The New World of Work:

A Dialogue About Education in the
Global Knowledge Economy

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Before joining Microsoft in October 2003, Rasmus was an analyst with Forrester Research Inc. His achievements included inventing conceptual frameworks for enabling the future of work, including adaptive workspaces and intelligent content services.

Before working for Forrester, Rasmus was manager of workgroup computing at Hughes Space and Communications Co., where he handled network operations, e-mail, collaboration and an 8,000-client Windows NT® rollout. As a technology writer, Rasmus has worked on staff at PC AI Magazine and Manufacturing Systems Magazine, and has been a columnist for several other publications. He has authored nearly 200 trade journal articles and three books, including "Rethinking Smart Objects," published in 1999.

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EXECUTIVE SUMMARY

In the 21st century, educators need to be sure that learners are well-prepared to face the challenges of a more complex, interconnected and transparent world. That means institutions need to continue their own learning journey by embracing innovations that will eliminate the rigid structures of education and replace them with fluid opportunities for learning. Educators needs to find ways to incorporate technology into the design of learning so it can integrate global education resources, help accelerate economic opportunity in developing economies, and develop education environments that allow learners to not only obtain the skills necessary to create, find and understand information, but to do so in a culture of lifelong learning that teaches them to be critical and creative thinkers.

Software will provide educators with new tools that will complement their teaching techniques and methods and enable them to innovate, ultimately transforming the classroom experience into one that inspires learning, and brings a personal learning experience to each learner based on his or her needs and learning style. Information and communication technology will provide the means for educators to scale the learning experience by allowing them to rapidly individualize instruction and take advantage of the wealth of resources available on the Internet. In addition, technology will help educators streamline administrative tasks, enhance their own ongoing learning, and make the educational system more transparent and responsive for stakeholders. Microsoft Corp. delivers software and solutions to empower students to achieve more; and to better enable educators, ministries of education and school districts to prepare students to be informed and active participants in society.

Although much of this paper focuses on the experiences and opportunities of primary and secondary education in developed markets, the lessons can be applied to universities and other tertiary institutions. Those in emerging economies may look to this dialogue as they attempt to apply lessons learned from the developed world and create new institutions that model the best of contemporary education while bypassing the negative aspects of legacy learning systems.

More information can be found at: www.microsoft.com/education/ NewWorldOfWork.mspx

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OVERVIEW

Over the past 40 years, education has become increasingly important as a determinant of social and economic success. As reported in "Education at a Glance: OECD Indicators — 2006 Edition," two generations ago Korea had the standard of living of today's Afghanistan and was among the lowest performers in education. Today, 97 percent of all Koreans 25 to 34 years old have completed upper-secondary education, the highest rate among the Organisation for Economic Co-operation and Development (OECD) countries. Korea's gross domestic product (GDP) in 2003 came in at $679 billion (U.S.), eleventh among 186 countries. The experience of Korea is not unique. Between 1995 and 2004 alone, the number of students attending university more than doubled in China and Malaysia, and expanded by 83 percent in Thailand and 51 percent in India. These economies have also grown as their access to educated citizens has grown to world class stature. In the U.S. work force between 1973 and 2001, the wage premium for a college degree compared with a high school degree rose from 46 percent to 76 percent. In 1970, more than half of employed U.S. adults worked in blue-collar and clerical jobs. Today, less than 40 percent of Americans have such jobs, many of which now require at least some college education. This trend is equally true elsewhere in the developed world. OECD data shows that members of the population in OECD member countries who completed tertiary education continue to enjoy a significant advantage in both income and employment over those who only completed secondary education, and there are signs that gap is widening. And it's not just jobs and workplace skills. The everyday tasks people perform as citizens and consumers are becoming more complex, and they too require skills that education can impart. Rewarding activities of all types increasingly require the skills to manage information, work collaboratively, juggle multiple tasks simultaneously, and take personal initiative. Educational institutes are expected to prepare students for these sorts of challenges so they can be effective not merely as workers, but as members of a complex, connected and participatory society.

The New World of Work

At Microsoft, we believe that the world or work in the coming 10 to 15 years will be characterized by several important themes whose outcomes will affect people, organizations and governments in both developed and emerging economies:

- **One world of business.** Global economic integration pushes people and cultures into continuous contact and deeper inter-relationships, creating new pressures on and opportunities for companies, communities, workers and governments.

- **Always on, always connected.** Ubiquitous connectivity allows people to connect to each other, information and systems anywhere and anytime, fundamentally redefining the boundaries between work, school and life.

- **Transparent organizations.** Governments, consumers and stakeholders of all sorts demand increasing levels of accountability and transparency from companies, agencies and public institutions, bringing about fundamental changes in how organizations manage themselves.

- **Work-force evolution.** Demographic shifts are changing the nature of the work force, creating a labor pool that is more diverse than ever before. Attitudes about work are also changing as younger workers and workers from emerging markets begin to dominate the work force.

This "new world of work" poses three major challenges for education. First, how do educators and institutions enhance the learning experience by creating open learning environments that allow them to leverage the resources of a global economy? Second, how do learning institutions respond to the new world of work by being more transparent and operating more effectively and efficiently to deliver their services cost-effectively? And, finally, how do educators deliver a more personalized learning experience to each student to better prepare them to participate in the emerging society of the 21st century?

Technology plays a central role in how people will navigate the new world of work and its implications. The real story of the new world of work, however, are the people empowered with the right tools that will help their organizations meet the demands of change. The people involved in education — the learners, the educators, the administrators, the education board members and staffs of ministries — will collectively take advantage of new opportunities, minimize risk and creative solve new challenges. Software and technology, in Microsoft's view, exist to serve people's needs and amplify their capabilities by providing flexibility, productivity and simplicity so they can create, analyze, share and apply their knowledge to create value.

Preparing for the Knowledge Economy

Education is key to creating a 21st century economy. Our youth are entering a world that has been characterized by constant growth in the volume of information, increase in the speed of information transmission, and ever-growing connections between people facilitated by global communications and social networking technology.

