Flipped with Purpose:

Refreshing Technology in the Classroom

Dr. Gary L. Ackernan, Ph.D.

Dr. Gary L. Ackerman, Ph.D.
http://www.hackscience.net
gary@hackscience.net
@garyackermanphd

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PREFACE

When the term “flipped classrooms” became popular a few years ago, I was working as a teacher and technology integration specialist. One of my colleagues observed, “we have been flipping classes for a long time, but we have been doing it better,” and he was right. Since then, I have worked with K-12 and community college faculty to implement and refine these models. At the encouragement of several colleagues, I prepared formal presentations to educational conferences and collected this reworking of workshops, presentations, and conversations I have had with faculty. The ideas presented here all are drawn from answers to teachers' and administrators' questions that have arisen as we worked to flip classrooms.

INTRODUCTION

When I was first compiling my ideas about flipped classrooms, I was talking with a colleague about my dislike for the term “flipped classrooms.” She nodded in agreement as I said, “it seems to be on the same trajectory as every other educational fad we have seen in the last 30 years, and its too bad, because today’s technology makes fundamental reorganization of classrooms possible.” We agreed that it seemed that all educators were anxious to appear to be on the “cutting edge” of practice, so they began labeling any use of technology a “flipped classroom.” It was quickly becoming clear that, despite the value of the idea as a scaffold for reorganizing classroom for 21st century learners, “flipped classrooms” was becoming a meaningless term. She understood my reluctance to use the term “flipped classrooms” in the title, but she observed, “you will have more people pay attention if it appears in the title.” Thus I set out to collect and present my ideas and experiences flipping classrooms... with purpose.

Perhaps we should not have been surprised that flipped classrooms appears like every other educational fad adopted by educators in the last 30 years. As an industry, education has proven very skilled at horizontal reform; collectively educators jump from initiative to initiative quickly and before the results of any one can become apparent. Many find this to be a comfortable state of affairs, as one can always respond to criticism with "yes, [the previous initiative] did not work out as we planned, but [the next initiative] should accomplish our goals."

Flipping classrooms can open a discussion that can lead to deeper and more meaningful understanding of teaching and learning which can lead to vertical reform if it is sustained and it changes the experience and outcomes of education. We have seen technology transform how businesses buy and sell, performers entertain, audiences are entertained, citizens engage in political discourse, workers work, governments govern and conduct war, bullies bully, romances begin (and end), and friends and families stay in touch; but much schooling occurs as it did before computers and networks arrived. Flipping classrooms causes educators (individually and collectively) to redefine the role of information technologies in classrooms, modernize their assumptions about learning, and reinvent curriculum to be authentic.

Historians tell us technologies do not transfer well, and in this way, education is like all other technologies. Many educators try to copy curriculum and instruction that was successful in one school, and find it fails in the second school. The reality is that a successful upside-down classroom (my term that will be detailed in following sections) will be created by a teacher who creates and recreates based on the local resources and expertise. For this reason, this book contains many guidelines and themes along with examples that will advise educators, but there are no procedures or recipes for building curriculum and delivering instruction. Such advice is sure to produce unsatisfactory results and motivate educators to find the next educational band wagon. The advice and models presented here are those that have helped teachers flip classrooms in ways they have found to be effective and enjoyable and sustainable, but each classroom designed along theses guidelines has been a unique creation.

Traditional Classrooms and Flipped Classrooms

Instruction can be deconstructed into two components, that which is done face-to-face with students and teacher in the same place at the same time and that which is done independently without the teacher present. In the traditional model of instruction, the teacher introduces a new idea to a group of students and that idea is practiced for homework; and then a new idea (or perhaps a more nuanced aspect of the previous idea) is introduced, and then it is practiced for homework. The result is that students experience the curriculum from new to known, and a familiar rhythm to many classrooms:

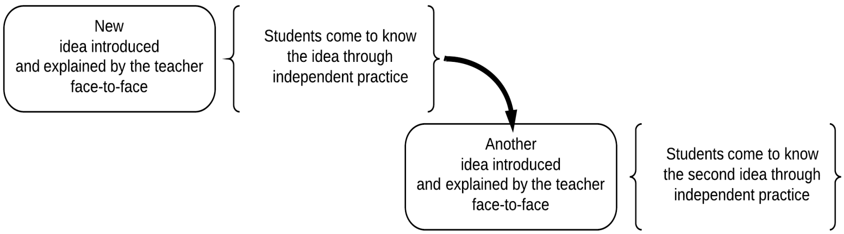

Figure 1. Traditional classrooms proceed from new to known

Proceeding from this traditional organization of classrooms, we can see the variation introduced when the classroom is flipped. The most common form of flipping classrooms takes advantage of the capacity to deliver video via the Internet. In the idealized version, students arrive in class having watched and understood the recordings of explanations and lectures delivered via video. With the instruction having been delivered before students arrive, the work traditionally done independently is done in the presence of the teacher (see table 1).

	New ideas introduced by	become known through...
Traditional Classrooms	the teacher..	independent practice.
Flipped Classrooms	recorded expert...	guided practice.

Table 1: Traditional and flipped classrooms

The video in flipped classrooms comes from one of two sources: either the instructor creates it himself or herself, or the teacher points students to *YouTube* or one of the several other sites where video instruction is available. (In my experience, students interact with teacher-made instructional videos less than instructional videos created by others, and teachers find the work on creating instructional video to be very time-consuming and the results unsatisfactory.) Class time is then available for solving problems based on the video lessons, and the teacher is present to clarify and explain as needed. Two advantages are recognized for this model of flipping classrooms:

- Because the independent activities are delivered via web-based video (usually lectures or similar presentation of declarative or procedural information), they can be watched and re-watched as necessary by the students. Students can receive additional instruction (although usually the same instruction repeated) whenever it is needed and they can largely control when, where, and how often they access it.
- Students are engaged in guided problem solving and practice which allows them to develop deeper understanding than they would develop if they practiced alone. Many advocates for flipped classrooms identify the troubleshooting, additional guidance, and other support students receive as they work as a key benefit to this model of instruction.

It appears that flipped classrooms are simply a variation on the pedagogy that has characterized schools for decades. R. Keith Sawyer (2006), a learning scientist from the University of Washington, suggested 20th century education was based on instructionist models which are informed by five assumptions about human learning and appropriate schooling, none of which are supported by scientific evidence:

1) Knowledge (including facts, procedures, and concepts) essential for one to be “educated” are well-known;
2) Instruction is an effective method for transferring that knowledge to students;
3) Essential knowledge has been translated into a curriculum, and instructional models are valid, reliable, and predicable for all populations;
4) Instruction should proceed from simple to complex;
5) Testing is an effective way to measure learning.

Ronald Gallimore and Roland Tharp (1992), educational psychologists who studied conditions in classrooms that influence learning, observed,

> For over 100 years, there has been ample evidence that recitation, not teaching, is the predominant experience of American school children. Sitting silently, students read assigned texts, complete 'ditto' sheets, and take tests. On those rare occasions when they are encouraged to speak, teachers control the topics and participation (175).

Gallimore and Tharp suggest that most human learning has occurred in informal settings, and that in those settings, teaching is perceived as assisted performance and that learners are expected to demonstrate knowledge. Scholars such as Sawyer and Gallimore and Tharp have concluded that 20th century schooling was largely contrived to reflect the artificial outcomes necessary for the industrial economy. They argue for reinventing schools to replace instructionist models with pedagogy that more accurately reflect the nature of human learning and the realities of 21st century cognitive tasks.

Whether the lecture in traditional or flipped classrooms comes from a live person, or a video (even if the lecture is from a professor at a world-class university), it is still a lecture and intended to be a medium in which the audience is passively receiving the information. Flipped classrooms appear to be perpetuating this model of education that is being challenged by discoveries from the cognitive and learning sciences, as well as observations from educational practitioners, the model is being perpetuated by philanthropists and politicians who argue for educational reform.

Upside-Down Classrooms

In this book, I develop the concept of the upside-down classroom as a more sophisticated alternative to flipped classrooms. In upside-down classrooms, instruction does occur independently and that instruction is designed to prepare students for face-to-face sessions. Whereas flipped classrooms rely on the instructionist model and its dubious assumptions, upside-down classrooms use independent instruction to provide experience and context for authentic learning activities that occur in face-to-face sessions. In upside-down classrooms, there is:

- A new role for technology to facilitate social interaction, and experience access, analyzing, creating, and sharing information;
- Recognition of the nature of learning as informed by research in the cogitative sciences;
- Authentic curriculum, so active learning replaces guided practice in face-to-face sessions.

The End of Integration

Educational technology has been available since the late 1970's, and throughout this history, educators have struggled to decide the role of technology in the curriculum. The first computers were scattered around in classrooms, but then they became centralized in "computer labs." Later still, they began to return to classrooms as one-to-one and bring your own device initiatives expanded.

Just as educators have struggled to decide the correct place for computers to be located in the school building, they have struggled to decide the correct relationship between students, teachers, curriculum, and computers. These struggles can be observed in prepositions that can be used to describe technology-rich instruction. Educators have experimented with:

- *Teaching by computers* as illustrated by the edutainment software that is marketed to teach students a range of subjects, often with arcade-style games. More recently, tools for test preparation have been marketed to educators, and these are a variation on the teaching by computer model.
- *Teaching about computers* as illustrated by the long-abandoned computer literacy curriculum in which students were taught the parts and functions of computer systems. This model is still encountered, however, as computer programming and Internet safety curricula seek to teach students about computers.
- *Teaching via computer* as illustrated by the very popular "*PowerPoint* and projector" lecturing that one observes when waking around many schools today. With this model, the computer has replaced the overhead projector or the chalkboard of previous generations. The classroom dynamics are unchanged, but ostensibly technology appears central to the teaching.

"Technology integration" has been the mantra of educational technologists since about the turn of the century (20th to 21st). Technology integration has often been referred to as "teaching with technology," as the goal of technology integration is to use computers, software, and networks as previous generations used pencils and papers. In the 2006 edition of a popular textbook for courses designed for educators learning to create technology-rich classrooms, Robyler (2006) defined integrating educational technology as "the process of determining which electronic tools and which methods of implementing them are appropriate responses to given classroom situations and problems" (9). Robyler and other appear to approach technology integration as a predictable endeavor and proceed from the assumption that an educators can know unambiguously which technologies will accomplish which goals. In this characteristic, advocates for technology integration appear to be perpetuating instructionism.

One of the early advocated for technology integration was David Jonassen who used the term "mind tools" to capture the nature of the interactions between students and computers. Jonassen suggested, "Mindtools are generalizable computer tools that are intended to engage and facilitate cognitive processes," and he continued, "[they] are both mental and computational devices that support, guide, and extend thinking processes of their users" (2000, 10). Upside-down classrooms are physical places in which online spaces and Mindtools are deeply embedded. Face-to-face discussion continues conversations that began online, and online experiences informs classroom discussions. Technology is leveraged to facilitate knowledge building and sharing. The boundaries between curriculum and instruction and technologies blur as do the boundaries between campus and community and the boundaries between real problems and academic studies.

The Nature of Learning

The fields of cognitive and learning sciences are providing 21st century educators with a clearer view of the structure and function of the human brain than was ever available to educators. This knowledge is also challenging much that was assumed to be true by educators only a few years ago. While this knowledge is new and dynamic, and thus subject to change, there are several characteristics of human learning that are well-supported by this research:

- Students must take an active role in learning. Although physical activity is associated with learning, "active" refers to cognitive activity. The work of holding information in short-term memory, reflecting on it, changing it, and thinking about it is essential for learning.
- Learning is as much a social activity as it is a cognitive activity.
- We learn best if we find an emotional connection to what we are studying; if we don't care, we don't learn.
- Learners are individuals, and each learns is a slightly different manner. The differences that matter include physical and cognitive differences as well as cultural and experiential differences.
- Learning requires hard work that challenges us, but that is not overwhelming. Tasks too easy are boring, while those too difficult are incomprehensible.
- Classrooms should include clear expectations from the start of an activity as well as opportunities for formative assessment. These structures facilitate students as they learn to self-regulate their learning.
- We learn best when we can form horizontal connections between what we know and what we are learning.

Teaching and schooling ill-defined (we don't really know what it means to be "smart"), difficult to understand (we are unsure of how to accomplish it), and there is little consensus surrounding it. Hosrt Rittel and Melvin Webber (1973) defined such planning problems as wicked. Public planners who address wicked problems suggest that are too specialized or solutions that are too broadly applied are deemed unacceptable, and so are replaced quickly. The same planners suggest that solutions that provide broad and diverse choices are judged acceptable by greater parts of the populations, and thus are more long-lived. In addition, planners suggest that using broad guidelines to design local solutions is more effective than prescribing standardized solutions for every sub-population.

Organization of the Book

This book is organized into six chapters:

In "Why Turn Your Classroom Upside-Down," I review several trends in society including the emerging characteristics of the digital generations along with trends in the rapidly evolving information technology landscape. These trends changed—in a fundamental way—what it means to be educated for the 21st century. As this is an aspect of this work that it little-considered in my conference presentations, it is a long chapter.

In "Authentic Learning," I explore further details of the wicked nature of curriculum and the characteristics that make curriculum authentic, and thus more aligned with out emerging understanding of the nature of learning.

In "Beyond Video Instruction: Curriculum Models," I present six curriculum models that can be used to organize the instruction that occurs outside face-to-face sessions. The models presented in the chapter facilitate the work of reinventing homework in upside-down classrooms, and examples are given from K-12 settings.

"ACE Your Classroom" is the chapter in which I turn attention to the design of face-to-face curriculum in the upside-down classroom. Many have found this section to resemble graduate schools research in which students become the cognitive apprentices of teachers.

Upside-down classrooms are necessarily technology-rich places. Educators in these classrooms will be using virtual classrooms, so technology must be available and increasingly improved. "Managing Necessary Technology" is the chapter in which strategies for planning and managing this technology are considered.

A specialized technology necessary for upside-down classrooms is the learning management system (LMS) that provides virtual classrooms. Important planning considerations for school and technology leaders are reviewed in "Virtual classrooms."

"Becoming an Upside-Down Educator" is the final chapter in which dimensions and models of professional learning that support teachers as they turn classrooms upside-down are reviewed as are habits that facilitate planning and design of upside-down curriculum.

1: Reasons Turn Your Classroom Upside-down

A valued and trusted colleague is fond of saying "if you tell me 'why,' I can figure out 'how.'" In these words, she captures the idea that rationale is as important as practice in education. She is unlikely to follow any educational fad (or program or set of standards) that is not aligned with what science tells her about teaching and learning. In this chapter, I answer the question "Why turn your classroom upside-down?" and the answer focused on three points:

- Society is changing, largely because of the influences of ubiquitous information technology. Students arrive at school coming from, and are being prepared for, a rapidly changing technology-rich society. In the upside-down classroom, the role of technology reflects the role of technology in the greater society.
- The digital generations (which includes those born since 1990) have a fundamentally different relationship with information and information technology than previous generations did. Upside-down classrooms

use technology that students perceive as natural.

- Technology, the tools available to students and teachers, both on campus and away from campus, can be leveraged for many purposes in schools. In addition, educators have a responsibility to give students experience studying ideas and interacting using the dominant information technology.

Once these reasons for creating upside-down classrooms are developed, I turn attention to the educational opportunities offered by upside-down classrooms.

Society is Changing

The generations alive at the beginning of the 21st century are observing a change in culture that has not been observed for centuries. Since the printing press introduced text to the masses in Europe sometime before 1450 (printing arrived in Asia even earlier), human society has been dominated by print and the social organizations that are built upon print. Ong (1982) concluded that laws, currency, monolithic religion are all social organizations that evolved because of the influence of print. Likewise, schools were designed to prepare the young to participate in the economic and political and cultural life of society dominated by print.

Reading, writing, and performing computations on paper (the three R's of my schooling, my parents' schooling, and my grandparents' schooling) are the artifacts of a curriculum designed for a print-dominated society. The “lessons” necessary to participate in print-dominated society run deeper than many suspect. Historians Michael Hobart and Zachary Schiffmann (1998) suggested that the first written records introduced the concept of standardized and unchanging information to humanity. Gleick (2011) argued that much of the reflection and the logic that are understood to be part of thinking were not possible before the indefinite memory of the written word.

