THE ICTCM: TEACHING PORTAL TO THE 21ST CENTURY

by

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The ICTCM is one large, supersized learning community. It is a meeting place where people from all types of campuses come to show what they've been doing in classroom technology and to learn what others are doing. It is not one of those meetings where a few superstars come to tell us what to do and how to do it. It is a close to an egalitarian society as we've experienced. The conference is friendly, is accepting of others' ideas, and is helpful to those just there to see what is happening. Why is this? Possibly, for the many years of this conference, at least the first twenty, where attendees were mostly alone at their institutions, each feeling a commitment to do more in the classroom, each with the belief that technology could help, each needing the support of their colleagues, and each wanting to perfect what they are doing. Indeed, it was with this in mind that Bert Waits and Frank Demana originally created this wonderful community more than a generation ago.

People coming to this meeting are open minded, as must be the case in the new but large-scale world attempting to change the ancient world of teaching. As the great American philosopher Eric Hoffer, in his *Reflections on the Human Condition* (1973) tells us

> *"In a time of drastic change it is the learners who inherit the future. The leaned usually find themselves equipped to live in a world that no longer exists."*

Hoffer further tells us that "*The central task of education is to implant a will and a facility for learning; it should produce not learned but learning people*." That is why we have come and keep coming to these annual meetings, now for 25 years. We know the math, but are learning students (of technology) who hope to produce learning students. In fact, "hope" may not be completely accurate. The words "hope," "believe," and "know" all come to mind. The ICTCM is an amalgam of faculty hoping and believing and particularly knowing we can improve the learning of our students using technology.

In this brief note we consider in turn several topics, including What the ICTCM meeting means to its followers, relatively new but well established technologies, new technologies, and new

genres of technology. "New" is a relative term, which here we intend to mean five years and less.

I. The ICTCM – who, what and why. The ICTCM has been the pivotal technology conference for a quarter of a century. Worldwide attendees have come to explore all aspects of teaching with technology, and to learn new technologies. The influence of these folks and the multiples of people they have connected with has brought us to where technology is today, as least in teaching application. But, just what does it mean to typical attendees? Almost for each there is a special reason. However, foremost among the reasons is that the ICTCM provides a stage, for example, to find out what's new and what's interesting. More importantly, they come to find out what works and how? And how much work is required to make it work? And can they modify as needed to their own situation? Of course, the novice at technology, and there are now very few, can learn much, but it is the active practitioner that learns the most. They have a knowledge base upon which to render judgment, to assess prospects, and to possibly look deeper. Namely, with some tech experience, one can determine which new methods and devices have promise and which may not have promise. (It is as important to know what doesn't go anywhere as the opposite.)

There is a definite social aspect of meeting old friends, comparing notes, and meeting new ones. Plunging on a little more we genuinely wish to find out what colleagues think is important, are coming attractions, and to charting the effort of changing technological course.

Case study. Recall, in the early nineties, there was no real way to put math online. HTML did not have the power. There remained only PDF, a dominant document format, both then and now. But download times over a modem (even at 1200 BAUD) was slow and PDF files were large. This prevented large scale deployment of math text for course use. LaTeX files, on the other hand, were much smaller but who had a LaTeX compiler? Not many knew this arcane type-setting language and moreover even fewer wanted to learn its intricate technical details. Along came Scientific Notebook. It had a WYSIWYG palette-based math editor with LaTeX under the hood. It was genuinely easy to learn, had a CAS engine for symbolic computations, and the small files could be uploaded and displayed quickly even if the interface was a modem. But the end user needed Scientific Notebook at the download end. This was for many a costly requisite, even at just $79 way back then. Now we have MATHML, which does display math, is free, and creates relatively short files. This is a venue in much use today, though only Firefox supports it. However, there is a server side JavaScript insertion called MathJax that renders LaTeX math beautifully in almost all of the browsers. Nonetheless, with normal Internet speeds, the PDF format is clearly competitive and now widely used. Yet, at that early time, people needed to make considered decisions, as much time was needed. More currently, many math and stat faculty are using MathType to generate mathematical documents.

Most of us like talking with the vendors. They are the true optimists of the meeting - especially about their stuff, and generally know much about it, have all kinds of experience, and form the commercial fountainhead for attendees wanting to learn about products. We all know the sizable difference between the product, something you buy, and the methods of application – remanded to the faculty user, i.e. you.

The ICTCM is the place to ask really detailed questions of the experts. All are happy to help out; all seem to want to show you what they've done and even recruit you to use their work. Sharing is openly welcomed here. One can also identify the true developers, i.e. those that have taken the time to develop new teaching method using technologies. Finally, regular attendees can witness firsthand the evolution of the various ermerging technologies or new technologies in the service of teaching. (e.g. Excel, Maple, Matlab, CBL, Clickers, Wii, Prezi, Macsyma, Livescribe, and more.)