Education provides educators and students with frameworks and methods that help them integrate new information, new skills and new approaches to navigate complex relationships within information and better manage relationships between people and processes. Education teaches people how to think critically and creatively so access to information doesn't result in an avalanche of input, but rather becomes an important factor in making better decisions.

As the single-job, single-employer career path of the industrial age recedes into history, adaptability is becoming the watchword of success. Many workers are already facing significant changes in the skills, practices and responsibilities of their job over the course of their working life. Lifelong learning skills and continuous education and training are critical as the nature of work changes. Many will choose to tackle emerging types of work that might not have been imagined when they were in school. Workers who are not just educated, but also know how to learn, will be able to embrace these transitions and thrive, while those without solid learning skills might not.

Education also plays an important role in helping emerging economies prepare for transformation. Strong educations systems will help those in emerging economies rapidly accelerate their ability to innovate and, by doing so, create new opportunities for the advancement of their citizens.

21st Century Skills: A Moving Target

The education system has always prepared individuals for success in work. Education still faces many of its traditional challenges, but in the new world of work its goals and scope have expanded. Not long ago it was still possible to expect that low-skill industrial work could provide sufficient economic rewards, and that a social safety net would catch those who fell through the cracks. Today, most high-skill jobs are unattainable without an education that prepares people to deal with the complexities of an interconnected, information-driven world.

In addition, many technology skills and associated social behaviors are being learned outside the classroom experience. It is important that education systems, along with parents, recognize the need to help students learn how to integrate those external experiences, even when the classroom may not be as technologically sophisticated as the student's work or home environments.

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Preparing for the Knowledge Economy (continued)

Technological change is occurring so rapidly, it is hard to predict exactly what specific skills will be required for the highly valued jobs of tomorrow, or what current jobs may follow the buggy-whip maker and the manual typesetter into the footnotes of labor history. However, one predictable feature of today's economy is the ability of innovation to bring entire new classes of work into existence. Displaced industrial workers may well become tomorrow's information worker as economic and technological shifts transform local economies based on global trends. Today's call center worker may, with the right training, go on to play some highly valuable role in a completely new job created by widespread adoption of social networking technology.

Future workers will be able to stay current with or reinvent their abilities more readily than workers in the past by learning how to effectively and critically access content and rapidly absorb new information, how to identify mentors and learning partners in social networks, and how to critically assess new information so it can be used effectively. The key is creating learning environments in which these skills become part of the lifelong learning repertoire of every student.

The Right Educational Context for Technology

Learning to use a computer may seem like a complex task — especially to those who were not brought up in a digital environment — but computing skills should be thought of more like learning to use a pen or any other means of expression. There is a time and place in an educational curriculum when handwriting is taught as a skill, usually in the first or second grade. During those years the form and style of a student's handwriting counts nearly as much as grammar, spelling and originality of thought. When teaching later grades, most educators tend to take a greater interest in more substantive areas and will only dwell on handwriting if a student's work borders on illegible. Likewise in art classes, basics such as color theory and perspective are taught and measured at a certain early point, after which student art is judged on more wide-ranging aesthetic criteria.

In 2005, Microsoft's Information Worker Board of the Future, a group of college-age students from all over the world, gathered in Budapest, Hungary, to provide input into the company's plans for the Microsoft® Office system. During that meeting, the Board of the Future recommended that Microsoft encourage educators to see computing as a language. Just as students progress beyond rudimentary skills in language and art from their earliest educational experiences, this group of young people saw computing as a new fundamental skill that should be nurtured in much the same way that a kindergarten student's crude crayon drawings lead to more ambitious artwork as the child matures. And, like other basic tools, computing should be used to support any subject — a concept the board called the "infinite canvas."

Computer and software competency should be seen as an enabling skill for expressing a student's knowledge. Proficiency in a particular program is primarily helpful in the context of solving a larger problem. More useful is a general understanding of software metaphors and conventions: how computers organize and present data, how interfaces work and behave, how to use software to model complex systems, and how to analyze information. With these capabilities, most people can learn and use new software quickly and intuitively, even when dealing with unfamiliar applications. They know where to look for features they expect and how to work around unexpected situations without becoming discouraged. Most important, they understand what to expect from the application, how to take advantage of its features and how to apply its capabilities.

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Preparing for the Knowledge Economy (continued)

Consider an actual recent eighth grade assignment:

> **Research your family history as it relates to World War II. Create a PowerPoint presentation that describes what a member of your family did during the war.**
>
> **Also create piece of art that illustrates what you have learned.**

In the art project, no medium was specified, no technique suggested. Why? Because by eighth grade, the student is expected to understand enough about different types of artistic techniques to choose a technique suited to the story being told and to his or her personal interests and capabilities. The computer assignment was specific: It has to be a PowerPoint® presentation. If the students had been taught computing in the same way they were taught art, the assignment could have been more general. The assignment would given the student the leeway to consider the best tool for telling the story. Rather than the computer being an "infinite canvas," it became a constrained work space.

Educational experiences need to move beyond what education writer Todd Oppenheimer observed about students often spending more time mastering the computer skills necessary to complete the assignment than gaining mastery of the traditional subject matter.

As students learn, they internalize the capabilities of information and communication technology (knowledge many acquire outside the classroom), so the way they use software to accomplish their goals reflects a personal style similar to the way handwriting and artistic preferences reflect the unique experiences, skills and abilities of each student. Educators can provide guidance and correct bad habits, but need not — and should not — place any more emphasis on presentation quality than they would on the handwriting of an eighth grade student for an assignment for which specific software skills were not being tested. It is more appropriate, for instance, to evaluate students on how they used a computer to enhance their expression of learning, not on how they used a particular tool.

Core Skills for the New World of Work

As technology and software use evolves into a capability for expression rather than a set of discrete skills, students and educators can devote more time to cultivating the aptitudes young people will need to be effective workers and citizens in a more globally interconnected and information-intensive world.