Prior to the invention of writing, all information was stored in the "oral literature" of a society. Societies without writing are said to demonstrate primary orality. In these societies, knowledge tends to be dynamic, being updated quickly as stories and poems are shared in communal settings with all generations present. In addition, societies with primary orality develop informal educational practices.

In the early to mid-20th century, electronic media began to influence the popular and political life of citizens in Western countries. According to writer and critic Gilbert Seldes (1960), patterns of information use associated with electronic media resemble those in cultures demonstrating primary orality. In general, electronic media require no special training to consume. Electronic media tend to be consumed by large groups (although individuals may be isolated), so the ideas disperse rapidly and are ephemeral.

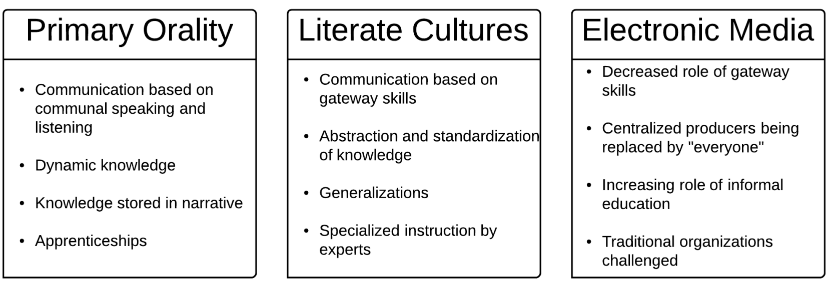

Figure 2. Cultures and information technology

In the 21st century, there is a global information network that can be accessed to almost everyone and the network is available on devices carried in pockets. New trends have been associated with social organizations in areas where networked technology is available. Manuel Castells, a scholar from the University of California, Berkeley, noted, "Technological innovation, and organizational change, focusing on flexibility and adaptability [are] absolutely critical in ensuring the speed and efficiency of the [organizational] restructuring" (1996, 19). Yochai Benkler, a professor at Yale Law School, observed that access to communication networks is associated with greater transparency in all aspects of culture which contributes to individuals participating in democratic governance to a greater degree. Benkler observed "the change brought about by the networked information environment is deep. It is structural. It goes to the very foundations of how liberal markets and liberal democracies have coevolved for almost two centuries" (2006, 1).

Digital Generations

Most commentators mark the beginning of the first digital generation as 1990. Children born in that year entered school just as the Internet was becoming available on the consumer market and as it was being installed in schools. At about the same time, the price of computers dropped precipitously, so that in the United States, desktop computers could be purchased for less than $1000.

Those children also entered adolescence just as web 2.0, the participatory Internet and its iconic platform *Facebook* became available, and they entered adolescence as cell phones became widely available. They graduated from high school with smart phones in their pockets. They have never known a world without computers, the Internet, and cell phones; so their experience is deeply connected to technology. The children of those born in 1990 are beginning to enter school, and they will have a much different view of technology and information than their parents and grandparents who are (at best) digital immigrants.

Several research groups have been very active in studying the first digital generation and their relationship to information technology and these groups are confirming the findings of the others and each is contributing new discoveries to the character and nature of these generations:

- In the data from the Digital Youth Project, which was part of the MacArthur Foundation's Digital Media and Learning initiative, Mizuko Ito (2009) found evidence that young people are actively learning very complex information independently when online.
- John Palfrey and Urs Gasser (2008), scholars form the Berkman Center for Internet and Society, introduced the term digital dossier to refer to the collection of digital records kept about an individual. Palfrey and Gasser observes that young people invest heavily in their online life and they have even given control of it over to others.
- Don Tapscott (2009) observed that the digital generation expect to be able customize media and they expect quick interaction. These are demonstrated in play lists and the expectation that friends respond to messages in minutes.
- Sugata Mitra (2010) described an intriguing (if informal) research project in which he placed computers in rural India, and discovered that children had learned amazingly complex ideas about science by teaching themselves and interacting with the per-programmed machines.

Interestingly, these research groups are beginning to adopt ethnographic methods for conducting their studies. These tools are usually reserved for those settings in which the researchers study cultures other than their native culture. This decision is driven by the recognition that existing instruments for collecting data may not be valid for the digital generations or that existing tools may miss important but unknown factors related to digital generations' interactions with IT.

The effects of information technology on individuals and generations can be illustrated in three conclusions that have important implications for upside-down educators (and all other 21st century educators): adolescence defines natural technology, the increasing sophistication of media consumers, and the information technology skills inversion.

Despite evidence that brains remain plastic into adulthood, humans brains do adapt to the patterns of cognition that are experienced when young, and those become the basis of what individuals expect from other people. The technologies that one uses during his or her adolescent years form the basis of what he or she perceives to be natural and all other technologies are perceived to be artificial. Looking back, individuals tend to judge earlier technologies as primitive and a step contributing to progress that culminates in the natural technologies. Looking forward, individuals tend to judge emerging technologies as artificial and their use to be superfluous (see figure 3). The use of emerging technologies is usually judged as degrading human cognition as the new skills require different skills than are necessary for the natural technologies.

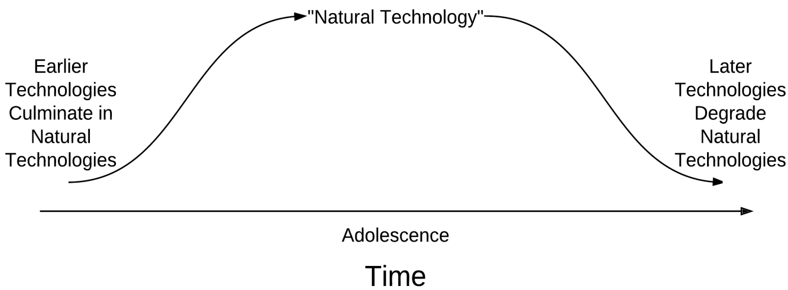

Figure 3. Natural technology

Bruce Wexler (2008), a psychiatrist from Yale University, explains this phenomenon as a human building an internal cognitive structure of skills, knowledge, and attitudes as they mature through adolescence. Because age cohorts experience approximately the same the sociocultural milieu through adolescence, these structures tend to be similar and technologies perceived to be natural tend to follow generational patterns. When a human finds himself or herself in a setting that is contrary to what is natural, he or she feels dissonance and the setting (or some aspects of the setting) is perceived to be artificial.

The emerging sophistication of digital media and the accompanying sophistication of media skills are captured in the observation of Seels, Fullerton, Berry, and Horn (2004) that interest in and attention to media is characterized by a bell-shaped curve. Media that are familiar, simple, redundant, and expected are associated with low interest and attention because they are perceived as boring. Media that are too novel, complex, inconsistent, unpredictable, and surprising are associated with low interest and attention because they are perceived as incomprehensible. Between these extremes of low interest, there is a level of novelty and complexity that creates a high level of interest and attention (see figure 2.4). The authors argue that as users of media gain experience, more complex and novel media are required to hold their attention, so the location of the curve is moved to the right. As all users (including young people) gain experience with technology and complex ideas, learners will demand new and more complex ideas and media in classrooms at a rate greater than expected by populations in previous generations. (see figure 4).

We know that young people born since 1990 have never known a world without IT. We also know that they tend to adopt IT to a greater level than older generations, plus they tend to have a more positive affect towards IT. They have technology, like to use it, and use it a lot.

The result is that—for the first time in human history—the younger generations are likely to be more skilled at using the dominant information technology than those in older generations (figure 5). This conclusion is open to debate, especially if one considers skill at interpreting information, but the level at which members of the younger generations use digital media is impressive.

The information technology skills inversion extends in several dimensions. Young people have more experience finding and using digital media than their adult teachers. Young people have a more positive affect towards IT than adults; they have a more positive attitude towards IT and they are more persistent and resilient when they are faced with difficulties using the IT.

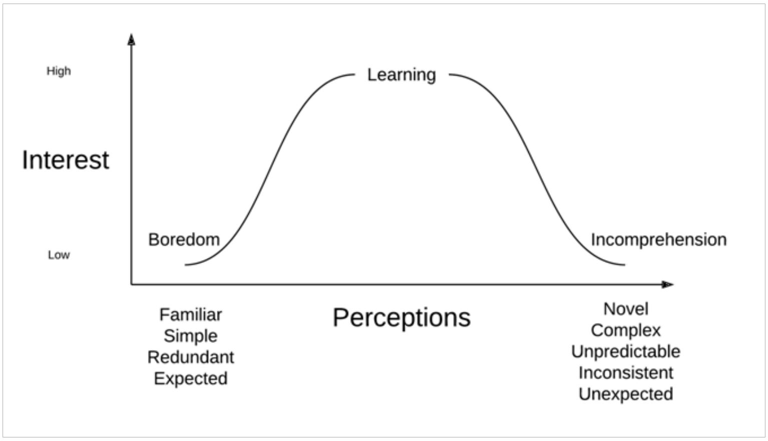

Figure 4. Sophistication of media consumers

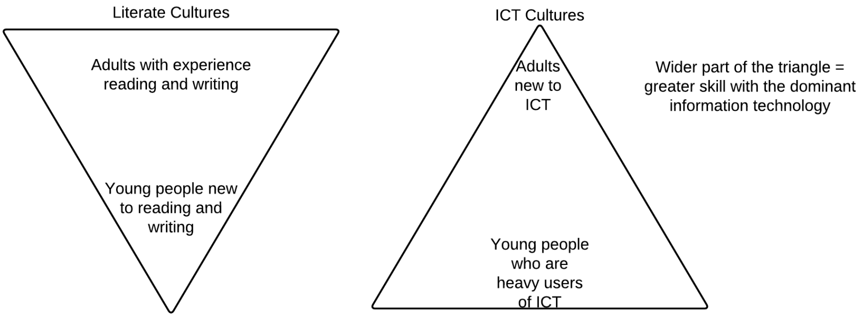

Figure 5. Information technology skills inversion

Christine Greenhow, a scholar from the University of Minnesota, observed that the digital generations are active learners in informal settings and that IT plays an important role in that learning. This combined with the observation that the dissonance results from difference between everyday experience and schooling, the work of embedding IT into schooling represents an important challenge for 21st century educators. Greenhow (2008) stated the challenge for 21st century educators is to answer these questions:

> Can educators similarly tap students' enthusiasm and creativity to shape and carry out their education agenda? Can educators link students' in-school learning and out-of school living to make education more relevant, meaningful, and connected to kids? Can we bridge conventional schooling practices (where content, in many ways, is centrally determined) with informal learning practices (where they spontaneously create content and share) (188)?

Evolving Technology

Technology (both its physical development and its adoption in populations) is characterized by slow growth initially, followed by a period of rapid growth and then a second period of slow growth. This is frequently called an s-curve. In recent decades, there has been a straightening of s-curves and innovation has caused a series of s-curves in information technology.

Today's digital networked technology evolves with amazing rapidity. In previous generation, the completion of the s-curve may have required decades, but today devices move from a concept to the designer's table and into the market in months and then the market is saturated in months as well. This means s-curves are straightening. This effect arises from a shorter time necessary for the trend illustrated in the s-curve to complete the pattern (see figure 6).

Hannemyr (2003) users entertainment media to illustrate this effect: Whereas radio took decades to reach 50 million users, television took only a few years, *YouTube* reached that many users in months. For educators, the planning that was typical in the 20th century could proceed under broad s-curves, as trends could be identified and curriculum and instruction adjusted slowly. For 21st century educators plans must be revised

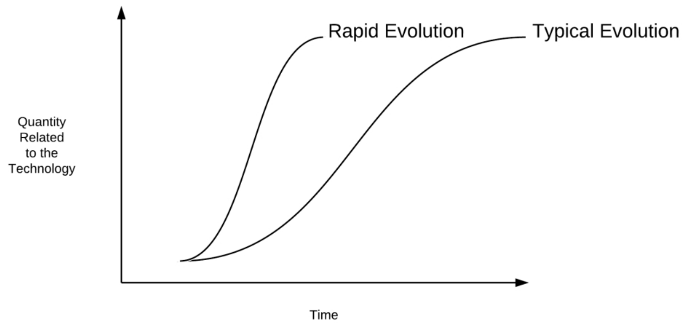

Figure 6. The straightening of s-curves

Typically, the leveling of an s-curve results from a limit being reached that restricts further improvement. Especially with computer technologies, the leveling of an s-curve has been associated with a jump to a new s-curve as a new approach is discovered and begins a new s-curve growth pattern (see figure 7).

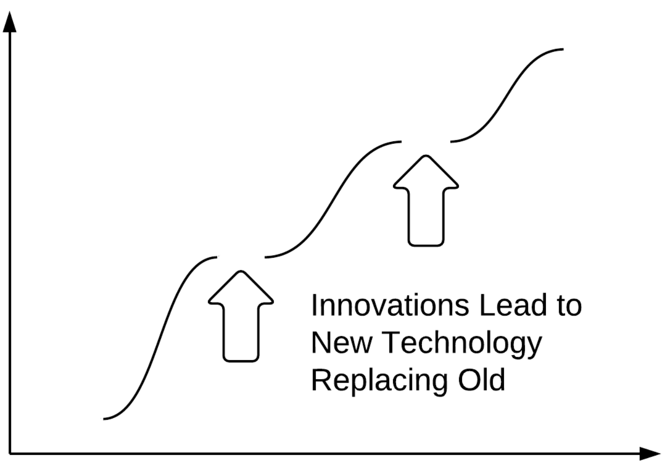

Figure 7. S-curves of innovative change

Whereas s-curves were broad and innovation infrequent until the last decades of the 20th century, the time since has been marked by straight and innovative s-curve patterns. This has produced a dynamic and changing IT landscape. Upside-down teachers tend to have this technology available, their students are experienced with it, and they are preparing students for full participation in that landscape. Schooling must give students experience with IT and prepare them for an unpredictable future.

Educational Opportunities

In the previous sections, I described societal, generational, and technological reasons that an educator would want to turn his or her classroom upside-down, but without practical reasons, educators are unlikely to make any changes. In this section, I describe some of the advantages others have found after turning classrooms upside-down. These are day-to-day changes in teaching and learning that can be observed after turning a classroom upside-down.

Efficiency of Instruction

In many communities, and in many assessment systems, value is placed on students' knowledge of “facts” and their ability to score well on tests. Even those educators who argue that is a vestige of an obsolete educational system will recognize a role for “testable knowledge” in schooling. Those educators tend to recognize this as necessary, but not sufficient for one's education. Upside-down educators who hold this position appreciate the efficiency that can be achieved through upside-down models.

- For those skills and that knowledge that can be reinforced by instructionist, upside-down classrooms provide multiple options for increasing the efficiency of instruction.
- Authentic curriculum increases students' interest and emotional connection to skills and knowledge, so students are more likely to deem those lessons “important.”

- While vetting resources, upside-down educators can identify multiple approaches to the same concept. By making multiple versions of a topic available to students, they diversify the instruction for those students who need it.

In addition to instructional efficiency, upside-down classrooms facilitate many of the administrative tasks and information management required of teachers. An example is online testing, which is supported by most every learning management system (LMS), and that is further described in chapter six. Once the test is created, students can complete it from any computer that is connected to the Internet, and multiple choice and similar questions that can be graded without human intervention can be scored immediately. Most LMS also allow teachers to create rules so that, for example, students who score low will be flagged and questions that are most students answer incorrectly will be marked as well.

Apprenticeships

By turning a classroom upside-down and thus removing some of demands for instruction to outside the classroom, the classroom becomes a place where students and teachers can engage in what is best described as cognitive apprenticeships. These activities resemble apprenticeships as the mentor and provides guidance as students gain experience working through problems that resemble those encountered by professionals working in the field.

Many educators observe they would adopt authentic learning or ACE activities (see the chapters "Authentic Learning" and "ACE Your Classroom"), but that there are too many demands on classroom time to allow these to be scheduled.

Expanding Campus

Prior to the arrival of widely available networked technology, classrooms were isolated and localized; upside-down classrooms extend the classroom in time and space. A virtual classroom can store an indefinite amount of information for an indefinite time. At near-zero cost, students can review any materials on a virtual classroom from any place where there is a computer connected to the Internet.

