merely focused on job skills to one that was seen by faculty as congruent with and supportive of the academic mission of CAS.

At the same time, we were working with representatives of the corporate community to identify the technology skills needed by employers. Fortunately there was great overlap in the judgment of the two groups even though the vocabularies are very different. A byproduct of the dialogue with employers was a reaffirmation of the value of a liberal arts education in the workplace. Dr. Carl Kelly, Oracle general manager, was motivated to conduct a study of the college majors of the employees at Oracle-Reston whom management had identified as the highest performers. He reported that the highest performers at Oracle are liberal arts graduates with technology skills. Dr. Kelly now tells corporate leaders that George Mason's TAC program is the best model he's seen of ensuring an adequate supply of such graduates.

With this set of skills in place—spe-

cific enough to be helpful in showing businesses what our students know and generic enough to allow faculty plenty of room to integrate them in a variety of ways into a variety of courses—we could begin to build our integrated, programmatic, and well-supported TAC program.

Building the Program

In order to solicit faculty to begin the process of integrating technology into their courses, we developed a request for proposal asking for portable and scaleable proposals. Faculty could apply for support of \$500 to \$4,000, depending on the project. (In the first two years of the program, CAS has spent about \$450,000 to support these faculty proposals.) Technical and instructional design support was also available through professional staff or student assistants. (About \$250,000 per year is allocated for staff positions, infrastructure improvements, software licenses, and other technical support to the TAC program.)

Each proposal had to stipulate which technology skills and skill levels would be incorporated into the course and

what measures would be used to assess the students' level of achievement with these skills. The proposals had to focus on making the technology integral to the learning in the course, not an add-on set of technology exercises or technology used simply as a delivery mechanism. Art students, for example, study and discuss the effect of virtual museums. Psychology students create an annotated Web site containing resources about life-span development issues. Biology students (80 percent of whom had not used this tool before) use online spreadsheets to plot lab exercises. The TAC Web site (<http://cas.gmu.edu/tac>) contains additional syllabi and assignments from TAC courses that illustrate this approach.

In two years these technology changes have been introduced into more than 70 courses in 14 departments. After the first round, we began to develop a grid of courses and skills so that we could make sure the program developed across the entire liberal arts curriculum and not just in a few areas, and included all the skills not just one or

What Are the Two Most Important Courses for College Students to Take?

When asked this question, AOL's Steve Case answered:

"I think a broad-based liberal arts education provides important grounding, especially since we are entering a phase of unusual changes as we kick off what likely will become known as the Internet Century.

"A shift to a more connected society will have profound impacts on business, education and government, as new perspectives and linkages are brought to bear. So having a broad understanding of the past and a broad perspective on the future will be more important than ever and that's what a liberal arts education, which exposes you to a range of perspectives, can help provide.

"In more stable times, having in-depth knowledge about a specific topic is useful. But in more chaotic, transformative times, it's much better to know a little about a lot of things. Generalists will be more valuable than specialists, and that means there will be a resurgence of interest in a liberal arts education."

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Table 1:
Tracking Process for TAC

	Bio 403	Math Initiative	Geog 110	Psych 211	History 388	History 499	English 201	Honors 121
1. Collaboration								
<i>Basic</i>				Y		Y		Y
<i>Advanced</i>								
2. Electronic Documents								
<i>Basic</i>						Y		Y
<i>Advanced</i>								
3. Presentations								
<i>Basic</i>						Y		
<i>Advanced</i>								
4. Research and Evaluation								
<i>Basic</i>				Y	Y	Y	Y	Y
<i>Advanced</i>					Y		Y	
5. Spreadsheets								
<i>Basic</i>								
<i>Advanced</i>								
6. Databases								
<i>Basic</i>								
<i>Advanced</i>								
7. Quantitative Analysis								
<i>Basic</i>	Y	Y	Y					
<i>Advanced</i>			Y					
8. GIS								
<i>Basic</i>								
<i>Advanced</i>								
9. Ethical and Legal Issues								
10. IT Platforms								

two. As the TAC program develops, our goal is to make sure the grid is broadly filled in so that students in every CAS degree will be fluent in a wide variety of technology skills.

The partial grid in Table 1 illustrates this tracking process for the first set of courses. The grid helps us guide proposals into areas where fewer courses have introduced certain types of skills. For example, we noticed in the first year that many courses introduced Web research skills, but few introduced ethical and legal issues

associated with technology. So, in the second year, we encouraged the development of proposals that addressed these areas that had received less attention. We make the grid available to faculty as they are working on proposals so that they can see what skill areas particularly need more attention in their department.