The Partnership for 21st Century Skills, a consortium of corporate, government and educational leaders, made several critical recommendations for education in its influential 2003 report, "Learning for the 21st Century." In addition to a continued emphasis on traditional academic skills, the group recommended that educators build curricula to support the complex thinking and collaborative analysis required by emerging trends such as the following:

- **Information and media literacy**
- **Complex communication**
- **Critical thinking and systems thinking**
- **Problem identification, formulation and solution**
- **Creativity and intellectual curiosity**
- **Interpersonal and collaborative skills**
- **Self-direction**
- **Accountability and adaptability**
- **Social responsibility**

Many educators concur with this list and see it as a matter of priority. The challenge is to provide educators with tools that allow them to create richer context that better ties these attributes to the classroom outcomes.

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Preparing for the Knowledge Economy (continued)

Moving Toward an Opening Learning Environment

Information and communication technology must be seen as a means for enhancing educational outcomes. Opening learning environments can provide educators with innovative ways to motivate and engage students and tools that allows them to individualize instruction to meet the needs of students with all types of learning profiles.

Emerging technologies can help smooth the transition from a traditional education setting to an open learning environments by reducing the complexities of tasks that are external to the educational mission — such as system administration, file synchronization, calendar and contact list updates, security measures, work management and access rights — so educators can focus on the craft of instruction. They can enable creative solutions to age-old issues such as classroom discipline, attention management and plagiarism. And they can open exciting new opportunities to bring complex ideas to life in ways that students find relevant and engaging.

Microsoft strongly believes that information and communication technology can transform learning by creating a rich marketplace where learning is an always-available experience with resources — both human and content-based — rated transparently by consumers as to how effectively they met their learning goals. As educational institutions and education itself transforms to meet the demands of the 21st century, people and organizations will need strong, flexible ways to manage that change.

As seen in many businesses, technology will allow educators to create learning experiences that engage students regardless of time or physical location. These opening learning environments will be inclusive, allowing people such as parents and administrators to monitor progress and participate in learning. Learning experiences

in the future will reflect the kind of world that has become commonplace in many businesses: one that extends the boundaries to include partners and customers. In the case of education, those partners may be other institutions around the world that enhance local curricula by providing resources to students and educators that directly link them to the places and activities being discussed. Open learning environments will also facilitate learning through qualified individuals willing to spend time formally or informally with students, acting in the role of coach, mentor or educator.

As open learning environments become more common, they will also be able to ameliorate the effect of demographic shifts that cause schools to be closed, causing political and personal strife. In the future, education experiences will be much less reliant on physical location. Open learning environments will create more resilient institutions by providing creative new options for policy-makers. The virtualization of the learning experience, for instance, will allow some physical locations to become learning hubs that bring together youth, adults and industry. These multi-use learning hubs could potentially distribute education resources more effectively and at a lower cost than single-use learning locations.

Open learning environments will allow educators and parents to help children learn how to navigate the world, make sense of what they find, and make good choices about their interactions with people and content — extending learning beyond a single physical location to an ongoing experience that stimulates learning and keeps students engaged. In higher education, open learning environments will allow a reach of intellectual stimulation and guidance that will provide all students with improved perspectives and insights, no matter what field they are pursuing or where they are pursuing it.

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Transforming Learning

Perhaps only comparable to healthcare professions when it comes to examining information work roles, educators have always focused on outcomes rather than outputs. Although managing administrative burdens remain an issue (which will be addressed later in this paper), the most critical issues facing today's educators are how to transform the learning experience by effectively incorporating technology so they can discover new insights about students; how to work cooperatively with other educators; and how to bridge gaps in talent that schools share with other geographically centered institutions. They must balance these learning-experience challenges with the demands created by a global market for education, increasing expectations from industry and community, mounting requirements for transparency, and demographic shifts that are affecting the populations of both educators and students.

Helping Educators Learn

For the educator, effective teaching is as much about their own learning as it is about the learning of the students. Educators have a limited amount of time that they can devote to self-development. Too often their own learning — be it focused on a subject, on teaching techniques or on areas that help them fulfill aspirations for advancement — is lost in the day-to-day demands of the classroom and administrative tasks. Technology can assist educators by giving them an easier way to connect to, and learn from, colleagues around the world through social networks, deliver learning in manageable portions through virtual learning experiences and conferences, and supplement their instructional time with qualified individuals willing to engage their students in alternative learning experiences. Information and communication technology can help educators solve problems — whether they are instructional challenges or discipline issues — collectively.

21st century educators will use technology to enhance the experience of their students, but they will also use technology to create a better learning environment that starts with their connection to learning and extends to the students and into the community.

Modeling Learning

The overriding skill required for the 21st century will be the ability to learn. Instructors can tell this to students, but they can only effectively instill an appreciation for lifelong learning by demonstrating it themselves — by learning from one another and from students as a routine part of their professional development.

The disparity of technology skills between educators currently offers an opportunity to model lifelong learning to students. Microsoft calls this idea "reciprocal mentoring." Educators with superior technology skills, for instance, can help their peers better incorporate technology into the curriculum — not behind the scenes, but interactively with students watching. Students will learn that their educators need to continue their learning by seeing that education process taking place before them. Conversely, more experienced educators may provide insights to newer educators by expanding their portfolio and depth on traditional subjects, or by team-coaching students. As technology becomes a more fluid part of the learning experience, educators will be able to demonstrate to students how to effectively integrate personal and business relationships into their work lives as they expose and engage their social networks as part of the learning experience.

The idea of modeling learning does not exclude more focused time where educators learn from each other outside the classroom experience, but it does offer one way in which educators can model the lifelong learning process early in the education of primary and second-

Transforming Learning (continued)

ary students. This is a skill some educators will resist out of fear that losing classroom control would prevent the introduction of innovations, but by incorporating lifelong learning into the learning process itself, over time educators will become comfortable with their own learning experiences being exposed to their students.