Time is also extended in upside-down classrooms as previously ephemeral interactions are saved, discussions can occur asynchronously, and presentations can be reviewed an indefinite number of times.

Access to online video and email and similar messaging systems extends the population of the classroom to far greater numbers of individuals. These populations can interact with the classroom population in various ways also. Many point out that classrooms can be extended in similar ways without using technology, but the non-technology solutions tend to be more expensive and slower than technology-mediated extensions. Also, students tend to have a positive affect towards the use of technology compared to other methods of extending the classroom.

Educated in the 21st Century

The dominant information technology has been print for so long that it has been natural for generations of students and teachers to conclude skills using text should be the focus of curriculum. Many of today's educators were adolescents when print still dominated culture, but print is being replaced by digital electronic information. This is leading to dissonance in several aspects of information technology that have implications for educators.

Whereas education and learning in print-dominated societies depends on the gateway skills of reading and writing, the digital generations are developing skill with other methods of learning. Also, they are taking control over their own learning and finding spaces and places to learn on their own. Steven Johnson, a well-known writer about popular culture and the influences of information technology on popular cultures argues that television and other media (including video games) are becoming more complex with richer narrative, more characters, and more complex plot twists. Compared to 20th century media, Johnson (2006) observed the modern media landscape is comprised of "Games that force us to probe and telescope. Television shows that require us to fill in the blanks, or exercise [our] emotional intelligence. Software that makes us lean forward, not lean back" (136). It appears that television is becoming a learning experience.

Information Skills

For recent generations (until the digital generations), the skills and knowledge necessary to be considered literate and numerate were well-known and stable. Reading and writing and calculating were the same for students as it had been for their parents and were to be for their children. As IT has become ubiquitous the nature of reading and writing and calculating skills has changed.

Whereas the information skills necessary for using print were largely taught through formal instruction, the skills for using 21st century IT are being learned organically and informally. Those who are quick and flexible learners tend to be the most skilled users of IT. Also, those who persevere when they encounter difficulties using IT and those who are resilient after difficulties, tend to have higher levels of satisfaction when using IT, and that satisfaction is associated with a positive affect towards technology and higher skill with technology.

Digital electronic networked information technology is changing the nature of social interaction, and thus it is redefining the information skills necessary for and expected by the digital generations. Specifically, Mark Deuze (2006), a scholar from Indiana University, Bloomington, identified *participation*, *remediation*, and *bricolage* as skills needed for the 21st century media landscape.

- Whereas previous generations were primarily consumers of media, there is an emerging expectation that individuals participate in the creation of the digital media landscape as much as they consume in that landscape. Social networking sites and media sharing sites are examples of IT that encourage this participation.

- The Internet provides access to vast information from sources of dubious reliability which necessitates individuals take an active role in assessing and evaluating information. In the past, reviewers and editors performed this remediation.
- Bricolage is a term that refers to one's propensity to explore and discover new uses for and uses of technologies. Being a bricoleur requires one to approach a new technology with openness to new connections and without feeling compelled to follow prescribed uses.

21st Century Organization

The purpose of education is to prepare students to fully participate in the economic, political, and cultural life of society. Several scholars have contributed to an emerging understanding of the nature of organizations and the characteristics of members of those organizations.

Olumuyia Asaolu (2002), a scholar in industrial and information engineering at the University of Tennessee, differentiates individuals and organizations that were influenced by Fordist (Old) technologies from those influenced by ICT (New) technologies (see table 2). In general, the individuals and organizations that interact in a manner reflecting ICT (New) technologies are more flexible and have more dynamic interactions, whereas individuals who interact in a manner influenced by Fordist (Old) technologies are characterized by specialized and predictable interactions. Asaolu concluded that the increasingly innovative advances in IT (from both industry push and user pull as well as users discovering new applications) will continue as IT becomes more ubiquitous and becomes even more deeply embedded in everyday life.

Table 2. Characteristics of Fordist (old) and ICT (new) organizations

Fordist (old)	ICT (new)
Energy-intensive processes	Information-intensive processes
Standardized activities	Customized activities
Stable product mix	Flexible product systems
Dedicated facilities	Flexible production systems
Automation	Systemation
Single firms	Networks
Hierarchical management	Flat management
Specialized departments	Integrated
Product with service	Service with products
Centralized organization	Distributed organization
Specialized skills	Multi-skilling
Minimal training	Continuous retraining
Adversarial relationships between management and labor	Participative relationships between management and labor
Long-term full time employment	Flexible employment

adapted from Asaolu (2002)

Jon-Arild Johannessen, a scholar from the Norwegian School of Management, suggested that organizations gain competitive advantage in the global economy by developing innovative solutions to complex problems. These problems are only solved through perpetual innovation, which is sustained in organizations with “invisible assets.” These assets include seemingly contradictory stances: openness to new ideas yet closed organizational norms that sustain innovation, and deep understanding of one field yet also understanding its connections to other fields.

Assets and social norms that support innovation become self-creating and supporting and develop organically. Innovative thinking can be neither imposed nor mandated and there is no recipe that can be followed by an organization's leaders to ensure that innovative solutions are produced. In innovative organizations, Johannessen (2008) concluded,

> the workforce will shift away from employees who have traditional, practical training backgrounds and towards an ever-increasing number of employees who have had a higher education and are theoretically well equipped." Such workers will "be capable of working in a problem definition and problem-oriented manner and possess skills for both analysis and synthesis (407).

Stephen Hall (2010), an award-winning writer about science and society, argued that human wisdom is built upon eight pillars: a) emotional regulation, b) knowing what's important, c) moral reasoning, d) compassion, e) humility, f) altruism, g) patience, and h) dealing with uncertainty. Hall's interest in wisdom arises from his interest in the question, "How do we make complex, complicated decisions and life choices, and what makes some of these choices so clearly wise that we all intuitively recognize them as a moment, however brief, of human wisdom?" (2010, 6). Hall recounted the story of a scholar who has become a leader in the field of wisdom studies, and who concluded,

> that wisdom represented a state of mind beyond standard metrics of intelligence, and this revelation forced him to see inherent failures in the educational system, and the philosophy of educational testing, and the degree to which too narrow measures like IQ tests fail miserably to predict lifetime satisfaction (245).

Extending this reasoning, Hall concludes that wisdom is knowledge and skill that can be applied in unpredictable and diverse circumstances. The problems that face humanity in the 21st century, Hall concludes, will require people who have experience and wisdom that is aligned with the eight pillars rather than people who can succeed in 20th century classrooms.

Conclusion

The motivation for reinventing curriculum and instruction for the 21st century comes from several factors. In general, we can conclude that students and society are changing in a manner that makes the schooling that was appropriate in the 20th century obsolete. Upside-down classrooms as presented in this book are designed to reflect that central and dynamic role of technology in society and give students experience with the complex and diverse skills necessary for our emerging technology-mediated society.

2: Authentic Learning

Much of the 20th century recitation script for education, in particular the articulation of measurable goals and the focus on efficiency, was based on the assumption that becoming educated was a problem that could be easily understood and defined. So that curriculum goals could be achieved efficiently, the problems that became learner tasks were de-contextualized; the context of rich information and social interaction from which the problem is derived was removed. While this was done for the purpose of removing complicating information, such de-contextualized problems were isolated from the real-world and have little meaning beyond the classroom, and students find them not engaging. Although such de-contextualizing removed opportunities for students to find connections between their everyday experiences and schooling which is now known to facilitate learning, it is still practices in many communities.

Kathy Davidson and David Goldberg (2010), scholars associated with the MacArthur Foundation's Digital Media and Learning Project, used the term flat classrooms to describe initial attempts in recent decades to design curriculum and instruction around context-rich problems rather than de-contextualized problems. They identified project-based learning, differentiated instruction, authentic assessment, and cooperative learning as some of the educational practices that preserve context and encourage social interaction in learning tasks. Educators and leaders have observed that efforts to create flat classrooms are sometimes met with resistance from various stakeholders in educational communities, however. Flat classrooms and IT allow for interactions that are mutually compatible; the methods are improved through the application of IT and teachers who adopt IT find flat classrooms easier to implement. Still, however, Davidson and Goldberg recognize educators have been slow to adopt IT-rich flat classrooms.

For 20th century purposes, de-contextualized curriculum created independent from students' interests and experiences that has been stripped of complicating factors and designed to create products and performances for teachers alone may have been sufficient. Advocates of flat classrooms are among those who argued that more complex and sophisticated problems are now necessary for students to develop skills to participate in new, innovative, and wise organizations. Brad Mehlenbacher (2010), a scholar associated with several programs at North Carolina State University, observed, "Over time, our definition of [learner] tasks has generally grown more realistic, meaning we have generally acknowledged that tasks cannot be easily algorithmized or parameterized" (233). By retaining the complexities of problems that become the focus of curriculum and instruction, it is reasoned learners will develop the innovative thinking that is of particular importance in the unpredictable future.

Jan Herrington, Ron Oliver, and Anthony Reeves (2007), scholars from Australia, concluded learning tasks that allow students to generate and test their own ideas and that replicate the rich situational complexity that is encountered by professionals are appropriate for meeting the needs of 21st century learners. They reviewed research and meta-research conducted around the turn of the century and found that classrooms in which that complexity has been conserved share nine characteristics:

Based in Real-World Problems

When challenged by students, “Why do we need to know this?” many educators respond by describing situations in which the ideas and skills being taught may be useful once the students have developed them. Herrington, Oliver, and Reeves (2007) noted, however, “it is not sufficient to simply provide suitable examples from real-world situations to illustrate the concept or issue being taught” (27). By leaving the details intact as the problems are transferred from the professional world into the classroom, educators preserve the conditions that make the skills and knowledge necessary and students find connections between their experiences and the problems as they gain experience working through—although not necessarily solving—real world problems.

Extended Time to Work

Because real-world problems require days or weeks (or even longer) of effort to sufficiently understand and solve, authentic learning tasks should allow students to work on the problems for similar lengths of time. Artificially simplifying problems so that they fit into available time frames may be necessary, but does jeopardize the real-world nature of the problems.

Access to Experts

In traditional classrooms, the teacher is the individual who has the most experience in the field, and hence is the community’s expert. Through authentic learning activities such as apprenticeships and case studies, students will encounter professionals and other experts in the field with even greater experience than the teacher. Access to these experts provides students with different perspectives and understandings of the structure of the discipline as it is applied to real-world problems. In some instances, educators who have experience in the field—for example music teachers who also have performing careers or science teachers who have worked as researchers—may be able to provide such expertise, but authentic learning requires the distinctly different perspectives of both the professional educator and the expert.

Multiple Perspectives

The problems that focus study in authentic learning environments are likely to be wicked and so the multiple perspectives that different individuals and populations bring to those problems are introduced to classrooms. When designing authentic learning tasks, educators will both recognize and encourage students to consider and reconsider the problem from different perspectives, and the planning will not prescribe students adopt a particular perspective. Further, in 21st century classrooms, authentic learning makes use of the primary and secondary sources that are available via networks, and so tertiary sources (such as textbooks) are of lesser importance.

Collaboration

Whereas much pedagogy is designed to encourage students to work together, and those methods do encourage social interaction which is fundamental to human learning, Herrington, Oliver, and Reeves define collaboration as social learning that results in a product that could not have been created independently by any of the participants. This represents a more sophisticated view of social learning than simply allowing or encouraging students to work together when completing learning tasks.

Reflection

Authentic learning tasks encourage students to think about how the parts of their solution fit together and the processes that led them to the solutions they create. Further, they are led to revisit their process and solution to assess their strategies and approaches. This process is typically referred to as reflecting on the work, and through those processes, students become meta-cognitive; they think about their thinking.

Access to Scaffolding

In traditional classrooms, both the cognitive structure of the disciplines and the details and applications of these structures are prescribed in the curriculum. In authentic learning environments, the structures are provided by the teachers and other experts and the students gain experience within that structure by filling in details and exploring applications. For example, a science teacher may introduce experiments as a tool that scientists use, and then students will study how experts design experiments and they will design their own experiments. As they conduct experiments from real-world problems, students in an authentic science classroom will gain experience with the details of experimental design and data collection and analysis. In this way, authentic learning facilitates coaching and guidance by teachers and experts rather than direct instruction.

Articulation

A part of reflection and a part of collaboration in authentic learning is articulation, and Herrington, Oliver, and Reeves include original speaking and writing and performing as part of authentic learning. Much articulation in K-12 curriculum and instruction occurs within the scaffolding provided by educators' questions and prompts. While that type of guided-articulation can be important as students develop expertise, authentic learning also requires learners to compose their own versions of new understanding and insights independent of expert scaffolding.

Authentic Assessment

In all learning environments, some tasks are completed with the expressed intent that the students' learning will be judged based on their performance. In traditional learning environments, these tasks are typically contrived and have little relevance beyond the classroom. Tests are generally identified as an example of tasks that have little relevance beyond the classrooms. (It should be noted that in some professions—for example those related to information technology—performance on tests is used as a gateway through which professionals earn certifications or licenses. As an adult, I observed my father, who had been a truck driver for decades, studying to earn his license to haul hazardous materials as cargo. While the test covered important aspects of hauling such materials safely and in accordance with relevant laws, once he earned the license, his performance on the test was of minimal importance to his supervisors.) In authentic learning settings, the products and performances used to judge students' learning are similar to those produced by professionals working in the field. The products and performances have meaning in the real-world, as well as having meaning in the classroom.

3: Beyond Video Instruction: Curriculum Models

Most traditional homework falls into one of two categories:

- Reading to prepare students for face-to-face class;
- Follow-up activities deriving from face-to-face class.

This homework is done away from the teacher who is the local expert on the topic, and so it is difficult for students who are doing homework to ask questions or get guidance. Those students who are preparing for class frequently cannot find relevance because the presentation proceeds from new and known. In flipped classrooms, homework tends to be preparatory for upcoming face-to-face sessions and it tends to prepare the context for the face-to-face activities.

In upside-down classrooms, the nature of the "homework" given to students is different than the nature of the homework given in traditional or flipped classrooms. In upside-down classrooms, the "homework" is used to both prepare students for upcoming lessons and to follow-up from face-to-face classes, but the homework:

- Can be easily completed independently;
- Is understood to be relevant to on-going studies.

In this chapter, several models of planning homework for the upside-down classroom are presented. For each, there are planning guidelines as well as examples drawn from various grade level and subjects that describe what each might look like in practice. Several of these models make use of ACE activities. ACE is my acronym to abbreviate the authentic activities that are designed for on campus sessions. ACE stands for activities in which students:

- Apply of the ideas and skills to complex and relevant problems;
- Connect the ideas horizontally, and;
- Extend the ideas and skills into new problems.

ACE activities are the subject of the next chapter. The models presented here are intended to be "no threshold" activities, in that students should not be expected to complete other tasks prior to engaging in these upside-down lessons. Reserving activities such as these for reward or enrichment is not a tenable position. As has been presented, this curriculum and instruction is necessary for all students.

Dimensions of the Models

Because these models are not presented as recipes, teachers who implement these will exert judgment as they adapt them to the local resources, goals, and communities. In general, there are three important dimensions that characterize these models.

Local to Extended

Whereas traditional classrooms were local places with a local population meeting at a specific place to interact with each other and to use local resources. Compared to traditional and flipped classrooms, upside-down classrooms are more extended phenomena. The extension includes place, people, and information.

- The physical place of a traditional classroom is extended into an online space and much of the information that is consumed is available via that online space and much interaction occurs through that online space.
- By connecting students in different sections or different school and by connecting experts from the community or the profession with learners, the upside-down classroom extends to the classroom community to other learners and experts.
- With a virtual classroom, the local classroom place extends into and online space. The problem of storing papers (for example) is relieved with a virtual classroom there is space to save every draft of every paper every student makes.
- Whereas traditional classrooms were places where teachers held tight control over the information that students accessed, upside-down classrooms recognize that students have access to many of the same information tools that professionals do, and many of the same information and tools that quacks do.