II. What technologies are hot? Overall, we live simultaneously in a teaching world of the traditional classroom, technology in the class, blended learning, and fully online learning. In the technology-in-the-classroom environs, we see single technology applications (e.g. the calculator) and bundled technology applications (multiple technologies used in concert). Let's look at some of the newer players on the stage. Not necessarily, only five years old, these technologies you would not see in any classroom in the mid 90's.

Assessment is one of the main thrusts of modern technologies we see again and again. The publishers, notably Pearson on the commercial side, has developed a serious assessment tool, MyMathLab, over at least a dozen years. It is now widely used, and apparently effective. Assessment technology answers the long-standing questions demanding answers owing to large section sizes: How to give, grade, and manage all that homework. Yet, other tools compete and complete this genre of technology. From England, there is STACK, a mathematics system for generating algorithmic problems. Evolving to a massively powerful tool, it has been highly effective in mostly European applications. WebAssign is a general full online course tool which allows also the creation of algorithmic programs complete with grade book functionality and other nifty features. It serves any faculty member, having already coded problems for many textbooks, but allowing the user to complete independently his/her own course with full features. WebWorks, an NSF funded project, is also a powerful assessment and gradebook engine. With thousands of coded problems available and free, it is the assessment option of choice for many colleges.

A by-product of these engines is the capability of measurements of teaching and learning effectiveness. It is, you may say, a stealth technology that works behind the scenes gathering data on how students interact with the assessment and other tools supported. This, we believe, will be hot for years to come. Much educational research will be carried out in these directions, probably for decades to come. For the researcher, this is a fertile area yet untouched.

The latest attempt to get students to learn better is through the so-called "Flipped Classroom." Here the principle technology involves learning videos the student is supposed to view before the class, with the class time devoted to the more productive aspects of problem solving, particularly for math classes. Of course, flipping the class venues may be combined with an online homework system, and other technology learning tools. It is a simple idea that is currently hot and shows promise. So far, mostly only those really committed to this and particularly skilled at teaching problem solving are committed. The longevity remains to be seen. I do recall, even when I was a student, being instructed to read the material before coming to class. I didn't; most others didn't either.

The last "hot" technology to be mentioned here are the widely used social media technologies. Examples include LinkedIn, Facebook, Twitter, Google, Digg, del.icio.us, Technorati, Slashdot, Newsvine, Reddit, Fark, and Yahoo! Just the number of them that have emerged in only a couple of years indicates that people do like them, do enjoy social discourse, and even become devotees. While these are interesting and students use such media in absolutely huge numbers, there is no clear path to how it can be used to enhance learning, beyond simply creating a facebook page for your students, and letting them communicate.

Any discussion of hot technology must include the genre of visualization software. There are two principle types, video capture and animations. Video capture technologies, notably Camtasia, form the bedrock of the recent technology reform movement for general education – as opposed to assessment. With it an instructor can make a lecture video lecture, often on PowerPoint, of what is planned for the day, post it online, for students to view at their leisure. It is a significant tool for the flipped classroom, as well. In fact, entire courses can be delivered using these instructional videos. And many courses are. ICTCM regularly offers special workshops on Camtasia, and has done so for several years. Remarkably, industry used video capture technologies for training some years before the academy caught on. Note also the total popularity of videos of the Khan Academy.

Yet, there is more on visual technology, including interactive applets, wherein the student interacts with the tool, inputting some value(s) or functions, and seeks some desired outcome. Tools for generating these applets include Java and Javascript, Maplets, Geogebra, and HTML5. Flash, now deprecated by the IPad's lack of support, was once the hope for the future but, for no reason of its own, is gone from the scene. Indeed, ICTCM offered many talks and workshops on the use of Flash. The downside of using these technologies is that to create them, there is a steep learning curve involving programming of a type. Static visuals, often just graphs, have helped faculty and students teach and learn all math that can be conveyed by visual means. Using Maple, Mathematica, Excel, Geogebra, Winplot, and many others, the faculty instructor is freed from his poor artistic ability and the student sees a clear representation of what is intended. It is expected statics graphics and animated graphics will be hot for many years to come.

In competition with the big Computer Algebra Systems (CAS) is Sage. Sage is free, open-source math software that supports research and teaching in mathematics, and the mathematical sciences. The overall goal of Sage is to create a viable, free, open-source alternative to Maple, Mathematica, Magma, and MATLAB. While not yet up to the level of Maple and Mathematica, it shows promise, and has many advocates in the teaching community.