Professor Birgitte Holm Sorensen from The Danish University of Education explores the idea of lifelong learning in a different way. She believes that as the hierarchy of the classroom evolve into a more collaborative setting, students will be empowered and encouraged to teach their instructors about how technology works. She see educators acting more as project managers for empowered teams of students largely managing their own educational experiences. This approach not only models learning, but begins to help student appreciate the skills they will need to communicate ideas in a way that they can be absorbed by others.

Technology creates an opening for modeling of lifelong learning, and even a mechanism for delivering it. Master teachers could help other educators by engaging in many-to-many teaching experiences where they interact with students and faculty in the context of a open learning environment. Many businesses adopt a wide variety of collaboration technologies that help them take advantage of talent in a distributed work force and retain knowledge from employees leaving a company. These techniques will continue to improve, but they are sufficiently advanced to be effective tools for educators. As master teachers and administrators experiment with collaboration technology to reinforce their own learning, they will influence the design and implementation of future tools that will provide them with the capabilities necessary to more easily and effectively deliver continuously learning to educators within their communities,and beyond.

Scale and Individualization

Whether an educator has five students or 35, it is important to gain insights into the uniqueness of each student. Over the next several years, as student records, achievements and assignments become increasingly aggregated in tools such as electronic portfolios, educators will employ learning analytics to supplement and validate their own observations about student performance. Learning analytics will allow educators to combine their own insights with those of previous instructors, parents and administrators so they can better address the individual needs of students. They will be able to maximize individual time with the students that need it most, and better group students to reinforce talent or address gaps in understanding. They will also be able to use learning analytics for social networks to gain a new perspective on relationships between children, and use this knowledge to foster better group dynamics.

Technology will also allow educators to better scale their work by providing educators with easier ways to build lesson plans that reflect the individual learning needs of their students. Rather than teaching from a single text, the educator will be able to put together lessons from a variety of sources, some that are designed to draw students together in collaborative learning and others that appeal to individual learning styles. And when educators build lessons plans from standard learning components, information technology will manifest the learning experience based on assessments and learning styles to meet each student's unique needs.

Leveraging student learning styles, however, is insufficient. It is just as important to expand a learner's mental models. Because educators in the future will have much greater visibility into learning styles

Technology creates an opening for lifelong learning and a mechanism for delivering it.

Transforming Learning (continued)

and the state of individual learning, they will be able to guide students in ways that help them expand their mental models. For example, primarily visual learners can be taught how to better incorporate verbal models to round out their capabilities. Learning analytics will give educators a new depth of understanding that will help them individualize their lessons, and will give students the information they need to personalize their experience. This will build new levels of engagement that would be unimaginable without the technology to aggregate assessments, transform learning goals into individual learning approaches, and create personal environments to anticipate student information management needs and learning styles.

With pervasive connectivity, educators will be able to call upon the knowledge of experienced individuals from other institutions and from outside the learning system. Master teachers will extend their reach by interacting well beyond the confines of their own classrooms. This aspect of the open learning environment will enhance access to scarce knowledge driven by the uneven distribution of local educator experience, or provide access to knowledge as it emerges from institutions or businesses.

To an educator, the effectiveness of learning is often governed by time constraints. Technology can enable improved ways of balancing administrative, community, classroom and personal demands, allowing educators to more effectively choose the best means for obtaining a goal for each student. It will provide entrée to vast stores of content that has been prepared for rapid retrieval and reuse, and easy access to social networks for support and learning — all of which will aid the educator in creating learning environments customized to the need of each student.

Re-Thinking the Classroom and the School Year

The traditional September-to-June school year observed in the northern hemisphere was first instituted in the 19th century to meet the needs of an agrarian society. As we enter a more knowledge-intensive era, some communities and schools are looking for ways to move to year-round learning, though these efforts sometimes meet with resistance. Open learning environments can give education systems greater flexibility by extending the resources of education beyond the traditional school day, year and physical location.

Flexible learning is already a familiar concept in many educational settings, though early models built on slow networks often proved unrewarding for both students and educators. As connectivity continues to extend in reach and quality of service, next-generation technologies can improve the experience and the results. Some current and forthcoming innovations include the following:

- **Conference cameras** that automatically shift between members of a group seated around the table, depending on who is speaking dramatically improve the quality of group discussions for participants on remote videoconference.

- **Portable multimedia communication** devices allow people to participate in rich online classes with voice, video, data sharing, and application sharing anywhere, anytime.

- **Collaborative work** spaces act as focal points for project teams or individuals collectively creating a document from remote locations, with the kind of vivid, responsive interaction that young people experience in online multiplayer video games.

With pervasive connectivity, educators will be able to call upon the knowledge of experienced individuals from other institutions and from outside the learning system.

Transforming Learning (continued)

- **Large information spaces** such as interactive walls, digital desktops and digital paper bring more visual and collaborative resources from the class-room into the remote student's work environment, so the experience isn't constrained by sitting at a desk and peering into a single small monitor.

- **Context-based collaboration and education** software for educators include embedded capabilities that streamline and simplify many of the complexities of preparing for and managing learning, acting as an educational lever by automatically transforming lessons into individual-ized learning experiences based on learning analytics.

As education focuses inward by using information to help connect learning to the individual, it must also focus outward, so educators can connect to the disenfranchised by providing access to information and educators in areas where skills are not easily obtained or retained. And when these two areas are brought together, as only technology can do, students from around the world will be able to experience superior education, regardless of their geography or social standing. The rigidity of classroom, struc-tured texts and one-size-fits-all curricula will give way to fluid learning tuned to the style, aptitude and curiosity of the individual learner.

Simplifying Administrative Tasks

Education has generally been a slow adopter of information and communication technology as a productivity-enhancer, not just in the classroom, but also in various support and administrative areas. With more demands being placed on education by parents, students, employers and society, educational institutions and educators can benefit greatly from the more extensive implementations of information and communications to speed and simplify routine tasks and facilitate communication. This will help ease the burdens on over-worked educators and give them more time to focus on the craft of teaching.