Passive to Active

In traditional and flipped classrooms, students are perceived to by passive. There are many metaphors that have been used to capture the idea that teachers tell students "things" and that students then "know" those "things." As cognitive and learning scientists have discovered, learning is a much more social and active process than the instructionist model allows. In upside-down classrooms, teachers design curriculum and instruction so that learners are actively connecting new ideas with their previous knowledge and they are actively building knowledge.

Active learning is a concept that is becoming increasingly sophisticated as the cognitive and learning sciences elucidate details of human learning. In general, active learning requires students build knowledge rather than simply receive information from teachers or texts. Marlene Scardamalia and Carl Bereiter (2006), educational psychologists from Canada, suggest knowledge building is grounded in several approaches:

- Knowledge is build by communities rather than individuals;
- Knowledge is idea improvement as opposed to discovering truth;
- Collaborative problem solving;
- Use of authority as opposed to deference to authority;
- Knowledge as an emergent property.

Contextualized to Decontextualized

Much curriculum is built upon skills and knowledge that is necessary for real-world problems, but those problems have been sterilized. In an effort to make the information easier to understand, many of the factors that make the problems difficult to resolve in the real world are removed. The curriculum is thus is contextualized; it has little meaning outside the classroom. When curriculum is decontextualized, the curriculum has meaning both inside and outside the classroom.

The differences between contextualized and decontextualized learning can be illustrated with a personal experience. When I was 42, I suffered a stroke, and it required several weeks of therapy for me to learn to walk again. When I first met the therapists, they gave me a long list of tasks to remember when walking such as “snap that leg forwards,” “toes up,” “land heel first,” and others. It was clear I had forgotten how to move my legs to walk. My therapy included both contextualized and decontextualized activities:

The contextualized activities were those exercises that seemed to have little connection to walking. Standing on a pillow on one foot with my eyes closed was a favorite, as was pulling myself down the hall on w wheeled chair and digging my heels into the floor and contracting my hamstring.

The decontextualized activities found me walking in a variety of settings. I found as a waled on grass and gravel that the muscles I used when standing on a pillow were used and that when I ran, my hamstrings worked much like they did when pulling myself down the hallway.

For me, both types of activities were necessary to learn to walk again, but neither was sufficient for my walking. I believe the same to be true of all education; some exercises are necessary, but real-world problems are also necessary.

Check-ACE-Preview

Check-ACE-Preview is the model which most closely resembles the flipped classroom model because video is used to prior to face-to-face lessons. The fundamental difference between Check-ACE-Preview and flipped classrooms is the underlying pedagogical model. In flipped classrooms, the pedagogy is instruction and the purpose is to introduce a new idea that will be the focus of the following face-to-face lesson. In upside-down classrooms, the video contributes to the narrative of the unit and to students' general understanding of the topic.

The difference between the role of video in flipped classrooms versus the role of video in upside-down classrooms can be seen in Scardamalia and Bereiter's

(2006) differentiation of knowing about and knowing of. Knowing about is defined as the ability to declare knowledge when prompted; knowing of is a far more complex and integrated way of knowing. One who knows can declare knowledge about the topic, can demonstrate relevant procedural knowledge, and has a sense of the field of knowledge and how the knowledge can be applied to solve new problems.

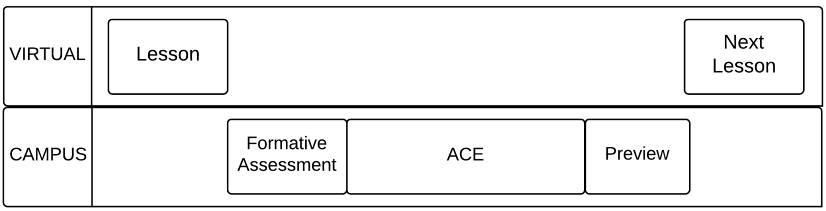

Figure 8. Check-ACE-Preview

To implement a Check-ACE-Preview lesson a teacher will:

- Assign students to view video (or complete other online experiences);
- Use formative assessment strategies to check students understanding of the virtual lesson;
- Engage students in face-to-face ACE activities that continue to develop the ideas in the video lesson;
- Preview the next video lesson which may include providing graphic organizers or other scaffolds to facilitate understanding.

Example

When teaching physics, I make extensive use of Walter Lewin's lectures which are available from several sources. (Lewin teaches an introductory physics course at the Massachusetts Institute of Technology, and video of his lectures has been posted online for anyone to use.) One of the first activities we undertake is to measure the speed of sound. Over the course of a week, students watch one lecture in which Lewin discusses measurement and error and parts of a second in which he discusses sound waves.

During the week when students watch Lewin's lectures for homework,, they are designing experiments to measure the speed of sound using the space and materials we have available in the lab (and invariably the corridor as we need the sound to travel a longer distance than we can observe in the lab.) When students are designing experiments, they are expected to consider how Lewin gathered and analyzed data during his demonstrations.

The formative assessments used during the week vary. Students are asked about error as defined by Lewin, and then students are asked to describe how they included considerations of error in their design. Students are asked to complete online quizzes which ask some declarative and procedural information from Lewin's lectures. While these are graded, students understand this is a relatively small part of the total grade; the application of the ideas to experimental design and correct data analysis on experiments is a greater part of the grade.

Walter Lewin's lectures are used frequently when I tech physics. In many of the lectures, Lewin uses advanced mathematics. In those situations, I am sure to identify formulas that Lewin uses as well as the purpose of the formulas (in writing) as part of the preview.

Design Principles

When designing check-ACE-preview lessons, educators should:

- Find lessons that continue the narrative of the ACE activities in the classrooms. The instruction for procedural knowledge that is commonly accomplished through video in flipped classrooms can be better accomplished with worked examples which is another of the curriculum models described in this chapter.

- Design authentic ACE activities; if face-to-face activities lead to knowledge about the topic (rather than knowledge of the topic), then the model is being incompletely implemented.
- Check-in's are important to ensure students understand the lessons they are accessing outside of class. Many formative assessment strategies are available and can be used to vary this aspect of the model.
- Avoid "reteaching the material 'the right way.'" Vetting the lessons and providing students with outlines or similar previews of the instruction minimizes teachers' sense that the instruction was inappropriate.
- Seek to match the vocabulary in face-to-face activities to that used in the video and other media that comprise the homework lessons.
- Point students to content that is better than can be presented by the instructor. (I use Walter Lewin's lectures in physics classes because he is a far better lecturer than I am.)
- Linking the videos or other materials from a virtual classroom (see chapter 6: Virtual Classrooms), they can be indefinitely available to students to revisit as necessary.
- Understand the importance of pointing video or other interactive presentations are more accessible than textbooks. By directing students to these when they are independent, they are more likely to complete the tasks and engage in a meaningful way.

Quest

The quest model takes it name from the computer gaming community. In quests, players pursue a goal or earn points with independence. In upside-down classrooms, the teacher identifies a stand-alone activity that is related to the classroom content, but that can be completed independent from face-to-face sessions. Typically a quest uses a web site in which users can complete tasks and earn points, thus progressing on the quest and (as long as the site is sufficiently educational) learning the curriculum.

When a classroom is turned upside-down with a quest, working on the quest becomes the homework assignment, and students exercise choice and control over when and how the quest is pursued. Most teachers will assign a stopping rule for a particular quest such as “stop when you earn *x* points” or “pursue the quest for five hours.” (Sites that make good quests can track points and other statistics related to user access.) Educators who find success with the quest model suggest the model is appealing to students who have significant experience playing video games, and can both interact with devices with greater facility that adults and develop complex strategies for playing online games.

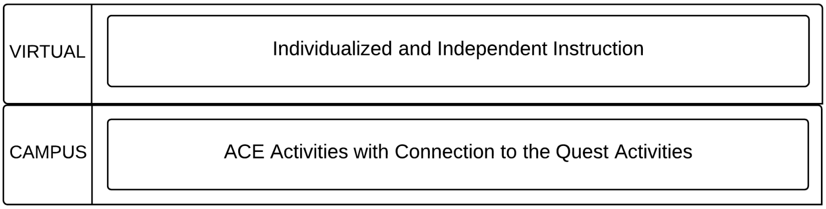

Figure 9: Quests

Upside-down educators who use this method will often separate the curriculum into the quest curriculum and an authentic curriculum that occurs in face-to-face sessions. These educators will facilitate students initial access to the quest site and ensure each can access the site and understand how it operates and how they are expected to engage with the site. After the initial “on-boarding,” many upside-down educators encourage students and monitor their progress, but the quest becomes an individualized endeavor. This character of quests appeals to a segment of the educational community that advocates for individualized educational programs.

To implement a quest, an educator should:

- Find and vet the site. In particular, educators should focus on the terms of service and privacy policies of the site. Those sites that potentially violate the Children's Online Protect Act or other regulations and policy related to young people's online life must be avoided.
- Ensure students have access to the site, including knowledge of user names and passwords and devices with sufficient web connection and properly configured web browsers.
- Provide the students with clear stopping rules and expectations;
- Monitor student access throughout the quest to identify and troubleshoot poor performance.

Example

Middle school students were studying computer programming as part of their unified arts rotation. The instructor divided the students into research groups for on-campus multimedia programming projects. The work was easily divided into tasks, such as designing characters, scripting the story line, programming interactions, and creating audio files, and so collaborative and active learning was easily accomplished through that activity.

During the weeks when students were working on the multimedia programming projects in class, they had the assignment of independently working though a web site that introduced Java though a series of prescribed lessons. Students were expected to earn an established number of points (per the site's point scheme) during the given number of days.

Design Guidelines

Among the features that teachers find useful when choosing quest are:

- Quests are well-designed for aspects of the curriculum that focus on declarative or procedural knowledge. (Examples include: computer programming, spelling, math facts, vocabulary building, typing, test preparation, strategy games, and similar topics.)
- The best quest systems system includes tutorials and systems for automating the evaluation of students' responses. This provide immediate feedback and instruction when students are working on the quest.
- Educators have a responsibility to ensure students are familiar with the quest site prior to expecting they use it for work upon which they are evaluated.
- Teachers must ensure the sites used for quests are compliant with rules such as the Child Online Protection Act, local technology policy, and they must comply with the site's terms of service.
- There is the potential for "cheating" as progress is associated with accounts, but there is no way to be sure who was the individual using the account. For this reason, many educators make sure to select quests of

high interest and incorporate the ideas and lessons into other projects that are used for assessment and evaluation.

Data Analysis

All science teachers (as well as teachers of many other subjects) are familiar with laboratory activities; students construct an apparatus and collect measurements based on prescribed methods (or students otherwise gather data). These activities are usually followed by analysis of the data to identify patterns, answer questions, and draw conclusions. A common complaint of those teachers is that students do an inadequate job analyzing the data and draw weak conclusions. By preparing students to collect data outside of class, teachers can turn the classroom upside-down and make time available for guiding analysis.

While this is a model well-suited to science and math that deal primarily in quantitative data, it can be used in other areas as well. For example, my upside-down colleagues have had students analyze various texts (including both fiction and non-fiction) and analyze video (including speeches and dialogue in foreign languages). In all of these cases, the students arrived at class with their data, and reconciling differences and identifying commonalities became the data and the analysis was guided by the teacher.

To implement data analysis, the educator will:

- Identify and vet a simulation or primary data source.
- Model the data collection procedure to prepare students for data collection.
- Give clear expectations regarding and model data collection.
- Plan for providing a similar experience for those students who lack access to the sources.

- Design and complete data analysis with the students as an ACE activity.

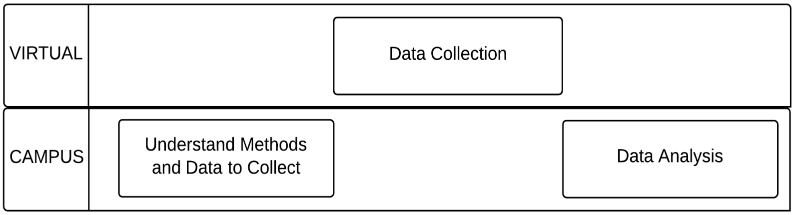

Figure 10. Data analysis

Example

A group of fifth grade students (in a school with a recently completed one-to-one laptop initiative) were studying pendulums in science class. One of the objectives was to have students understand the relationship between the length of the pendulum and its period. In class one day, students were introduced to a virtual pendulum maintained by a university physics department. Students were shown the pendulum and its controls. The teacher modeled the data collection procedures he expected the students to follow, including the data to be recorded on a spreadsheet.

Students then navigated to the virtual pendulum on their laptops and experimented with the pendulum to ensure it functioned on their laptops. Students then opened spreadsheet template prepared by the teacher and recorded several trials of the experiment. For homework, the students completed several additional trials.

When students arrived at class the next day, the teacher led them through an analysis of the data, including making a prediction about the period of a pendulum of a certain length. Students then built pendulums to test their predictions (and reconcile the differences between the idealized virtual pendulum and the real pendulum existing in a frictional world).

Design Guidelines

When designing data collection for upside-down classrooms, be mindful of the following:

- The 21st century finds vast amounts of primary data available on the Internet. Texts and speeches are available in their original form as are news accounts and other archived sources. While these can be very useful and facilitate data collection, students must also gather their own data, especially from local sources. Students need to complete wet labs as well as virtual labs.
- Some teachers have reported that they have success introducing the idea of writing lab procedures with students by having them describe the steps in using virtual labs. The concrete example of "this is how to operate the virtual lab" tends to easier for students who are first learning to write procedures to understand and follow.
- Students must understand clearly the data collection steps prior to gathering data. (Of course significant differences in results can become a topic of meaningful discussion.)
- If the virtual data collection requires an active Internet collection (which is common), then teachers must develop a strategy for allowing the full participation of students who lack access to adequate technology.
- While it is tempting for the educators who is pressed for time to skip the data analysis and proceed through the curriculum, they are missing the point of the lesson. The efficiency of instruction afforded by the virtual

lab allows for time to guide students through the data analysis.

Context/ Experience

Academic learning and interaction is largely mediated through text and writing. Lev Vygotsky suggested that this results in education that proceeds from formal to informal as educators put literacy before experience. Upside-down educators understand that experience first can improve literacy. In my traditional schooling (decades ago), my Humanities teachers arranged for our class to view a film of "Romeo and Juliette" after reading the play. For many of us, that film caused the react, "oh, that's what the story was about." The upside down educator appreciates that value of using the film first.

In upside-down classrooms, teachers have found that they can use video and other experiences to give students experiences and context that makes the text-based curriculum more approachable, understandable, and relevant. This model is similar to the flipped classroom model in which video instruction is provided, but the intent is to provide a broad and multidimensional introduction to a topic, not to provide instruction. The model is similar to the Check-ACE-Preview model, except that there tends to be a direct (but not instructional) connection between the video and the ACE activities that follow.

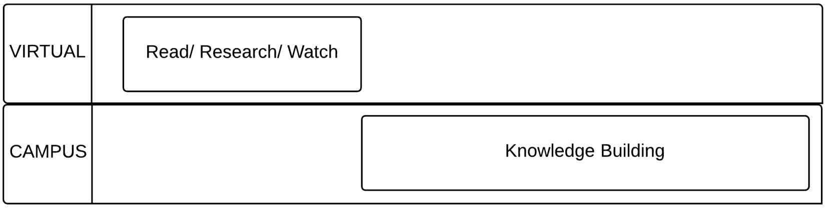

Figure 11: Context/ experience

To implement upside-down lessons to provide context or experience, the upside-down educator will:

- Find and vet resources;
- Provide necessary scaffolding and motivation to ensure students participate;
- Work during ACE activities to establish and strengthen the connection between the content/ experience activities and academic skills and knowledge.
- Consider the timing of assigning and perhaps reassigning these activities.

Examples

To introduce a unit on poetry to high school students, an English teacher and I collected several video readings from modern poets. These were added to the English teacher's virtual classroom. The students arrived in the computer room one day to add a few formatting details to their research papers, and then print their papers and submit them to the drop box in the virtual classroom. After completing the tasks, we watched together some of of the readings.

One of the videos showed Billy Collins reading his poem "Litany," and in the video, he explains how he used the first two lines of another poet to write his poem. After hearing Collins read that poem, students were assigned the task of finding three poems and rewriting them in the same manner that Collins had to write "Litany." Students had the option of reading their poems at an upcoming performance night.