We started the process with general education courses in order to enhance the impact of the new technology requirements. As a rule, we expect basic skills to be introduced in general education

courses and advanced skills to be introduced and developed in courses within each major and/or in the IT minor courses. A third phase of the program, still under development, is IT internships that will provide practical applications of IT skills in the workplace context.

This broad-based look across various curricula moves the TAC program beyond the episodic approach that results from individual faculty initiatives. The proposals encourage collaborative efforts among faculty in a department so that skills introduced in one course or at one level are reused and reinforced in other courses and at other levels in a variety of discipline-related tasks in multiple contexts. Faculty teaching upper-division courses are more likely to introduce advanced technology skills if they can feel comfortable that their students have already been introduced to these skills in lower-level courses. The department of history and art history provides a good example of this model with broad-based departmental implementation of technology skills across a number of courses. (Its projects are featured at <http://chnm.gmu.edu/tac>.) The physics department has likewise proposed an ambitious five-year plan to introduce technology skills into virtually every course in the department.

Program Support

By happy coincidence, the development of the TAC program coincided with the development of a new IT support unit at the university, the Division of Instructional Improvement and Instructional Technologies (DoIIT). DoIIT's mission is to support excellence in learning and teaching by providing information, training, mentoring, and facilities for faculty, students, and instructional support staff. DoIIT brought together some existing units that had previously had separate reporting lines and created some new structures so that students and faculty would have improved access

to the support resources they needed. The DoIIT Web site (<http://www.doiit.gmu.edu/about.htm>) has more information about its mission and structure. DoIIT's position within the IT unit ensures that instructional considerations are taken into account in all technology planning activities.

Part of the improved support for the integration of technology included wiring every classroom for network access and putting in zoned lighting in every general purpose classroom to make it easier to do electronic presentations without forcing students to sit in the dark.

DoIIT's Instructional Resource Center (IRC) provides facilities where faculty can work on the development of instructional resources. It is open 45 hours a week, staffed with both professionals in instructional design and student assistants who provide support for using the technology. See the IRC Web site for additional detail about IRC services and facilities (<http://www.irc.gmu.edu>).

To make it easier for faculty to develop online resources, DoIIT introduced WebCT as a course management tool. Using this tool, faculty are able to set up a course Web site that includes online quizzes, bulletin boards, asynchronous discussion, and collaborative presentation sites. Staff from DoIIT's Instructional Resource Center provide regular workshops on WebCT as well as mentoring and open lab sessions for faculty working on developing new materials. The staff have also developed online resources to help faculty and students, available at <http://www.irc.gmu.edu/WebCT/default.asp>.

To provide additional assistance to faculty and departments engaged in TAC projects, DoIIT has developed a new program to train graduate and undergraduate students as technology assistants. These students are assigned to work on specific TAC-related projects. The Technology Assistants Program (TAP) started

in the spring of 2000 with seven students from New Century College and will be expanded for the next academic year as departments recruit students to participate. Not only have faculty benefited from having the students' assistance, but the students themselves find the experience rewarding and instructive.

A distinctive feature of the IT support for TAC is its focus on supporting students as they learn technology skills. DoIIT has a separate unit, the Student Technology Assistance and Resource Center (STAR), that provides training, mentoring, and facilities to support student work with technology. In the last year STAR had more than 10,000 student visits for assistance with designing Web pages, learning spreadsheets, making electronic presentations, and other skills in the TAC goals. Although STAR has several professional staff members who coordinate its various programs, the heart of the center is its student mentors who work with other students to help them learn and apply new technology skills. In addition to mentoring and training students, STAR has also worked with University Life, the Provost's Office, student government, and our local business partners to sponsor an annual celebration that showcases student TAC projects for the entire community. (See <http://media.gmu.edu/i2000/index.html> for Innovations 2000.) Because DoIIT has worked closely with the TAC program from its beginnings, the IT support unit has been able to anticipate and plan for student needs in developing technology skills identified in TAC.