Today there are many software solutions available to assist in areas such as grading, attendance, seating charts, lesson planning, ordering of supplies, and other support functions. forwarding the future, these types of solutions can be improved by doing the following:

- **Integrating more tightly with mainstream information applications** such as e-mail, schedule and contact management, document creation and Web site management for ease of use and the ability to combine information of different types (e.g., overlay atten-dance records on assignment calendars)

Simplifying Administrative Tasks (continued)

- **Offering mobile, remote and online access so** educators can perform these tasks anywhere, anytime and on any device

- **Automating routine functions,** such as synchronizing calendars, auto-generating reminders and notifications, auto-updating Web sites and shared schedules, and helping assemble the resources they call for in their lesson plans, based on schedule, context and availability

Enable Transparency

Communication — within schools and between schools, parents and the community — is one area where technology can deliver benefits. Today, many schools still use a disruptive public address system to make announcements during the school day; send paper copies of schedules, bulletins and permission forms; and use a variety of convoluted systems to communicate grades to students and parents. A number of current and emerging technologies can remove these points of friction, including these examples:

- **Subscription-based information feeds** (RSS or similar technology) will allow all parties to "pull" up-to-date information to their choice of devices, without requiring them to constantly check static information sites for updates.

- **Online meetings** (such as through Microsoft Office LiveMeeting) use rich media environments to facilitate remote forums and parent-teacher conferences to supplement traditional partner meetings and more effectively involve busy parents.

- **Collaborative work spaces, expertise location, real-time communication** and other collaboration solutions connect education professionals from different schools, disciplines and communities to develop a common approach to shared problems and spread good ideas.

- **Data analysis** of student performance can help educators and administrators pinpoint causal factors in broad student performance trends. Looking at the same learner's progress year over year can help educators address the factors that contribute to individual learning progress. Both require strong data analysis tools.

- **Information rights management (IRM) technology** gives educators and administrators the ability to restrict access to data and documents even beyond the firewall. This means schools could post progress updates, test results and report cards onpublic sites or distribute one master document in which each student and parent would only be able to see their own information.

Simplifying Administrative Tasks (continued)

Future of Education: Classroom 2015

It's 1:30 p.m. on a Thursday afternoon, and a group of 25 tenth grade students at Link Pointe High School file into Mr. Coleman's fifth-period English class. As the students take their seats, their digital slates automatically connect to the classroom's network and brings up the class work space. They can see homework completed the night before. The display shows what was accepted, and for some, that Mr. Coleman has already graded and commented on their work.

Behind the scenes, as the homework is submitted, the classroom management system performs a quick text search on each essay to flag possible plagiarism. One or two papers get a yellow mark next to them, indicating that Coleman should follow up later.

Mr. Coleman glances down at the seating chart displayed on his desktop work surface. Icons representing each student light up with representations of each computer's desktop as the digital slates connect up, so the teacher can see at a glance what each student is doing on his or her computer. He notes two excused absences and an e-mail from the athletic department requesting that Tanisha Knight be allowed to leave at 2 pm to travel with the junior varsity girls' basketball team for an away game. He can also see her parents have approved the request. He taps "OK," generating a response that goes to the student, her coach, her parents and the school's records database.

The lesson plan Mr. Coleman has prepared automatically populates his screen, an interactive whiteboard in the front of the class, and the students' desktops with the first item of the day. The class is discussing Shakespeare's "Henry V." Mr. Coleman has loaded video clips of important scenes from several film versions, along with maps of England and France, examples of arms and armor from the 15th century, page facsimiles from the quarto and folio editions, and an essay comparing the character and actions of King Henry to a figure from recent political history.

Predictably, what captures the students' interest is an interactive simulation of the battle of Agincourt. The class divides into two teams, one side playing the numerically advantaged French, the other playing the English "happy few, the band of brothers" led by Henry. The simulation soon demonstrates the tactical superiority conferred by the English longbow, leading to a conversation about whether Shakespeare was trying to make a point about military technology, given the historical tensions in the period when he was writing the play.

Mr. Coleman then asks if any of the students had participated in online discussions about the play or mentioned it in any of their community workspaces. One girl replies that she had, and that she'd received an instant-message response from one of her friends in France, explaining the meaning of some French dialogue in Act III. Mr. Coleman plays the scene in question from Kenneth Branaugh's 1989 film version for the class and asks the girl if she would share her friend's insights with the class. She opens up her conversation archives, clicks share, and Mr. Colemen drags the content onto the work surface for all to see. A discussion follows about Shakespeare's use of humor in plays that aren't designated as comedies. As the period winds down, Mr. Coleman assigns the class to prepare an advocacy presentation on whether Henry V is more of a comedy, a tragedy or something in between. As usual, he indicates he will accept written essays or multimedia presentations, as long as the arguments are clear and well-supported. Each student sees the looming deadline immediately posted to their calendars, with a clear indication that the parent Web site has been updated with the assignment description and due dates as well.

At 2:15, the class files out and the teacher's work space automatically configures for the next period.

Creating a 21st Century Learning Environment

Creating a learning environment that prepares students for the realities of 21st century cultural, economic and political life requires a combination of thoughtful policy reform and appropriate technology. While the policy development is best left to education subject-matter experts, Microsoft sees a number of ways that innovative technologies currently in the research and planning stages can benefit the next generation of educators.

These technologies are also elements of solutions detailed for educators above. As educators become more adept at the application of technology to their own learning, they will be able to provide a richer, more authentic experience to students. The future of technology in the classroom is as dependent on educators adopting and infusing technology into their lives as are good curricula that reflect the learning needs of the students. It will not be sufficient for students to understand media in the future; they must also become media producers. It will not be sufficient for students to absorb facts; they will also need to understand relationships and implications and how to build mental models that permit them to apply their learning to future problems. Technology will greatly enhance the ability of educators to reach beyond physical tools of learning — be it a page in a book or a classroom — and seek new and innovative ways to involve the learning experiences of their students.

Visualization and Modeling

The ability to discover and express meaning from large and complicated sets of data is a core skill for people who want to participate fully in the knowledge economy. Partly as a result of the information and communication technology build-out of the last two decades, the world is awash in data of all kinds. The challenge for educators is to develop their students' perception of complex relationships that will allow them to separate useful information from background "noise."