Design Guidelines

Teachers who design context/ experience models should understand:

- There may be discrepancies between the context/ experience activity and the classroom version of the piece. This is common with film adaptations of texts, but resolving those can be an excellent ACE activity.
- The boundaries between this model and others blur. In many ways, the Walter Lewin lectures (described in the example of check-ACE-preview) provided content/ experience for the ACE activities. In addition, quests can become context/ experience for ACE. For example, playing the classic game Lemonade Stand (in one of its modern iterations) can provide experience for students learning accounting.

Worked Examples

Especially when educators include significant amounts of authentic ACE activities in their campus-based instruction, there is frequent need for students to be reminded of how to perform certain tasks or to solve particular problems. In these situations, a collection of worked examples can be helpful in the upside-down classroom. A worked example is a step-by-step illustration of how to solve a problem. In the upside-down classroom, the virtual classroom becomes the repository for worked examples, and students can access the collection as needed.

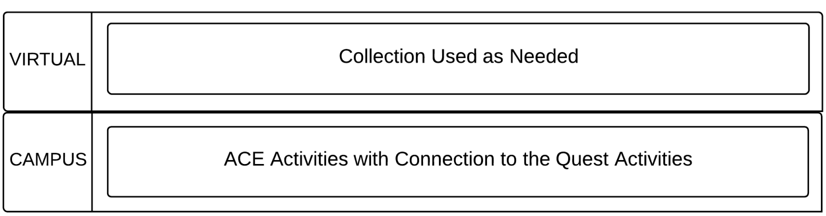

Figure 12: Worked examples

To implement worked examples, the upside-down educator will:

- Have accesses to a virtual classroom or web site where the examples are stored and managed for student to access.
- Find and vet worked examples from other authors.
- Create worked examples himself or herself.
- Share good worked example with colleagues.
- Includes students in the creation of worked examples.
- Learn to manage contents on the LMS so that only the intended worked examples are available to students.

Example

When working with emerging researchers to compose their first research papers in which they are expected to follow specific formats for the references page, I often will give students access to a slide show that shows students step at a time how to properly format references. The slide show is used in class when I give a brief lesson on how to create the references page of a research paper. After that, it is available on the virtual classroom, so that students can refer to it as they write research papers. This presentation is made available to other teachers in the school, so they can use it when they assign research papers.

Design Guidelines

The decision to use a worked examples begins with recognizing a curriculum, item for which a worked example will be helpful; choose those tasks that can be broken into steps. Many educators find that slide shows created using *PowerPoint* or a similar program are the easiest tools to use when creating worked examples.

- Include a rationale for the worked examples or a method of identifying the type of problem that is illustrated in the example.
- Multimedia design principles suggest that the best worked examples will combine: text, graphics, natural voices providing explanations that can be controlled by the user. The more of these that are included the better)see figure 13).
- Be aware that the greater amounts of media require greater efforts and expertise to create.
- Math equation editors are built into most word processors, and these can be used to create digital files with math symbols as appear in print.
- All operating systems include tools for taking screen shots of what is on a computer display. These are a very useful tool for teachers creating worked examples.
- Modern smart phones can be used to capture images of documents that are readable on computer displays.
-

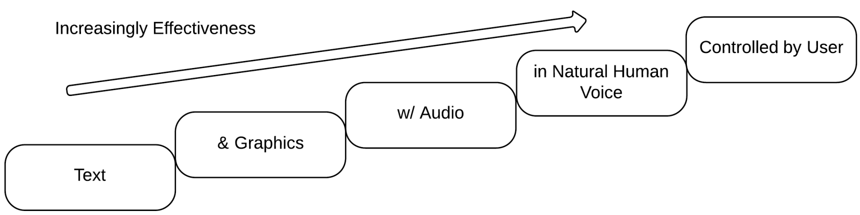

Figure 13. Media for effective worked examples

Reflection

A classroom in which there is active and authentic learning occurring will be a loud place, as it will be full of social interaction. While learning is a highly social activity, it is not an exclusively social activity, and reflection is also necessary for learning. Reflection requires an individual to think back over the learning activities to find connections, to resolve questions, and to become meta-cognitive. Quite and isolation is an environment necessary for the extended thinking needed for reflection.

In traditional classrooms, discussion is an important method that allows teachers to assess students' understanding and to give them experience with spoken language. In those classrooms, however, discussions can be dominated by individuals (either student or teacher), some students may be reluctant to participate, and what is said is usually lost (just like all spoken language is lost). Further, the discussion is local and synchronous; those who are not in attendance cannot participate in or even observe the discussion. For these reasons, upside-down educators move reflection activities to the virtual classroom.

In upside-down classrooms, teachers can use technology-mediated discussions to allow discussions to occur in a more permanent and asynchronous manner. On virtual classrooms chats, discussion boards, blogs, or wikis can be opened for participation for extended time and the contents can be archived.

To implement reflection, the upside-down educator:

- Ensures students have access to the virtual classroom.
- Designs prompts for initial responses as well as for students to respond to others' responses.
- Participates in the reflection to model professional interaction, without dominating the discussion.

- Reflects on the effectiveness of the prompts and seeks to improve them.
- Moderates published reflections to be aware of potential inappropriate responses and encourages positive participation through guidelines, examples, and modeling.

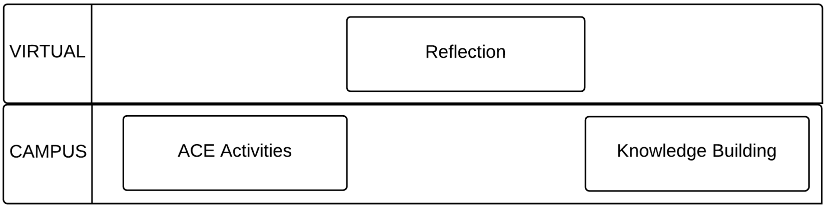

Figure 14: Reflection

Example

Discussions are a common instructional activity in active classrooms; students react to teachers and to each other as they consider the meaning of texts they read and other experiences they have in the classroom. There are many opportunities for reflection in classrooms that make extensive use of ACE activities.

When teaching physics, our first lab activity is the to measure the speed of sound. After exploring the supply of microphones and lab interfaces that connect the microphones to computers, and observing spikes that can be observed on the computer when a djembe is struck near the microphone, students are assigned the task of deigning an experiment that would allow us to measure the speed of sound. Students create a slide show that details the experimental design and data collection. The slide shows are posted on a blog available on the class LMS.

Students are assigned a specific task when reflecting on their classmates' slide shows: “Review classmates' experimental designs and identify a potential source of error with design.” Once students have identified potential sources of error with designs, they are assigned this follow-up activity: “Modify your design so that it addresses at least one of the potential sources of error.”

Design Guidelines

When designing reflection activities, teacher should understand:

- In upside-down classrooms, teachers and students have access to virtual spaces that make discussion boards, blogs, journals, and wikis among other tools that facilitate reflection. Each is valuable for different types of reflection prompts.
- When discussions and similar reflections are done face-to-face, the teacher can react to the flow of the reflections and redirect, refocus, and restart discussions that have lost momentum. In online reflections, such reactions are not possible as the reflection is largely asynchronous.
- Reflection is most effective when it is focused by effective prompts. Prompts are questions or statements that provide scaffolding to initiate students' reflection.
- Prompts can be written to scaffold both initial reactions to a text or an experience as well as to scaffold students' responses to other students' posts. One of the common complaints of educators who begin using online reflections with students is, “they just post silly stuff.” In many

cases that is an accurate assessment of the online interaction of students, and any faculty with the complaint reduce silliness of interactions by using good prompts to scaffold both their initial reaction and their reactions to others' posts.

- When reflection is facilitated by prompts and an online platform, students and teachers can take advantage of the permanent and asynchronous character of online interaction. Individuals can post and then edit later, and they can improve their understanding by revisiting discussion that are lost in face-to-face discussion.
- Prompts should require original articulation and replace summarize, restate, share with generalize, illustrate, compare, contradict, annotate.
- Many teachers find more success with online reflection if the entire task is broken into several parts with separate deadlines. For example, students may be given a prompt to scaffold reflection on a text, and two days to complete the initial prompt. After all students have submitted the first reflection, then a second prompt is given to scaffold student's reflections on each others' initial post. After that second prompts, then the whole discussion could become the focus of a summary or other knowledge building activity.
- There is ample evidence to support the conclusion that humans tend to pay greater attention to situations that are novel. When organizing online reflection, teachers can take advantage of that by using different tools. Most LMS provide teachers with threaded discussion boards, blogs, journals, and wikis which can be used for online reflections. In addition, there is a growing number of tools that allow users to reflect using audio and video input.

4: ACE Your Classroom

In upside-down classrooms, much of the work that was once done in-person is transferred outside of face-to-face meetings. As a result, time is freed up to implement in-person curriculum that is redesigned to be authentic. In this book, ACE activities, those that promote facilitate and require students to apply, connect, and extend the lessons into new and complex problems in settings as authentic as is reasonable, have been presented as appropriate this purpose. In this chapter, the role of the teacher in the ACE activities is considered and several models for organizing these activities are presented.

Guiding Principles

In addition to designing ACE curriculum in a manner that is authentic (see chapter 2: Authentic Learning) and that recognizes the nature of learning (see the Introduction), upside-down educators find that deeper learning principles are useful in guidelines for selecting and assessing ACE activities. They also find that their role changes in the face-to-face classrooms.

Collen Carmean and Jeremy Haefner (2002), scholars from the western United States, suggested that curriculum and instruction in the 21st century should be characterized by five properties that they refer to as *deeper learning principles* which appear to be associated with students who more clearly understand the curriculum and who are more able to transfer the skills and knowledge they learn to different situations. According to Carmean and Haefner, deeper learning occurs when learner tasks are:

- *Social*- Social learning occurs when students and teachers interact, and feedback is given in a timely manner. The interactions in social classrooms are initiated and mediated by both the teacher and the students, with students playing an active role in leading social interactions on a regular basis.
- *Active*- Active learning occurs when the problems arise from real-world situations and are solved through effort by the learner.
- *Contextual*- Learning is contextual when it builds upon students' prior knowledge and experiences and requires students to demonstrate new understanding.
- *Engaging*- Learning is engaging when it respects differences, arises from students' curiosity, and is challenging but not threatening.
- *Student-centered*- Student-centered learning includes time for reflection, and encourages students to think about their thinking and to take an active role in planning their learning.

A generation of educators has been taught that they should be a "guide-on-the-side" rather than the "sage-on-the-stage." (At least this the advice I received when I was training to be a teacher at the University of Vermont in the

1980's and it is the advice I have given whenever I have the opportunity to work with educators as they create curriculum.) These bumper-sticker summations of pedagogy have been useful as we have thought about the rediscovery of Progressive education and the creation of technology-rich authentic learning environments.

More recently, a new bumper-sticker pedagogy has arrived on the scene, and it appears to more accurately describe the role of the teacher in upside-down classroom than guide-on-the-side (and is much more accurate than the increasingly dubious sage-on-the-stage). *Mentor-in-the-middle* seems the best description of the upside-down teacher as this educator plays a central role in modeling and guiding students. At several periods during my career as a student, I had the opportunity to work with teachers as mentors, and these seem to have been particularly educative periods during my education. Mentors play six roles in classrooms:

- *Facilitator*- Educators serve this role when they design the course and syllabus, and then plan the day-to-day activities of the students.
- *Coach*- In this role, educators identify the skills and knowledge necessary for each individual to accomplish the curriculum and then take steps to ensure each develops to the greatest degree possible.
- *Artist*- When combining traditional approaches and new insight into new creations that can serve any of the mentor roles, the upside-down educators is being an artist.
- *Critical reflector*-Encouraging meta-cognition (thinking about thinking and understanding oneself as a learner) is the role of critical reflector, the upside-down educator helps students become meta-cognitive.
- *Model*- Knowledge of a field of study requires students have appropriate abilities to participate in the field; these are well-learned when the

upside-down educators demonstrates the participation.

- *Scholar*- Upside-down educators are the most accessible expert in the field to the local community and the expert who is available for the longest time. This give the teacher the greatest opportunity to reflect the structure of the discipline to the students.

In this chapter, several options for creating ACE activities in classrooms are described. This is not intended to be a complete list, and these are presented as models that have proven successful, but there are no recipes provided for implementing any of these. Also, it should be recognized that all of these models are appropriate for almost all students populations. Reserving participation in these activities for those students who "need enrichment" or "have completed their regular work" is an unjustifiable position.

It is also not unjustifiable to reserve ACE activities until "after students have learned the basics." As part of their mentor responsibilities, upside-down educators do provide guidance so that ACE activities are achievable by students, but there should be no threshold for students to participate in ACE activities. The upside-down educator understands the role ACE activities can play in facilitating students learning "the basics," and so they include it in the curriculum for all learners.

Research

"Research" is a term that has many different meanings. These three activities are commonly called "research:"

- *Finding information* for other purposes. When a teacher is in search of a new lesson plan idea, or a student is in search of images to include in her project on animals, each is finding information. While this is a necessary and useful skill, it is a small component of research and should not be the goal of ACE activities.

- *Reporting* the answers to questions. Individuals who are reporting are seeking the answers to questions which have been answered by others. When reporting, those answers are found, and presented in an encyclopedia-like article.
- *Researching* is the process of answering questions that have not been answered by others or the process of gathering and analyzing data to confirm or refute others' answers.

Depending on the sophistication of the students and the curriculum goals, ACE activities can include reporting and researching, but finding information is rarely the focus of ACE activities.

Characteristics of Research

Research and reporting begins with a question that is drawn from students' experience and that encapsulates a problem that is relevant to the student and that is drawn from the curriculum (see figure 15). This question focuses and motivates the reporting or research. Simplicity is not always a benefit as the more complex the question, the more potential for the question and work to be engaging through connection to prior experience.

Reporting typically requires one to find and summarize well-known information to answer the question, so different reporters are likely to arrive at the same answer. Many teachers find this heuristic useful in differentiating reporting questions from researching questions: “if I can predict the answer, then it is reporting.”

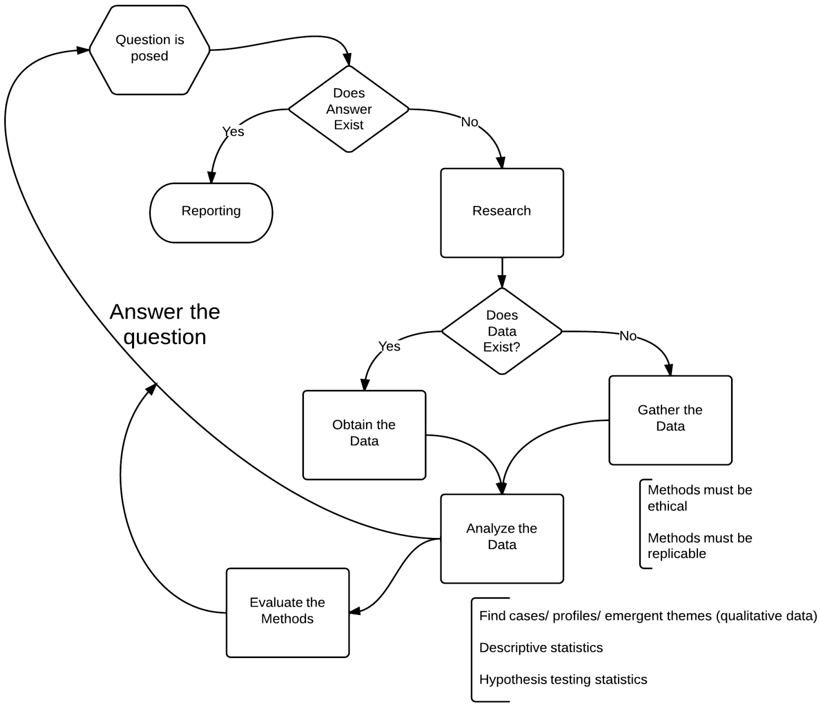

Figure 15: Research and reporting

To answer a research question, one collects data. The data can come from many sources. Data can already exist, and the researcher will cull the relevant data, then analyze it to find the answer. The researcher can also design his or her own methods for gathering new data which is analyzed to answer the question. In all cases, researchers must decide which data are needed to answer the question, and must make reasoned decisions when collecting data and analyzing data.