Assessment

As part of its assessment mechanism for the TAC program, George Mason University has partnered with the Virginia Foundation of Independent Colleges to pilot Tek.Xam, a computer-based test that measures information literacy, problem-solving, and technology skills. In the spring of 2000, George Mason was among

the first schools to begin making this test available to students. The TAC program plans to use the test as part of its benchmarking of students' success in acquiring technology skills. More information about Tek.Xam is available at <http://www.tekxam.com>. DoIIT is actively engaged in learning about other commercially available assessment tools that can be added to the resources available at the university.

Another assessment mechanism developed by DoIIT is a sophisticated interactive Web site for registering and tracking participation in IT training. It also provides online assessment of all IT training and facilitates collection of evaluative data to improve the program. (See <http://ittraining.irc.gmu.edu>.)

Our focus in the next year is to help faculty work on assessing how student learning is being affected by the changes they are introducing into their courses and programs. More than 40 CAS faculty members have attended workshops in assessment and designed assessment plans for their courses. We look forward to seeing their results and using them to help us set future directions for the development of TAC.

Summary of Success Factors

Efforts to incorporate technology in instruction at George Mason did not begin with the TAC program. In the early '80s, the university developed the Plan for Alternative General Education, a program focused on integrating the arts, sciences, and technology to give students a more meaningful general education experience. As it became increasingly apparent that information technology would play a significant role in higher education, the university launched the Instructional Development Office to foster and support faculty who were exploring diverse ways to incorporate technology into their teaching. These experiments, over 200 in all, involving faculty from a wide variety of

disciplines, made it clear that learning, not technology, must be the driver if technology was to play a successful role in the classroom.

George Mason launched New Century College (NCC) in 1994, a four-year integrative studies program, with a strong commitment to interdisciplinarity, collaboration, and self-reflection. The college was an early leader in using technology to achieve its learning goals and includes technology literacy as one of its core components (see <http://www.ncc.gmu.edu> for more details). NCC is now part of the College of Arts and Sciences, where its innovative curriculum can influence pedagogy throughout CAS.

George Mason's commitment to integrating technology and learning is not confined to the classroom. In 1995 it opened the George W. Johnson Center, a totally new concept in the development of student life. The goal was to provide students with a living and learning center that does not separate the two activities. The building combines a library, technology labs, an art gallery, a cinema, four restaurants/cafeterias, a bookstore, and technology assistance centers all in one building. Constructed around a central mall, the building is seamless, with open stacks in the library and students free to take books to eating areas and food to the library. The building is a metaphor for George Mason's commitment to new ways to enhance the learning experience and has become a magnet for universities from across the globe, anxious to learn about this innovative concept.

While we have focused on technology in instruction before, we can identify five elements that distinguish the TAC program from our previous efforts: ongoing support, support focused on course development, use of technology for learning, coordination of faculty efforts, and a clearer connection between faculty initiatives and the university support structure.

ONGOING VERSUS SPORADIC SUPPORT

Prior to the TAC program there was a modest amount of support for technology and teaching/learning awarded through various programs. Funding was for one-time efforts and was unpredictable, depending on availability of money each budget cycle. There was no systematic follow-up and no effort to collect information on what technologies faculty were using or what students were learning as a result of this support.

In the new environment there are more substantial funds to support the TAC program, both for new proposals and for continuing efforts. More importantly, these funds have become part of the base budget, ensuring that the university can continue this program for the foreseeable future and bringing increasing numbers of faculty into the program. Faculty have already come to rely on this as they plan for course development for the coming years. As part of this ongoing support, we have established an accountability structure to enable us to track what is being done.

FACULTY DEVELOPMENT VERSUS COURSE DEVELOPMENT

In the old environment funds were provided for development for individual faculty who worked on their own research or teaching projects. This faculty development, as valuable as it is, may or may not have resulted in any concrete changes to courses. There was no assurance that the support would result in tangible changes to the curriculum, changes in what students would actually experience in the classroom.

In the new environment support is awarded to faculty proposals that are focused on course and program development, ideally on specific assignments within the courses. The TAC program works closely with faculty on the development of technology-enhanced assign-

ments and provides assistance in instructional design as well as for the development of materials to support the assignments. Though we provide assistance to faculty to learn the technologies that they need, we stress that the focus has to be on the course.

TEACHING VERSUS LEARNING

Similarly, instructional projects in the old environment were by and large focused on the use of technology to deliver course material. A faculty member might develop electronic presentations, for instance, to enhance his or her teaching or a Web site for posting class notes. No consideration was necessarily given to how these technologies enhanced student learning.