Visualization technology expresses data relationships explicitly, giving people a vantage point from which they can spot trends and patterns, and explore the relationships by navigating paths or drilling into context. Insights that no human would discern from reading columns of numbers or hundreds of individual documents can become immediately apparent when visualized. Modeling allows people to give visual expression to their own ideas. The computer adds environmental elements based on real-world data so the model appears more realistic.

Visualization and modeling have been applied in education to obvious areas like mathematics, statistics, physics, engineering, architecture and design, where they are used to make abstract ideas such as formulas and equations real and vivid. Improvements in processing speed and software design may soon bring extremely sophisticated visualization systems such as those used in meteorology, econometrics, molecular design and film production special effects within the practical reach of secondary schools. Educators will have powerful new tools for expressing complicated concepts using concrete, visual examples that express the important relationships in ways average students can understand.

Visualization will also play a role in open learning environments by helping learners and educators navigate large social networks, by visually representing relationships between performance and approach, and by creating visual road maps for learning that graphically represent the desired outcomes of an education process and the pathway to that outcome, along with the ability to visually explore connected resources.

Creating a 21st Century Learning Environment (continued)

Simulation

Simulation for game-based learning provides interactive ways to see how changing variables affect dynamic systems. Most young people today have already been exposed to some of the most sophisticated simulations on the market: video games. Often dismissed by both parents and educators as a waste of time or worse, video games instill powerful messages about cause and effect relationships and promote strategic thinking, resourcefulness, problem-solving and (in the case of multiplayer games) collaboration. Games and simulations can also be used to teach storytelling, role-playing, historical and sociological subject matter (as in games like "Age of Empires®" or SimCity), language skills, and fine motor skills. These tools have been effective in commercial training and instruction for many years, in computer-aided forms, and as learning exercises performed by teams. Advocates of game-based learning, like Marc Prensky create a compelling argument for this: "In geography — which is all but ignored these days — there is no reason a generation that can memorize over 100 Pokémon characters and all their characteristics, history and evolution can't learn the names, populations, capitals and relationships of all the 181 nations in the world. It just depends on how it is presented."

Obviously, the educational value of a particular game or simulation depends entirely on its design. Many commercial games teach good problem-solving and strategic thinking skills in the context of subject matter that is entirely inappropriate to an educational environment. There are some good products available for the education market currently, but because of economic realities, most high-end resources still go toward commercial development. However, software and systems are becoming increasingly easy to use and affordable. Using next-generation tools, educators will be able to create and manage custom interactive simulations that use the appeal of complex gameplay to drive home basic concepts, subject matter and skills across a range of subjects. Imagine playing out Civil War battles where strategy and strength replay the outcomes of history, and where students are allowed to change parameters and learn firsthand how small changes in conditions could possibly influence the contingencies of history.

Simulation will enhance the open learning environment by bridging learning perspectives in collaborative simulations where perspectives on historic alternatives or literary options are not just argued, but simulated by students from several learning institutions over time. Simulation will help engage imaginations in new ways and support the testing of ideas with a robustness not possible without it.

Social Networking

Social networks connect people from disparate locations in a single virtual space where they can interact, either in real time via instant messaging or asynchronously through messages and blog posts. Social networking technology is more popular with young people than with any other demographic group. Many young people are exposed to virtual communities through services such as Windows Live™ Spaces and MySpace, online video games, blogs, media-swapping networks, and mobile devices. Indeed, the ability to form, maintain and leverage social networks is one of the unique assets that the Millennial Generation brings to the workplace and society, and it is likely to be especially useful in the emerging global economic environment that pushes far higher levels of risk and responsibility onto individuals.

Few schools, if any, make use of this enormous asset of social networking as an opportunity for learning. Many students have developed extensive networks outside of the classroom, and the use of these networks for learning could
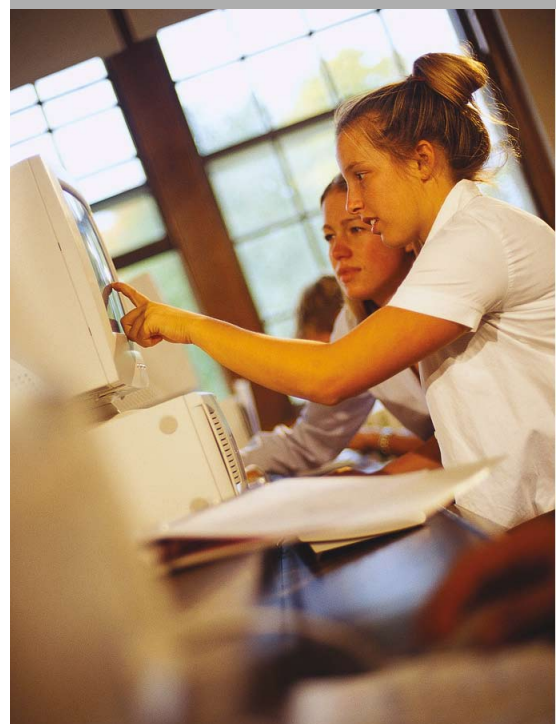
Creating a 21st Century Learning Environment (continued)

help drive peer learning opportunities and provide a platform for formal instruction through safe, responsible social networking practices. In coming years, educators will be challenged to devise policies that incorporate these increasingly common virtual communities into an educational framework. Some obvious applications are in social studies, geography and language skills, where the students' firsthand relationships with people around the world can add a real, practical dimension to the subject matter.

Innovators in education are likely to embrace social networking technology as a way of supplementing scarce resources, creating the foundation for open learning environments. Technology can play a role facilitating basic interaction between and offering guidance for students. If local educators do not have sufficient knowledge to teach part of the curriculum adequately, they will be able to call upon their own social network to supplement their experience or knowledge. Reputation systems within social networking environments can provide real-time consumer feedback to help reveal to educators, students and parents which members of the community are most effective in meeting learning goals.