Researchers also worry about the answer to the question "How do I know?" While one is not likely to engage emerging researchers in epistemological discussion, it is reasonable to help young researchers understand that what information they collect and how they collect it matters and there is always uncertainty in data collection. For these reasons, upside-down educators will sometimes "assign" research questions with uncertain or multiple potential methods to answer. In addition, they will assign different students the same research question so that the differences between their methods and their data can become part of the analysis.

Researchers must also be considered with the ethics of their data collection. Researchers cannot endanger anyone with their collection and they must collect only the information they need. Further, the way they collect data will affect the quality of the information they collect. As with epistemology, a teacher is unlikely to engage in deep ethical discussions with students and their research activities should not include ethically questionable areas, but awareness of ethics is important for any researcher.

The purpose of research, of course, is to answer the research question. The answer must be supported with evidence drawn from the data, and the details of how the data is used depends on the type of data. Questions answered with qualitative data are supported with excerpts from the text of the data that was collected. If the data are quantitative, then some descriptive statistics are used to answer questions. As the researchers become more sophisticated, analytic statistics may be used to test hypotheses. A final step of research is evaluating the research to recommend questions that remain unanswered or new questions that have emerged and to recommend steps to improve the data collection.

In the upside-down classroom, research follows the apprenticeship model that is found in graduate students and faculty members in universities. In these relationships, the faculty member is the individual who leads and guides the graduate student in finding and narrowing a problem and question, devising methods of studying it, and gathering and analyzing the data. The graduate student is learning the craft of researching and is given direction but not told what to do.

Clearly there are differences between the populations of K-12 educators and their students and university faculty and their students, but the idea of cognitive apprenticeship and the role of teacher helping student develop skills and knowledge through guidance and modeling as much as by instruction can apply to both settings. In these apprenticeships, faculty is forced to deeper understanding of the ideas under study by students and students come to deeper understanding through something. The work of designing data collection and analysis is cognitively challenging and necessitates guidance, it should be done under the tutelage of an in-person teacher and thus it belongs in the classroom.

Healthy Test Preparation

Tests are a topic that can be very contentious in many communities. While standardized tests have gained in public profile in recent decades as politicians seek to hold educators accountable, there is a large body of evidence that questions the appropriateness of tests for many reasons and purposes. In addition, the construct being measured by the tests has been ill-defined thus the validity of the instrument for measuring the outcome of education is dubious. Currently, the standardized tests appear to be both measuring and defining the outcome of education: One is presumed to be “prepared for the future” if they score well on the test, but that is not established by evidence.

Despite the different opinions related to testing, the reality is that in many and diverse situations in the 21st century, a test represents a gateway to professional opportunities. While SAT tests are commonly held as an example of test that "matter," there at many other examples that are probably more illustrative of important tests. Almost every student can attend a college regardless of the score he or she earned on the SAT, but no individual can practice law or drive a school bus without first passing the test.

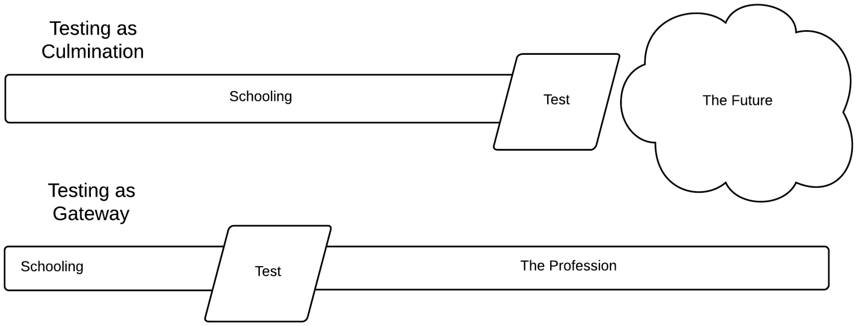

Figure 16. Test as culmination versus test as gateway

The difference between tests in professional life and tests in education appears to be that education approaches a test as a culminating activity whereas professions approach as a gateway activity (see figure 16). Of course, professional tests are informed by the skills and knowledge that will be needed for success in the professional and there is a high correlation between success on the tests and success in the field. Such correlation between success on academic tests and success in life is dubious, in large part because of the political turmoil surrounding tests and in part because of the diverse populations served by public education.

If tests are presented as a measure of "professional" knowledge, and if students and teachers prepare for the tests in the manner that professionals do, then there is a greater likelihood that students will both develop a healthier relationship with tests and they will perceive them as a serious measure of their skills and knowledge.

In the upside-down classrooms, teachers can take ACE time to prepare for tests in same way that professionals prepare:

- Case studies and other types of real-world settings are used during preparation so that students understand the concepts in context.
- Teachers give students experience looking at released items so that students see the connections between the test items and the authentic curriculum they experience in the upside-down classroom.
- Released or sample questions are used over an extended time so that students have the chance to reflect on the items and be continuously reminded of the steps.
- Students are given experience with the testing environment. For example, if the tests are given on computer systems, then students must have experience taking computerized tests.

"Word Problems"

In his seminal book on paradigms in science, T. S. Kuhn (1970) identified four aspects of the dominant paradigm in each field. One of these is what he described as the "exemplars" which are the problems and typical solutions that form the foundation for the field of study. The problems comprise those found at the end of chapters in textbooks. Understanding how to solve those problems can be an ACE activity in most classrooms.

The questions drawn from cases and situations are best applied to ACE activities. Sets of problems assigned from these collections can be most effectively used as ACE activities when they are the focus of study groups or when students lead study groups, or when questions are the focus of wikis on the virtual classroom.

In traditional classrooms, teachers instruct during class and then assign students the work of completing word problems at home. Many parents are familiar with the difficulties of trying to help their children understand and solve the problems.

Teachers in upside-down classrooms realize that having students try to solve word problems with parents (who are typically less skilled in the content of the problems than the teacher) to supervise and provide support and guidance is not a plan for success. A simple way to begin turning a classroom upside-down is to arrange the for the simple algorithms to be introduced and practiced at home, where step-by-step tutorials are available to support students (and their parents) and the more difficult problems are solved in the classroom with the teacher to provide guidance and support.

Project-Based Learning

Project-based learning (PBL) is typically undertaken as students define a topic and project of interest and then plan and direct much of the work as it proceeds. The teacher is available as a mentor, but the work is largely driven by the student. The amount of independence the student has in defining the project is typically negotiated between the student and the teacher and this is resolved based on the characteristics of the student and the nature of the project. While the specific details of PBL are determined by local communities, the following are typically recognized as essential characteristics of the model:

- *Student choice* in the topic, specific questions, methods of inquiry, and presentation modes. This aspect of the project is heavily influenced by teachers, especially with respect to appropriateness, safety, and ethics. Regardless of the negotiations during this process, the students must perceive the final project to be relevant and important.
- Opportunity for *deep study*, including creative and innovative learning. While it should emerged from appropriate curriculum, PBL cannot be

driven by specified curriculum or instruction. Deep study also requires extended time.

- *Connection to academics*- Through PBL, students come to value and apply the lessons contained in the curriculum. Most PBL educators find students go in search of content that is typically “covered” in the curriculum as they conduct their PBL. Instruction in these areas is delivered on an as needed basis and often is similar to that instruction presented in traditional or flipped classrooms.
- *Connections to community*- While grounded in the curriculum and a vehicle for motivating and applying academic skills, PBL also has deep and obvious connections to the local community. Environmental and social problems often form the basis for PBL, although many educators encourage students to avoid obviously partisan politics in their selection of a topic for PBL.
- *Active participation of experts*- Both teachers and experts from the community interact with students as they engage in PBL. This begins with advice on topic selection and continues to modeling and feedback on methods, and extends to providing feedback prior to final presentation. In addition, experts are highly involved in assessing ad evaluating PBL.
- *Presentation to an audience*- Because of the clear connection to the community and the importance of the topic to the students, there is typically a public presentation of finding at the culmination of PBL.

Many communities that undertake PBL incorporate it into graduation requirements. In these communities, PBL is a process throughout the students' career so that when they arrive at a high-stakes and largely independent project, they have developed skill at all aspects of the process during his or her education.

Makers

The maker movement seeks to build curriculum around making “things.” Grounded in design and engineering, this model of curriculum and instruction encourages students to envision solutions to problem, design systems to implement their solutions, then build and test and refine those devices. Maker curriculum includes activities such as:

- Robotics
- Computer programming
- Engineering
- Arts
- Industrial arts

As with all ACE activities, students who participate in a maker curriculum reflection the activities, find connections between their designs and the curriculum, and apply the lessons typically presented in the curriculum as they make projects. In addition, makers find they access the traditional curriculum on an as needed basis when making.

5: Managing Information Technology

The upside-down classroom requires technology play a role that is fundamentally different than it has been in previous iterations of technology-rich learning environments. When computers first arrived in classrooms in the late 1970’s they were found as single machines in scattered classrooms and were used by teachers as they taught their assigned classes. Soon afterward, computer arrived in far greater numbers and were installed in “computer labs” and specialists were responsible for leading students through lessons. Late in the 20th century, technology integration became the accepted model of technology-rich instruction and technology crept slowly and incompletely back into classrooms as it was used to access and manipulate and create and share information.

For much of this history, technology was a specialized curriculum. Students were taught about computers, taught how to use computers, or used technology for special projects. Even as technology integration became the accepted model and advocates encouraged teachers to break down the boundaries between technology and curriculum, the two seemed associated but still separate.

With the arrival of the web 2.0 phenomenon in the mid-2000's, the term *mash-up* has been used to describe a product in which users mix and remix media to create a new experience. This has been extended in recent years as website authors and publishers are including embed code so that users can post and re-post resources from one site into another. The result is the boundaries between one's creations and another's creations are blurred.

The upside-down classroom is essentially a mash-up classroom. These classrooms include an online space as well as a physical place, and each includes elements of the other. Students on campus will spend time in the online space as part of their activity and work added to the online space will become the focus on attention during instruction in the physical place as well. In these classrooms boundaries between online and in-person interaction blur and the boundaries between information and interaction, consumption and creation also blur.

For many students, computers and associated technologies functioned as an "add-on" to curriculum and instruction. For years, computers were an enrichment activity, and educators felt justified in reserving screen time for those students who had finished their regular school work. Even as experiences using technology was recognized as an essential aspect of education and restricting students' access to computers become less-accepted among educators, technology continued to play an ancillary role in many classrooms.

In many schools, it was necessary to schedule time in computer rooms well in advance to be sure each class had access to the limited resource, and so computers were reserved for special projects. In reality, many teachers found a technology they were comfortable using, and that activity became a staple for their courses until the curriculum changed or the technology died.

In the upside-down classroom, using IT is not a choice and it is not reserved for special occasions or projects. While this does pose a challenge in those communities in which computers are not widely available outside of school, upside-down classrooms as envisioned in this book cannot be accomplished without reliable computers. In upside-down classrooms, technology is essential so that:

- Previously ephemeral activities can be saved. For example, discussions that were previously open only to those students who were attending (both physically and mentally) can take place online with the input and responses are indefinitely available to anyone who has access to the classroom.
- Information and interaction can be extended at near-zero marginal cost.
- Teachers can leverage asynchronous communication. Students can watch and re-watch instructional (on contextual) videos or other media on an as-needed and when-needed basis. Students can participate in online discussions when they have something meaningful to contribute (which may be after they have thought about the discussion for some time).
- Students can access information indefinitely and flexibly and in many formats. Online video, interactive and animated web sites and software simulations are all media that are essential to turning a classroom upside-down.

The information technology that characterizes upside-down classrooms is also designed to be accessed by a range of devices and platforms. This is to accommodate the reality that learners will be accessing the resources from their own devices as well as devices owned by the school. In the ideal upside-down classroom, the resources will be accessible by any student using any device they have available including older computer systems and mobile devices. Upside-down classrooms include technology that is:

- *Platform neutral* so students can access it from several versions of Windows, the Macintosh operating system, and Linux as well as from Android and iOS systems.
- *Web-based* which increases platform neutrality and decreases the need to purchase, install, and manage applications on devices.
- *Based on universal formats* so, for example, students can use documents and images and video without the need to install applications or configure systems to properly handle proprietary media.

Managing School-Owned Technology

In the 21st century, schools are technology-rich places. IT infrastructure includes computer rooms with desktop machines connected to local areas networks and the Internet via Ethernet, laptops and tablets that connect to wireless networks, interactive whiteboards, and many other devices. The networks in schools are complex, and include devices such as firewalls to secure the networks and content filters to limit access to inappropriate content and potentially harmful sites. The work of installing and maintaining these systems falls to IT professionals.

Planning Cycle

One of the perennial complaints of educators is that the systems are not configured for easy use; one of the perennial complaints of technicians is that educators do not use the systems as designed. In my experience as both an educator using others' systems and a technician designing systems for educators to use, both complaints are valid.

In schools in which the IT is most effective (it serves the needs of educators and their students in a secure and reliable manner), there tends to be an on-going discourse relative to the IT. This discourse is based on the assumption that the purpose of the school is to ensure that students have meaningful experiences and that decisions within the school (including IT decision) must meet the needs of students. The on-going discourse is characterized by the implementation cycle as illustrated in figure 17.

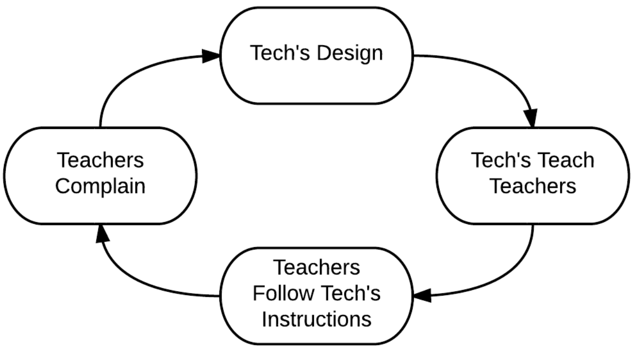

Figure 17. Technology planning cycle

Beginning in the top center of the cycle:

- Technicians design and build systems according to their skills and knowledge and as the budget an extant technology limits them.
- Once the system is designed, the technicians have an obligation to ensure the teachers and other educators (and their students) understand how to use the system.
- The teachers then have an obligation to use the system as it has been designed and explained to them.
- Teachers then have the obligation to complain about the system; complain here is used only loosely. Their criticism and complaints must

be in terms of ease of use and usefulness (see the section on technology acceptance in chapter 8: Becoming an Upside-down Educator).

The cycle then repeats and technicians are obligated to collaborate with teachers (and teachers are obligated to be collaborative) to redesign the system. The cycle then continues. When properly and fully implemented, this planning cycle results in a technology infrastructure that is perceived as continuously improving by all users. In addition, the system is adaptable, incorporating new technologies, evolving to meet new curriculum demands, and usable by increasingly sophisticated users.

Of course, this cycle is affected by other essential inputs as well. Technicians must ensure that the systems comply with the Children's Internet Protection Act and Child Online Protection Act and similar policies. Teachers must ensure they are communicating with technicians so they can be proactive in design rather than simply reactive; if a teachers becomes aware of a new system, then they need to tell technicians so they can research the best way to make it available. Leaders must understand and be aware at which stage in the cycle the process is and make decisions based on that process. At some points, technicians are more empowered than teachers, but at other points teachers are more empowered technicians. Also, time and money are necessary for purchases, training, and other needs throughout the cycle.

Sufficient Access

In the 21st century, school technology leaders have a responsibility to ensure students have access to sufficient technology so that students can gain experience with the devices, information sources, and information creation tools that are common throughout society. For the purposes of this book, the following are considered necessary for sufficient access:

- Enough computers so that each student can use his or her own station. The computers must be supplied with updated web browsers capable of playing common video and audio files without the need to install software, as well as speakers (or better yet personal headphones or earbuds).
- Sufficient broadband (including wireless) so that students can upload and download files without noticeable delay. In addition, the wireless should be secure, but not to the point where security interferes with access.
- Internet filters that are adequate to protect the system and users, but that does not interfere with access to necessary information.
- Systems in place to allow for extended hours to access school computers to accommodate students and teachers with limited access to computers away from school. This may include collaborating with community organizations or refurbishing school computers and donating them to students who need devices.