Learning analytics, predictive analytics, together with data mining, promise to be members of the next generation of hot technologies. Learning analytics is about looking under the hood of how a student learns often by survey, often through stealth methods. Data mining is an emerging field (since 1985) most of us know little about. The overall forte of data mining is to discover patterns on usually large data sets. It can be used to anticipate needs, look for fraud, to study genomics, to analyze the "planet's" worth of social media data (e.g. FaceBook), and for national security needs. Among the many techniques used are innovative graphics, advanced statistical methods such as tree models. It already has applications in banking industry, the NSA, and with computer manufacturers. Adapting the old expression, "Data mining is looking for needles in a haystack."

There are a few notes of caution about data mining. First, there is a perception by many that all we need is big data. Patterns discovered will reveal new truths. Not true. Data mining does not solve problems, it just gives clues. Thinking is still a part of the process. What we may witness is that dumb decisions can be based on errant analysis of big data. There is a strong need by people faced by incredibly complex situations to simplify them. Could it be that data mining software will provide wanted simplifications? Without models, and the "common sense" factors, data mining simplifications could mean big mistakes.

Yet, the NSF is sponsoring multiple conferences and funding many proposals about mining massive data banks. The NSF thinks it important. Learning analytics promises to penetrate the fog of how students learn with technology all the while learning more about motivation, persistence, and self-efficacy. Learning analytics may be the only untouched and fertile ground yet for educational researchers to pursue. By carefully watching how students learn from fully online courses, we actually may be able to answer the questions, "How do students learn with technology?" "Can we compare online course usage with course success?" Data mining will provide the techniques for analyzing the learning data. Learning analytics can and likely will provide the path to heretofore under discovered facts, facts that never before could be observed. Think of it as something like an educational microscope. Look for learning analytics in the next few years at ICTCM meetings.

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become devotees. While these are interesting and students use such media in absolutely huge numbers, there is no clear path to how it can be used to enhance learning, beyond simply creating a facebook page for your students, and letting them communicate.

> *As we see, hot today does not imply hot tomorrow, and we have seen this again-and-again. One merely needs to peruse the ICTCM proceeding over the past two decades to see how many great ideas have simply vanished.*

Read more at http://thejournal.com/Articles/2013/03/07/Controlling-Social-Media-Current-Policy-Trends-in-K12-Edcuation.aspx?=K12EL&Page=3#ElheO8bXW2K090Io.99

III. New and old technology. What is here to stay?

From the comments above, it is clear that technology for teaching and learning can be applied in four distinct ways: to prepare, to present, to learn, and to assess. Maybe we should include "to entertain" with the social media component, YouTube, and the like.

We've already indicated that automatic course-based homework systems, computer algebra systems, and video capture are here for the long term.

The graphing calculator, which formed the originating technology, for ICTCM remains strong, particularly in the schools, notably grades nine and up. It is also strongly present in basic or entry level collegiate courses. Yet, it appears relatively little in higher level mathematics courses. While high school teachers and some college teachers believe they are a true teaching tool, the fact they haven't persisted into more advanced courses is of some concern. Newer models, such as the TI-92, are very powerful handheld devises, fully programmable and could make the jump to junior and senior level STEM courses. On the other hand, with all the Apps available for smart phones, it seems likely that there will be graphing calculator Apps on the scene soon. Indeed, there are already are such Apps, though a little primitive. Of the technologies studies at the ICTCM, the graphing calculator is clearly the oldest. In the literature, it receives much praise, often to the effect that it is successful if used wisely. Yet many use it as an adding machine.

The tablet is an interesting hardware that students can bring to class, that instructors can use to lecture. Including brands from the major manufacturers, these tables are fully Internet enabled. The tablet itself (iPad and Android) is just a highly mobile laptop, but with hundreds of thousands of Apps, they are making inroads to the classroom. There is a "Clicker App" possibly sounding the rapid decline of clicker devices. As well, there are graphing calculator Apps, many of which are free. Early this year TI (Texas Instruments) released an iPad App to mimic the functionality of its TI-Nspire. With the cloud application for instructor file sharing with students, it promises to be a player. The power and scope of Apps having dedicated purpose will prove the tablet is a serious technology of the next decade.

Other new and very important technology tools include the wealth of conferencing software. For example, there is Centra, and Go-To-Meeting, both of which allow an instructor to communicate with all their students in a live format. Centra even has Whiteboard technology on board. The ubiquitous free version is Skype, that I believe almost everyone uses. As long as there is a need for live, if not actually face-to-face, communication, these tools will be with us. However, it is believed that more is to be learned on how to use them as a far more effective live forum, perhaps more concomitant with actual face-to-face. It seems to be a powerful technology that has reach full power right away. We may say "*Quo Vadis*?"