Another suggestion from Microsoft's Information Worker Board of the Future was to use social networks to provide just-in-time learning in the workplace. If people have peers in their network capable of providing help with work tasks when needed, employee productivity and effectiveness can be immediately increased. This practice already occurs with young people through social networking behavior, so harnessing the habit for educational settings could be a new tool for keeping children engaged in the learning process. Social networking could also be a powerful tool for educators seeking collaborative learning with their peers. Social networks could expand educators' awareness of local resources and introduce and connect them to resources around the world.

Team-Based Learning

The ability to work productively in groups is another core skill for workers and citizens in a connected world. Information and communication technology has provided numerous channels for collaboration over the past decade, from e-mail and discussion groups to online meetings and work spaces. Educators have used these technologies to extend their reach through distance learning. Many classes today, whether actual or virtual, use team sites and e-mail discussion groups as a way to share information outside the classroom. These practices not only support class work, but also teach valuable skills that students can apply in the wider world.

Moving forward, innovations in collaboration solutions can help educators solve a long-standing issue of technology in schools. Todd Oppenheimer, in "The Flickering Mind," vividly documents how unmonitored computer use in the classroom often creates discipline and attention problems. That's because there's only one teacher and potentially a dozen or more computers to watch. But imagine a team collaboration environment in which the teacher's desktop can actively monitor and interact with every computer in the class, including networked devices like smartphones. The educator could not only monitor for discipline, but also broadcast content pointers to all desktops, or identify and quickly focus on a student who needs individual attention — all from the front of the classroom. The teacher could also pull content from any student's desktop to display on the a large shared display, issue and collect in-class tests electronically, and mark papers using a pen-based interface (as commonly found on Tablet PCs today). All this collaborative and remote-desktop technology is available today and is only awaiting education-based initiatives to embrace it. The collaborative environment need not be limited to a single teacher in a single classroom, but could be an environment

Social networking could also be a powerful tool for educators seeking collaborative learning with their peers. Social networks could expand educators' awareness of local resources and introduce and connect them to resources around the world.

where educators in various locations collectively interact with students based on personal needs, work emphasis and learning styles.

In open learning environments, collaboration technology will help eliminate the time constraints in student learning, giving them access to peer coaches from around the world for any subject imaginable. This unencumbered access to expertise could transform the classroom into a virtual work space in which students around the world work synchronously and asynchronously on different parts of the same project. Adopting information and communication technology as the basis for collaborative learning would make the classroom the starting point for a learning experience that connects students to other learners and educators who can challenge their imaginations and test their convictions by bringing real-world experience directly to them.

Oppenheimer's critique of computers comes from classroom experiences where neither the tools nor the techniques have matured. In the world envisioned here, computers are not equally boring alternatives to flash cards, board games or books, but interactive spaces that can thrive in much the same way that online communities do outside the school, the difference being the goal and assessment of work, which would remain the purview of the educator. Even if time shifts become common and learning reflects the chaotic aspects of modern businesses-oriented project work, sooner or later results will be expected. Deadlines, and the associated learning goals of assignments, should be closely managed by the educator. Collaboration technology can be an impetus to reinvent the classroom by removing the last vestiges of agrarian calendar and eliminating the linear expectations of the industrial age. Team learning, empowered by collaboration technology, creates an interconnected learning environment that provides students with

the information resources, work methods and thought processes they will need to succeed in a global economy.

Smart Content

The Internet has opened unprecedented opportunities for research and knowledge discovery. This has, unfortunately, often been accompanied by unprecedented levels of frustration, especially among educators, due to the unpredictable, distracting, often irrelevant and occasionally inappropriate nature of much of what is found online. Search technology has improved over the past several years, and many schools and libraries now provide some guidance to students on how to form queries, narrow results and use specialized resources. Still, problems remain, principally inappropriate content and plagiarism.

To protect students from inappropriate content, many schools have implemented filters and other restrictive measures. However, administrative efforts to firewall students off from harmful Internet sites and ban disruptive or distracting technology from the classroom always seem to be a step or two behind. Often, the most visible consequences are unintended, such as blocking teens from sites with legitimate academic content (e.g., information about breast cancer or drug prevention).

One way to approach this problem is to institute strong practices along with technological remedies. Rather than taking expensive, over-reaching and often futile measures to wall students off from the realities of the connected world (which often only provokes students to find ways around the restrictions), schools can be proactive in teaching responsibility and safety. The existence and communication of monitoring technology can also act as a deterrent to risky online interactions.

Creating a 21st Century Learning Environment (continued)

Most students can be socialized to recognize boundaries. Those who can't probably pose greater behavior challenges than what they do online. Being able to focus on the task at hand, manage one's time effectively, and avoid the temptations of online distractions are things that a lot of adults might find helpful. Teaching them in school as part of a basic study skills curriculum can help give young people a head start in attention management, which is likely to remain a vital work and life competency as the world continues to become more interconnected and media-saturated.

If that's not practical or desirable, technology may soon have a better solution. Current information rights management technology is used to protect documents and other digital assets from unauthorized access and distribution even beyond the perimeter of a firewall. The next iteration of IRM technology will embed security at a more granular level: parts of an image, words of a document, frames of a video. Content owners will be able to control access and distribution of their material on public networks based on policies that they set, and network managers (such as schools and companies) will be able to set access policies for their users based on the content itself, rather than its location. Reputation systems will extend to content to create powerful feedback loops that tag questionable content and help quickly identify the most effective content for meeting learning goals. In other words, administrators won't have to keep up with an ever-changing roster of off-limits Web sites; rather, they will be able to set a single switch that filters content regardless of its source. Students will be able to go to any Web site, but won't be able to view or download any content that identifies itself as commercial, entertainment-related or inappropriate.