Many teachers prefer school and technology leaders provide basic technology and service that is reliable and robust rather than systems that provide more complex, but less reliable services.

Tragedy of the Commons

Because many schools are places in which technology tools are frequently a shared resource, the tragedy of the commons can adversely affect individuals' access to technology. The tragedy of the commons arises when there is a limited resource that is available for groups to use. The resource is available for the benefit of everyone, but when one uses it, they gain the benefit but the consumed portion is unavailable for others. The tragedy arises when there are pressures to use the resource before it is completely consumed, and then overuse by individuals occurs. The tragedy of the commons can affect hardware and software, bandwidth, and budget and human resources.

School leaders have a responsibility to recognize this and to take steps to minimize the damage done through the tragedy:

- Provide a system whereby users can *report malfunctioning devices* and other problems with the technology, and include sufficient resources to fix those in a timely manner.
- Provide, also, a *scheduling* system to allow shared resources to be shared. This should include both regular times when teachers can plan to access technology, as well as open times when the space or devices are available at irregular times.
- Engage the community in *inclusive and transparent technology decision-making*, so that the decisions and the rationale for the decisions are clear to all. This includes transparent and common understanding of the planning cycle.
- Ensure *teachers are trained* in the use of new devices and systems so that the resources are not used in wasteful ways.
- Be both proactive and reactive when setting *reasonable and well-understood boundaries* for technology use.

Related to the tragedy of the commons is the task of creating budgets to support technology in schools. Part of the difficulty arises from the hidden needs of maintaining network infrastructure. Many of the devices on school networks (for example firewalls, Internet content filters, and managed wireless access points) require software to function properly. The manufacturer of the devices supply and update the software automatically and remotely; the devices connects to the company's servers and is updated without your technician's input. Without these updates, the device fails to to function, and the subscription to those updates is expensive (even a small school network with a few hundred devices can find these bill consumer several thousands of dollars per year).

The challenge for school and technology leaders has become having sufficient funds available after these bills are paid to put devices in front of students. Some of the strategies that school leaders are using to maximize the technology they obtain for the money they spend are these:

- *Cloud computing* which allows for some of of the infrastructure demands to be moved to other servers that are remotely managed. An example is gmail, a service by Google that provides email service for a fee that is far less per year than the cost of maintaining an email server by technicians hired by the school.
- *Open source software* such as *LibreOffice* and *Ubuntu* are being deployed in school and replacing software that can cost hundreds of dollars to license.
- Procedures for allowing students to use their own devices are being developed. This is frequently referred to as "*bring your own device*."

Teaching in Technology-Rich Spaces and Places

When educators first begin to teach using virtual classrooms and in technology-rich places, there are details of the practice that require some investment in time and energy to learn. In most cases, teachers report that once the transition is complete, the work requires less effort and attention than the same tasks did previously, but they also report that initial learning is necessary, and while it can be an obstacle to using technology, those who make the transition typically confirm that that instructional and data management tasks become easier and they make more efficient use of time after transitioning to technology-mediated teaching (see figure 18).

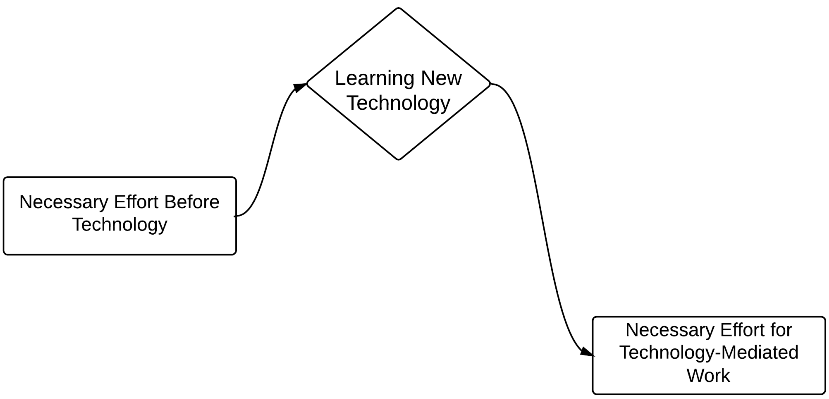

Figure 18. Changes in effort and efficiency with technology

Familiar tasks, such as writing homework assignments on “the board” for students to write down are transformed in upside-down classrooms as well. Most educators find the such announcements are best placed on the virtual classroom. Information posted there can be accessed by students at home or school (or from any other place with a computer connected to the Internet). In addition, others who are interested in the course (such as parents, special educators, administrators, and colleagues) can see the same assignments as students see.

Further, information posted to a virtual classroom can be stored indefinitely, so questions related to the assignment can be resolved by looking at the original. In upside-down classrooms, the physical places are often technology-rich as students use computers to access the virtual classroom and other digital resources as well as to create new information. Schools built prior to the arrival of computers for the education market (and some built since) tend to have infrastructure issues related to electricity and storage that pose a challenge for educators. Computers must be plugged into power strips, and computers must connect to access points whose signals may be weakened do to concrete construction. The set up and tear down time necessary for transforming classrooms into technology-rich places adds to the work of teaching upside-down and to the time necessary for a lesson.

6: Virtual Classrooms

Any educator who teaches in an upside-down classroom will make use of a virtual classroom to extend the classroom and to take advantage of the capacity of computers to manage information and interaction in all iterations of synchronous and asynchronous and face-to-face and distance settings. While the functions that are available on a virtual classroom are mostly available from other web sites, a learning management system (LMS) provides virtual classrooms and management schemes under one system.

An LMS, which is as essential to teaching in the 21st century as the photocopier was which I started my career in 1988, must be provided by school and technology leaders just as they provide computers, networks, and web site resources to teachers. The LMS web site is accessed via accounts (system administrators, instructional leaders, teachers, students, and even parents have access and different permissions) and the LMS provides a single venue for several methods for interaction among the participants in each course.

What Tools are Available on an LMS?

The tools provided by a virtual classroom are designed to reflect traditional classrooms: There are tools for sharing information, tools for facilitating interaction, and tools for managing enrollments, grades, and other data related to student progress. In general, a fully-functioning LMS will provide the following:

File Sharing and Linking

Teachers who use *PowerPoint* presentations in class can post those presentations on the virtual classroom. Likewise, files such as PDF file of articles, images, audio and video can be uploaded to the LMS or links can be added which point to the files on other web servers. In addition, embed codes can be used to place web media can be included in web pages created using the html editors built into LMS systems.

The file sharing function in an LMS can also be used to facilitate groups of students working collaboratively on a single file. The individual who uploads can identify others who can view, download, or otherwise use the file. Some LMS also include sophisticated commenting functions so teachers can provide feedback to students and so that peers can provide feedback to each other.

Interaction

Since the late 1990's a variety of tools for users to easily publish to the Word Wide Web have emerged, and these are built into LMS platforms. With these, teachers can facilitate and manage dialogue and discussion among learners and others who are given access to the course on the LMS.

- *Threaded discussion boards* are used in situations where the teacher seeks to post an initial prompt and then let the discussion follow different paths. In some situations that divergence of the discussion is distracting and contrary to the instructional goals, but in other situations, that is the intended outcome.

- *Blogs* are used when the teacher seeks to have students post in response to an initial prompt, and then encourage dialog that is focused on each individual's response to follow-up. With blogs, the discussion tends to focus on one individual's response.
- *Wikis* allow a group of individuals to edit each others' response to a prompt. In many LMS systems, the instructor can lock a wiki once a “good” solution or answer is provided.

Assessment and Evaluation

Each LMS includes a full compliment of tools for assessing and evaluating students' progress including increasingly sophisticated tools for real-time performance tracking and flagging or warning poor performance and analyzing performance on test items.

- *Online tests* can include questions that can be graded by the LMS, so scores are immediately available and recorded. These tests also include items, such as essay questions, that must be scored by the teacher. Regardless on the question type, feedback can be left for individual students, and scores can be overridden as needed. In addition, there sophisticated options for varying time limits, numbers of attempts, and other options regarding the test presentation.
- *Drop boxes* for assignments completed as digital files are also available. Each submission is archived with a time and date stamp so there are no questions about when the file was uploaded, and the contents of the original can always be retrieved. In addition, LMS provide various options for submitting to (usually fee-based) plagiarism checking services. Further, some LMS provide the capacity for in-browser commenting so a teacher can mark-up a submission without downloading

the file to his or her computer.

- *Rubrics* can be created within an LMS and then applied to assignments throughout the course. In addition, LMS are adding increasing opinions for clearly associating assignments and other items with specific course outcome or goals.
- A fully-customizable *grade book* is also available in all LMS platforms. Online tests can be added to the grade book automatically and columns with non-LMS assignments can be added as well. LMS grade books are also configured to support feedback and interaction between teacher and student.

Course Management

Each LMS also includes course management tools that allow the system administrator or teacher to manage the contents of his or her course, the rules by which it is presented to students, and the manner in which information and files are shared among course and within the community. In addition, various types of user accounts users can be associated with a course, so a colleague may be able to access a course without seeing students' grades, or a parent may be given access to observe his or her child's work.

On an LMS, content can be copied between courses, and even complete courses can be copied. In addition, templates can be created so that system-wide content or organization can be applied.

How Does One Obtain an LMS?

LMS platforms are available from many proprietary and open source publishers. Among the popular titles are:

- *Blackboard*- a commercial enterprise that purchased many of the smaller platforms that were its competition several years ago.

- *Moodle*- an open source system that has been around for many years. In general, this is more difficult to install and configure in a satisfactory manner than other open source platforms. Many companies provide hosted access to Moodle.
- *Canvas*- a relatively new system that is marketed as a highly-customizable LMS. This is used in many small and niche markets.
- *Atutor*- an open source platform from the University of Toronto that can be installed and configured on any web server as long as the appropriate version of web databases are available.

School and technology leaders can make LMS available in one of three ways. Each has advantages and disadvantages, including those associated with cost and control over student accounts.

- *Public*- Most publishers of LMS provide limited versions of their LMS at no cost to anyone with an email address. While these are free, and can be used for some purposes in K-12, most school and technology leaders find there is insufficient control over accounts and content to use this option with students.
- *Hosted*- Publishers or third-party providers will make hosted LMS available. These installations are made on servers controlled by the provider, and they take full responsibility for ensuring systems are backed-up, secure, and otherwise protected from threat. A school that purchases hosted service are given full control over the system, so they can manage all aspects of the system. In general, these are very reliable, and very expensive; a hosted system for a few hundred users can cost thousands of dollars per year.

- *Installed*- Either proprietary or open source LMS platforms can be installed on servers owned and controlled by the school. This option requires the greatest level of skill and the greatest level of risk as school and technology leaders are responsible for all aspects of managing and protecting the system.

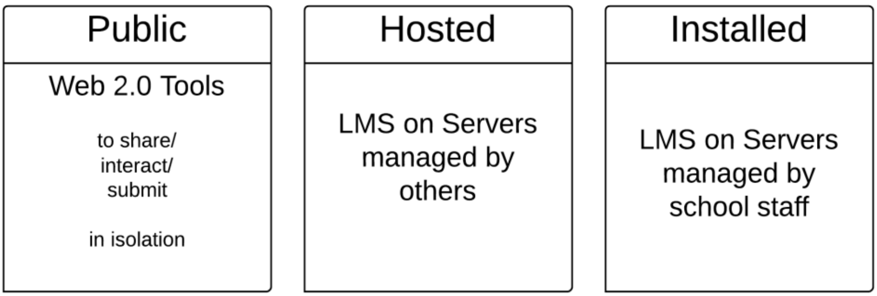

Figure 19: LMS installation options

How Does One Control Access to an LMS?

Access to an LMS (whether public, hosted, or installed) is controlled by a user's account, and the accounts can be configured for varying levels of access and control. These levels of access are common:

- *Administrator* accounts can control the creation and configuration of course and user accounts. These are typically reserved for technology leaders, network administrators, and school administrators.
- *Instructor* accounts can add content to courses that have been created by administrators and (usually) manage users in the course, as well as access students' contributions to the course, their tests and assignments, and the

grade book.

- *Student* accounts can access the courses in which they are enrolled and access whatever resources, assignments, and grades that instructors have uploaded.
- *Observer* accounts are usually associated with a student, and that account can observe (but not impersonate) that student.

A range of other accounts can be created to provide access to course developers, teaching assistants, and other types of access.

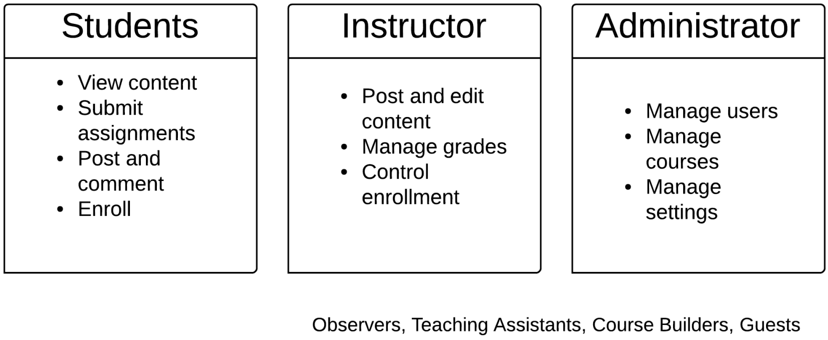

Figure 20: LMS accounts

Once courses are created on an LMS, students are enrolled depending on the procedure and set on protocols configured by the school and technology administrators. These can be simple, based on students self-enrolling or can be very complex and connected with the student information system used by the schools.

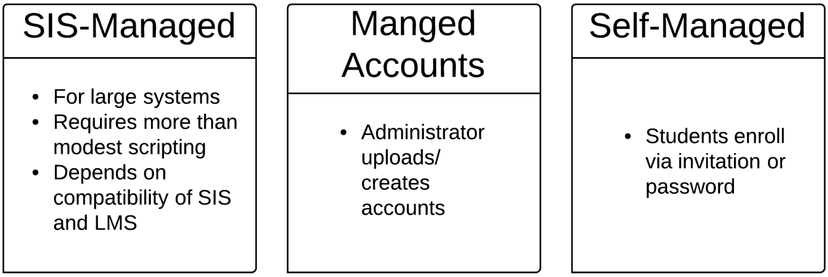

Figure 21: LMS enrollment options

7: Becoming an Upside-Down Educator

Upside-down classrooms may be unfamiliar to educators for several reasons:

- Teaching and learning is becoming more sophisticated as we better understand the nature of human cognition.
- Ubiquitous computers and virtual classrooms are providing technology tools that can be leveraged for many educational purposes.
- The society for which educators prepare students are similarly complex and sophisticated and increasingly unpredictable.

Educators who succeed in the coming decades will be those who adopt the tools that emerge and those who adapt to the changing educational landscape. This will require they become learners and adopt several habits of mind that will prepare them to design curriculum and instruction rather than simply follow recipes.

Dimensions of Professional Learning

The Apple Classrooms of Tomorrow project in the 1980's was the first effort to understand the changes in schools when computer technology was introduced. One observation that emerged from that work is that teaching a teacher how to use technology is not sufficient to ensure the teacher can teach using the technology. Since then, school and technology leader have differentiated training to use technology and learning to teach with technology.

In the 21st century, supporting teachers as they prepare for upside-down classrooms requires and even more sophisticated model of what teachers need to know. Professional learning will focus on helping teachers understand their new role as students become even more the product of IT-dominated cultures, as the need to prepare students for an increasingly complex world becomes more apparent, and as the technology in classrooms (and that extends classrooms) becomes more sophisticated.

Educators making the transition to becoming upside-down appreciate opportunities for p[professional development in these dimensions:

- *Learners* to understand the effects of IT on human learning and experiences;
- *Student tasks* to better understand authentic curriculum;
- *Technology systems* so they can efficaciously use the emerging networks and virtual classroom systems.