A new and free technology I believe it has not yet been discussed at ICTCM is EasyChair (http://easychair.org/). With this software, one has a complete conference management system allowing for paper submissions, with reviewing, with an organizational hierarchy all built right in. It began as a set of scripts written by a professor in Computer Science to actually hold a conference. Currently, it has more than 60,000 users. Like course management software, conference management software is here to stay. But how can we to use it for teaching? There is an interesting problem.

While many course management systems contain surveying capacity, not all do. I'm sure we have all received "take this survey" notice from SurveyMonkey or any of the other survey engines abounding. To say we are surveying ourselves to oblivion may be too strong, but we are surveying each other and our classes like never before. At a recent meeting in DC, I was surveyed five times during the course of the meeting, mostly to ask me "how's it going." As well, there were several pre-conference surveys.

Sage is free, open-source math software that supports research and teaching in algebra, geometry, number theory, cryptography, numerical computation, and related areas. Both the Sage development model and the technology in Sage itself are distinguished by an extremely strong emphasis on openness, community, cooperation, and collaboration: we are building the car, not reinventing the wheel. The overall goal of Sage is to create a viable, free, open-source alternative to Maple, Mathematica, Magma, and MATLAB.

In general, there are single technology advocates and bundled technology advocates. The new "big boys" on the block among these bundled forms. Online technology is moving toward **total learning environment software** – on a massive scale. As already discussed, some of these are comprehensive packages that include on the front end, those for students, text, including videos, testing, grade book, demos, announcement, applets, and more. On the back end, for faculty, there is test creation, learning analytics, bulletin boards, grade book creation. In this section, we assume all this is available, that decisions have been made about videos and those executed. Likewise, all applets have been creased and all and everything else discussed above and important are available. Then, what do we do next.

A. Enter the MOOC (Massive Open Online Courses). You want to teach only 50,000 students in your calculus class this term. How do you manage it? How do you get the students? How much work do you need to do? How do students get help? How do you assess their progress? How do they get college credit? What can go wrong? How can you assure good quality education for your students? (How much do you get paid? Generating 150,000 SCR means someone is gaining here.) Do MOOC's mean that cheap quality education has arrived? Are there past formats that promised quality instruction to the masses for little cost? At the time of this writing the California Legislature was voting on a bill to identify the most 50-60 bottlenecked courses to approve as MOOC's. The contract would be through Udacity (https://www.udacity.com/). All state institutions would be required to accept these courses for transfer credit. An instructor from a local area Boston community college informs us that his campus will partner with EdX to teach a course. The first time the college will select the instructor, afterwards EdX reserves selection authority. His take was this action union busting. Unions may have little to do with it; such a move may amount to a drastic reduction of faculty everywhere.

While the limitations of the ICTCM proceedings restrict the length of this paper, there is really no space to answer these questions, even in brief. But be assured, next year's ICTCM will consider the details of all.

B. Fully automatic course systems. These include Coursera (https://www.coursera.org/), EdX, and WEPS (World Educational PortalS). You can compare them somewhat with BlackBoard and other campus-based system. These systems are larger in scale and scope and often offer their materials without cost. They have subscribers from major universities and are often funded by these institutions at a considerable rate. While Coursera began with but a handful of campuses, all major university, it is now in partnership with more than sixty worldwide. It advertises itself as a social entrepreneurship company with partners of top university that seeks to educate students into the millions. Their hope is that all will have a first-class education. EdX (https://www.edx.org/) is similarly a partnership of about ten universities originated by MIT and Harvard. EdX has entirely similar goals. WEPS (https://myweps.com/moodle/) is another such venture in online education. They advertize their services to students as free access to educational materials is free. Anybody can study at WEPS Courses. Instructors are free to use and to edit the WEPS educational materials further.

These are the powerful engines that will support the MOOC's of the future. Unmentioned is how students will gain credit? How they will be assessed? How can faculty contribute or not? The questions are similar as for the MOOC's. More and more of these systems will emerge. Many college systems will visualize a serious reduction of paid faculty. But let us dig deeper to look at less transparent issues, and how they may affect you. It is enough to say now it is seriously in your interest to know as much as possible about this new genre of education. Again, this is a topic for future ICTCM meetings.

V. Conclusions. Some technologies come in with a roar, and then fade. Some technologies start slow and stay. Every possible intermediate combination enjoys examples in the technology about teaching genre. Can we predict which will be the winners or losers? Clearly, the documentation is significant, and some technologies have simply failed because of terrible documentation. The would-be winners need both corporate and faculty support over the long term. Even this has proved not to be a guarantee. Another factor, just plain luck, is likely as important as the others for success. To predict winners is a difficult problem.