With the implementation of the TAC program, the focus has shifted to active student learning. Rather than support a faculty member's preparation of a Web site with annotated resources, we now support the interactive development of such a site by the students in the course so that the students learn the skills of research, evaluation, organization, and communication necessary to create such an online resource. Instead of just providing a database of information for students to work with, TAC faculty build in the opportunities for students to design and construct their own databases and work with information they have generated and researched through the course. Instead of dazzling students with fabulous multimedia presentations, the TAC program encourages faculty to let themselves be dazzled by their students' creative work in finding new ways to communicate information with multimedia technologies. Such participative activities have benefits far beyond the use of technology alone.

INDIVIDUAL VERSUS COORDINATED INITIATIVES

In the old environment individual faculty members—usually those already fairly adept with technology on their own—

incorporated technology into their individual courses, with varying degrees of success. Most often, their work had little or no impact on other faculty members or other courses. There was no systematic plan for what technologies should be taught in which courses, for ensuring that students learned a range of technology skills across their programs of study. There was also no effort to identify and promote technologies that might be important for learning but weren't being taught in the existing programs. In short, though George Mason was an early leader in providing technology support for faculty, there was no consideration of how faculty efforts, supported or not, might fit with departmental or school initiatives.

In the new environment projects are proposed and supported in the context of departmental and school goals for the academic programs. As a result, support for such initiatives results in much broader implementation of change. The focus is not on just one faculty member's class but on a whole course or a sequence of courses within a department. Instructional resources are developed with the intention of using them within a number of classes or courses in a department. There is greater collaboration among faculty in a department to reach agreement about instructional and pedagogical goals and methods. For example, one current project involves designing a sequence of technology-enhanced lab exercises for use across a whole series of biology lab courses. Thus faculty in the biology department can be assured that all the students in the lab courses have experience in working with a particular set of technology tools and can design assignments in the next set of courses based on that knowledge.

We helped to create this more coordinated environment by consulting with department chairs from the very inception of the program and by requiring sign-off by department chairs for all pro-

posals. This ensured that even individual proposals were related to departmental technology goals. In evaluating faculty proposals, we also used scoring criteria that rated collaborative and group proposals more highly than one-faculty-member-one-course proposals. Starting this year, we have actually created a separate, more generous, funding category for departmentwide initiatives to encourage even more of these broader projects. Similarly, in conjunction with the university's revision of its general education requirements, we will be working this year with faculty in the general education courses to integrate specific technology-related learning objectives.

RELATIONSHIP BETWEEN THE ACADEMIC UNITS AND IT

Prior to TAC, there was a wide gap between what the faculty wanted to do vis a vis technology in their courses and the university support structure. There was not much interaction between the academic units and the information technology units of the university, even in projects directly affecting the integration of technology into the academic curriculum. So academic programs and technology programs were often planned in isolation from each other, with unhappy results and frustration on both sides since neither group had a good sense of the expectations and goals of the other. An early survey of faculty identified the unreliability of support as a major reason why they had not required their students to do more work in technology. For example, faculty reported wanting their students to be able to use spreadsheets in their courses but could not take time from the course material to teach this basic skill and could not count on students being able to get it elsewhere. Nor could they always count on finding the appropriate software available in the university's computer labs or having equipment available in their classrooms to

demonstrate and use technology tools in their classes.

One of the happy results of the TAC program has been greatly enhanced collaboration between the university's technology professionals and its academic professionals. The leaders of CAS have been able to express concerns about facilities and support issues directly to the leaders of the IT unit, and the two units have jointly worked on solutions to the issues raised. Training programs and support groups have been designed specifically for the needs of the TAC program, for example, and budget requests for technology have given priority to TAC needs.

Conclusion

At this point, heading into the third year of our program, we're pleased with how it is going. In the first two years we have involved more than 70 faculty and 5,600 students in TAC courses. Now we're setting our sights on achieving our goals for the coming year: more faculty (100) and students (7,500) involved, a review/revision of the technology skills list, an expansion of our student technology assistant program, improvements in our database and record-keeping system, and the development of internships and work experiences to enhance student learning.

While a surface analysis might suggest conflict between the liberal arts and technology, we've found them to be excellent partners for each other. The time-tested values of the liberal arts seem to adapt very well to the demands of the information age, and the tools of technology provide exciting ways to apply the values of the liberal arts in the workplace. *e*

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