The same basic approach to "digital watermarking" of content will give educators a much-needed tactic in the fight against online plagiarism. Tools will help them identify groups of words in sequence that were copied and pasted from other documents without proper attribution. Educators may also be able to submit and check papers they receive against a central registry to guard against the sharing or commercial distribution of student work. These techniques, however, rely on the responsibility of content providers to respect boundaries and properly code their content. The capability itself should be seen as an opportunity to enhance dialogue with students and parents about citizenship and responsibility.

Personalization

As manufacturing organizations rethink mass production and move toward mass customization, the desire for personalized goods and services will be reflected in students' expectations for their learning experience. Through everything from personal work environments and learning style choices to alternative languages and social network communication options, technology will allow student to take more control of their personal learning experience; meanwhile, educators taking on the role of project managers can set expectations, negotiate commitments and monitor outcomes. As managers of the modern work environment are learning, how, or where, or when, a person works within the constraints of expectations, is not as important as the person's delivery of a high-quality outcome.

At the core of personalization will be learning components that manifest themselves in different ways depending on specifications from educators and students, and as a result of the interpretation of learning analytics. These components will be brought together into sets that accomplish a learning goal. Open learning environments will quickly reveal the context for each student's learning and provide feedback mechanisms so educators can monitor progress, set constraints and actively engage each student through his or her personalized learning space.

Creating a 21st Century Learning Environment (continued)

Supplemental learning opportunities and supporting content will also be highly personalized based on pattern recognition and other interpretive technologies that understand goals, time frames, learning styles and other parameters. It is highly probably that in the future content retrieval will be much less based on search and much more based on proactive delivery of content, tools, references and other material in the context of the current learning experience. The way lessons and content are managed will be entirely up to the student, who will employ easy-to-use drag-and-drop tools to arrange their environments, and sophisticated indexing to keep track of the products of their learning wherever they may reside.

While ultimately personalization will provide students with tools to manage the pace and sequence of their own learning, as well as make significant modifications to the style and approach to learning, for the near term personalization will result from early-adopter educators increasingly using technology to enable personalized learning. The OECD has conducted extensive research into the role of personalization of education (and a link to its report can be found in the footnotes).

The 21st Century Learning Environment: A Future Learning

The ideas presented in this paper — about how technology will provide educators with new tools; change student-teacher interactions; and make education more manageable, more personal and more accessible — point at possibilities, but in reality they may play out in different ways depending on funding and education strategies. The ideas also only represent the interplay between technology and education; as with the use of technology in any area of endeavor, its actual implementation can surprise its inventors, challenge their assumptions, and even infuriate them. Many organizations around the world are working diligently to thoroughly examine the possibilities for how technology can best enhance the education setting. It is highly recommended that those looking for deeper insights into today's technology and how it can best be applied seek guidance from the International Society for Technology in Education (http://www.iste.org).

Microsoft's Commitment to the Future of Education

Microsoft is not an educational institution, and we don't claim expertise in educational policy. However, we are extremely committed to helping educators at all levels around the world adapt to the changing requirements of an integrated, connected and more transparent world. Information literacy and high-level thinking are critical to success in the new world of work, and we work with educational policy-makers, ministries of education and educational institutions to find creative ways to impart these skills to the next generation.

As educators adopt collaborative teaching techniques and just-in-time learning for themselves, manage projects as well as assignments, and increasingly teach across age groups and even geographies, strong communication and collaboration software will be as necessary as books and pencils.

Good software and services can support innovative processes, reduce the burden of administrative tasks, scale teacher experience, enable better internal and external communication, and extend the reach of education beyond the limits of schedule and geography. Open learning environments promise to stretch the boundaries of learning to embrace global sources of content and expertise that will challenge and engage students open to a world of learning that can be orchestrated, individualized and personalized. However, the implementation of technology must be matched with strong policies protecting traditional educational goals and values. Teaching students to use computers is a worthy goal, but not nearly as valuable as teaching them the skills and habits of information literacy.

Over the past 20–30 years, we have seen an evolution in the workplace and society as the widespread adoption of increasingly sophisticated information technology has placed an increasingly high premium on knowledge-intensive skills once only required for specialized professional work. Occupations as disparate as delivery driver, doctor, bank teller and graphic designer now fall under the broad category of information worker. So do the roles of student, teacher and school administrator. This does not mean that everyone is destined for a desk-based corporate office job or that the only responsibility of education is to prepare people to be productive workers; however, the paradigm of information work is useful in thinking about the challenges facing education in the 21st century.

Businesses have found that the value of their investments in technology like PCs and networks is compounded by comparable investments in good practices, organizational learning and work-force development. Schools can benefit from their experience. Systems and technology alone can't solve problems, but people empowered with tools that fit the way they think and work can generate the kind of innovative and flexible responses to the complex challenges of an interconnected world.

Learning requires well-prepared educators, curriculum support, methods for experiencing global learning resources, and a safe place to meet and collaborate with other students. Microsoft Partners in Learning grantees such as Global Kids (http://www.globalkids.org) demonstrate Microsoft's strong commitment to helping education institutions and educators engage students in new and innovative ways. And in West Philadelphia Microsoft has helped create a prototype School of the Future (http://www.microsoft.com/education/schooloffuture.mspx), which is designed to implement and test many new education paradigms in live classroom situations.

Over the past 30 years Microsoft's goal has been to maximize the potential of people in work, life, school, business and society. We invest continuously in better solutions, simpler work methods and innovative approaches that help our customers more effectively navigate an ever-changing world. With Microsoft's solid platform, powerful tools and familiar, easy-to-use software, educators can work with our development partners specializing in education to develop innovative solutions that meet the real-world needs of students, educators, administrators and communities, now and in the future.

The people｜ready business.

A people-ready business is one where people can apply their unique skills, insights and experience to create new products and services, work responsively with customers and partners, and drive operational excellence in every aspect of the business. People-Ready businesses support people with knowledge, practices and tools so that they can add the extra value that helps differentiate successful organizations in a competitive, fast-moving global economy.

End Notes

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6   "Learning for the 21st Century: A Report and Mile Guide for 21st Century Skills," Partnership for 21st Century Skills, 2003. http://www.21stcenturyskills.org.

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