These dimensions are understood to exist as a continuum; each is characterized by a current realization that is being replaced by an idealized realization. Reasonable educators understand there are many and diverse factors that limit the extent to which these dimensions can be changed. The goal of the upside-down educators is to recognize and incorporate idealized realizations of these dimensions (as currently understood and as they change with increased knowledge and experience). Upside-down educators seek to move towards idealized realizations, but understand theses are moving targets.

Learners

Late in the 20th century, the multidisciplinary field of cognitive science emerged as scholars entered a continuing period of making discoveries related to the structure and function of the human brain. Some of those discoveries are challenged what was assumed to be true about learning, and the learning environments and curriculum and instruction that support learning in which schooling had been grounded for several generations. Upside-down teachers have a responsibility to reconcile the emerging knowledge of human learning with their existing practices and the practices they adopt to become upside-down.

Because the cognitive and learning science are active fields of research, the science that informs educational decisions will change, so educators who seek to ground their practice in science will be actively learning about learning and modifying their practice as a result. Compared to the perceptions of learners prior to the discoveries of cognitive science, several trends can be identified in the learners dimensions of professional learning:

- Human learning depends on the active participation of the learner. Active learning requires a motivated learner who cares about the curriculum which is drawn from relevant problems well as opportunities to interact with experts and peers as new ideas are incorporated into existing knowledge.
- Both learners, and the society for which they are being prepared, value competence rather than compliance. Whereas previous generations could rely on relatively unchanging economic and political forces, the 21st

century is perceives as a time of rapid and unpredictable change. Learners who can adopt and adapt appear to be better prepared for the unpredictable economic, political, and social reality of 21st century culture.

- Learners' prior experiences that are relevant to their learning. Cultural experiences as well as prior learning experiences (both formal and informal) influences how students approach and understand and create new knowledge. In addition, students' experiences with IT and the information they access via IT affect how they learn.

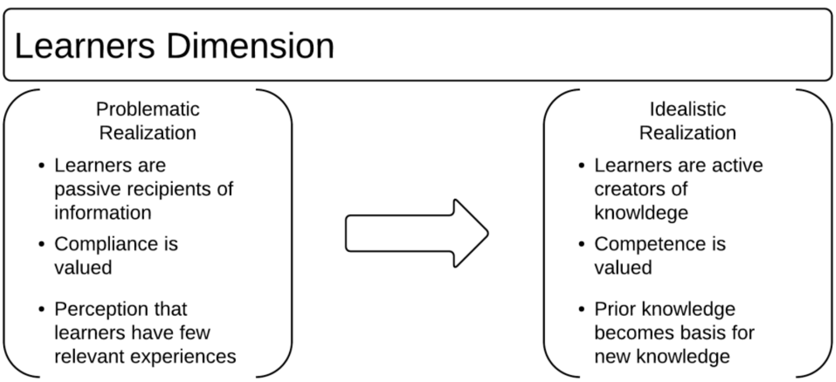

Figure 22. Learners dimension of professional learning

Among the greatest factors affecting the changing nature of learners in the 21st century is the information technology with which students interact. Among the studies summarized by Gary Small, a cognitive scientist who works at the University of California, Los Angeles, and his coauthor Gigi Vorgan in the 2008 book *iBrain: Surviving the Technological Modification of the Modern Mind*, were several documenting the effects of technologies on human brains. They described research in which scientists measured a larger portion of the brain controlling the right hand in expert violin players compared to other expert musicians, and research that observed London taxi cab drivers have a greater part of their brain dedicated to controlling spatial visualization than control subjects. Small and Vorgan even summarized Small's own research in which five-hours of interaction with digital information was associated with measurable changes in brain structure and function.

For several generations, young people have been heavy users of media. Radio and television programmers and marketers paid attention to the young people (and they continue to), and generations of youngsters have been told by parents and teachers to "turn the television off" when they are doing homework. In the 21st century, however, young people have begun using technology in ways that previous generations did not. Digital generations consume and create more (far more) content than previous generations, they interact widely through online spaces, and these experiences influence how they interact and how they learn in school and out of school.

Associated with the consumption of vast amounts of information and the ubiquitous technology that characterizes the digital generations, including students in K-12 schools, is the reality of multitasking. Multitasking is the term used to describe the situation in which an individual is consuming and multiple media at the same time. The phenomenon has been the focus of much research, but the results are equivocal.

Much of the uncertainty in the results comes from the differences between the observations made in the highly controlled environments of the laboratory and the observations that are made in the real world (in Naturalistic settings). In the laboratory, subjects who are multitasking are measurably (and significantly) slower at almost any cognitive task that researchers devise.

Scientists attribute the slowdown to the time necessary to activate different neural pathways to switch between the tasks. In the real world, the time limit imposed in the laboratory disappears, so the additional time necessary to complete a task does not appear to interfere with a multitasking subject’s performance of cognitive tasks. In general, researchers find that multitasking individuals perform as well as non-multitasking individuals in real world settings, but they take longer to complete the tasks.

There is evidence that the trend towards multitasking is extending and expanding; more people are multitasking with more devices in more places. There is evidence that multitasking is the preferred method of engagement for many young people; they like the social connections and their brains have adapted to multiple sources of information. There is (inconclusive) evidence that multitasking can interfere with attention. (Kraushaar and Novak 2010; Quan-Haase 2011). There is evidence that adults are less facile than young people at multitasking and that schools are taking steps to minimize students’ opportunities to multitask. Rosen (2010) suggested this may not be the appropriate response for educators, however, and concludes,

> The bottom line is that our students are multitasking and we cannot stop them without placing them in a boring, unmotivating environment. The trick is to develop educational models that allow for appropriate multitasking that improves learning” (95).

The reasoning supporting Rosen's conclusion is simple and appears to be supported by evidence from cognitive science: Young people and their brains are immersed in an environment of multiple simultaneous information sources, and so their brains become adapted to that stimulation, and they perceive such information and interaction rich environments as natural. Classrooms in which educators adopt IT and engage students with curriculum and instruction that reflects the information and interaction-rich environments in which they live will be creating environments the members of the digital generation perceive to be natural.

Student Tasks

The learner tasks envisioned in both the virtual interactions and the ACE activities that characterize upside-down classrooms may be unfamiliar to educators. Even if the models are familiar, upside-down educators find that it is necessary to constantly review the curriculum and its implementation to adopt (and adapt to) new tools, different students, and new goals. For these reasons, student tasks is the second dimension of professional learning.

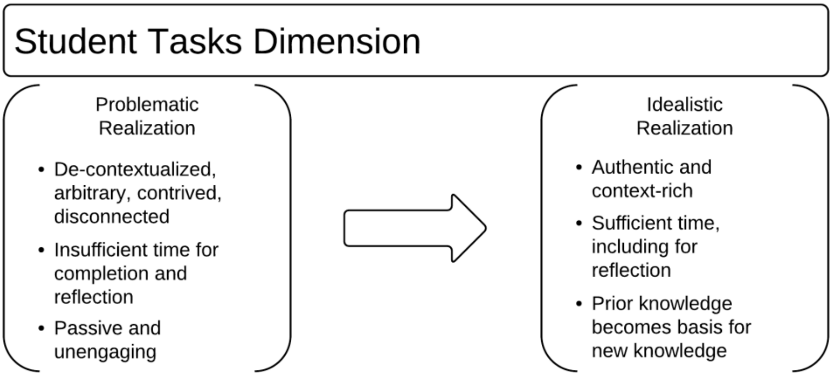

Figure 23. Summary of Student task dimension

The work of creating and implementing authentic curriculum is far more complex and unpredictable than creating and implementing curriculum that comes from textbooks or other highly prescriptive sources. As has been explained in previous chapters, authentic curriculum is designed locally but using guidelines from cognitive and learning science. The local curriculum is specific for the populations, goals, and resources of the local community.

As upside-down educators engage in the work of creating authentic curriculum, an online curriculum repository becomes an invaluable resource as the focus of a professional learning community. The repository is where teachers go to find and share links to appropriate online videos, templates for planning and instruction, ideas for prompts, and similar resources for teaching in the upside-down classroom.

To be useful, the curriculum repository should be created and maintained by local communities; many communities create a course on the LMS to serve as a curriculum repository. When local communities control the curriculum repository, the resources have been vetted for the local community, and the users have a relationship with the contributors. Fortunately, vetting resources is a task that is very easy to share. Once a good resource has been identified, its existence and location can be shared among colleagues so; for example, the science teachers in a school can contribute to and utilize a single collection of resources.

The curriculum repository is the product of a participatory culture, and they are most effective and useful when the community is dedicated to the ideals of open resources. Educators with access to a curriculum repository are free to use any items that exist there, but the expectation is that "you give as much as you take." Open resources are identified by four characteristics:

- *Reuse*- Participants in the curriculum repository contribute with the explicit permission that others may use their contributions in either the original format or in a revised format.

- *Revise*- Any participant in a curriculum repository may adjust any items as they see fit. This can be to correct mistakes, update it to reflect new understanding, modify it for different populations, or otherwise edit the resource. It is expected that the revised copy will be added to the repository to join the original.
- *Remix*- The curriculum that appears on a repository can be selected in any combination the educators finds appropriate. Educators who create a mash-up are remixing media.
- *Redistribute*- Explicit with contributing to an open resouerce curriculum repository is the permission for others to copy the curriculum as they need.

Because of copyrights, it is likely that resources obtained from publishers cannot be posted on a curriculum repository. To share resources they cannot copy, upside-down educators will give a complete reference to their colleagues via the repository.

Many educators also find the work of managing curriculum, in upside-down classrooms changes from creating to vetting and editing. In traditional classrooms, teachers take much time preparing materials for the classroom: papers are copied, books are collected, videos are cued, and materials unpacked and set out for students to use. In addition, teachers prepare to assess students' learning by selecting and transcribing questions to compile tests, and copy and disseminate the tests, and then preparing grades to be reported to parents and others.

In upside-down classrooms, the materials have largely been prepared by others. Lectures have been recorded, simulations have been programmed, and other resources have been published on the web and in other places available for students. Rather that preparing the resources for upside-down classrooms, teachers spend time identifying and vetting resources, and pointing students to those. For most educators, the amount of work is unchanged, but the nature of it does.

Technology Systems

Computer systems are at once simple and very complex; they are designed to move electric signals from one place to another, but the details of configuring and managing the systems can be overwhelmingly complex. Arthur C. Clarke is credited with saying, “any sufficiently advances technology is indistinguishable from magic.” While this may capture educators' perceptions of information technology, the reality is that educators must become more knowledgeable about the systems they use and more facile users of the systems so they can “keep up with “ their students.

Part of the complexity of IT systems in the 21st century comes from the fact that systems are networked to a level they were not previously. “Logging on” to a computer can have multiple meanings, for example a school is likely to require users to log on to local area networks, email systems, the LMS, and other systems. Those who build IT systems for schools have a responsibility to explain to the users of their systems (administrators, teachers, and students) how their accounts work. The users have a responsibility to understand which system they are trying to access so they can provide troubleshooting guidance.

In many school communities, IT functions that were once managed locally are being migrated to servers managed outside the school. This is commonly called cloud computing and refers to the fact that the servers are difficult to locate and the Internet has been portrayed as a cloud for years. The great advantage of cloud computing for schools is that server management is performed by others who have greater expertise and resources to protect systems.

While there are some training needs that must be met by school and technology leaders, there are some skills that every educator should enter the profession comfortable with IT skills such as:

- Using productivity suites and transferring skills in one to another;
- Using multiple email systems;
- Completing Internet searches quickly;
- Accessing and using different web media;
- Using digital libraries, including full-text databases;
- Completing initial troubleshooting and accurately describing malfunctioning systems to technicians.

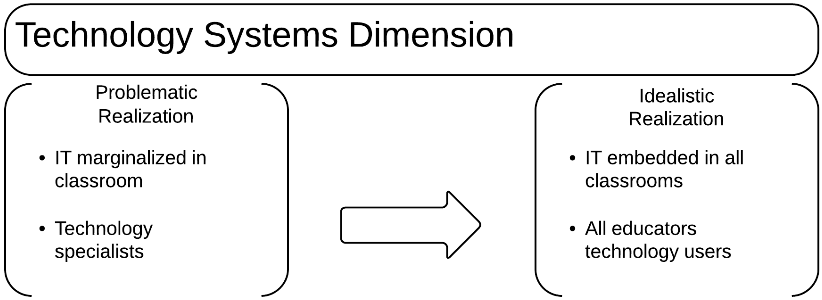

Figure 24: Technology system dimension

Since the 1980's cognitive load theory has been informing the study of tasks, especially technology-rich tasks. According to this theory, each individual has a limited amount of cognitive processing that can be dedicated to a learning task. When using unfamiliar tools, some of the cognitive load must be used to interact with the tools, thus is unavailable for learning. The cognitive load of using technology systems can become very complicated: Consider a graphing calculator. Many find these devices to be difficult to use, but they can make the task of visualizing advanced mathematics quick easy. As users gain experience with technology tools the cognitive load of using them is decreased, so the advanced ideas become more understandable with the tools. To reduce the cognitive load of technology tools:

- All educators should use the same systems, especially when providing the services available via an LMS.
- Encourage and facilitate frequent, but brief, use of technology systems, especially when they are first being learned by students.

Teaching Online

Whereas the face-to-face classroom is a familiar place to educators, the virtual classroom can be quite unfamiliar. Because upside-down classrooms include both in-person places and online spaces, they are often referred to as hybrid classrooms, and upside-down educators refer to the literature on online teaching and learning to guide their design of virtual classrooms. Among the advice typically given to online educators that upside-down educators fund useful is:

- *Be consistent.* For example if you are going to post homework assignments, always put them in the same area and use similar labels. Many teachers keep an announcement area and then change the color of the font as new announcements are posted so that students are cued to changes. By using only a few tools when they start using a virtual classrooms, many educators find that they can be more consistent and confuse students (and themselves) less than it they use more tools.
- *Give practice tests.* When first using an online test with a group of

students, administer a practice test so that students (and the teacher) are comfortable with answering questions online and the teacher is sure the tests are being configured correctly. This reduces anxiety for students, and ensures the test have been properly configured and can be completed on students' computers or devices.

- *Online discussions* must begin with a prompt that is sufficiently engaging to sustain the entire discussion. Work to craft these carefully—along with prompts to encourage responses to others' posts—as you may not be available to redirect discussion that gets off topic. Many educators find their initial endeavors with online discussions disappointing; those who persevere and seek to improve their own use of online discussions find them to be very valuable.
- *Feedback is essential.* It is tempting to compose a single response to an assignment and then copy and paste that to all students. While this may be appropriate in some cases, each student should have individualized feedback on assignments.

Upside-down educators must develop knowledge of and skill using 21st century tools for managing and sharing digital documents.

- While many open educational resources are available, not all digital resources are open, so educators must take steps to understand the copyright limitations on the text, graphics, audio, video, and other media they use.
- Web sites such *YouTube* and *iTunes* allow users to create and share playlists.
- By embedding media, educators can create mash-ups of media that are easy and non-distracting for students. By using embedded media,

however, one is connected to the original publisher, so it the media is moved or removed, then it becomes unavailable wherever it was embedded.

- No matter how an educators chooses to maintain a collection of digital resources, tagging becomes and important skill as the collection grows. A tag is search-able term that is added to digital information by a human; "technology-geeks" refer to tags as meta-data or information about the information. Because tags are created by humans, humans also give them meaning, and so an individual or a group can make any tags they wish.
- Some educators prefer to maintain a blog to collect their digital resources. When exploring the Internet, the blog can be opened in a web browser tab and whenever items are discovered, they can be added to the blog. Blogs are organized chronologically, can be searched, and allow users to tag their posts.
- Bookmarking is a familiar tasks or Internet users. Social bookmarking is also popular, especially or those who use many different computers. With accounts on social bookmarking sites, one stores bookmarks on the Internet, and as long as the browser is logged in to the social bookmark system sites that are bookmarked are added to the social collection. This can then be shared.

Models of Professional Learning

Recognizing that upside-down teachers require on-going opportunities for professional learning is essential for school and technology leaders who support upside-down educators. This professional learning must be characterized by a mix of self-selected and self-defined learning (based on one's expertise and understanding of current need) as well as new ideas which bring new tools, models, and perspectives to the community. Several models for professional development are appropriate. An effective professional learning program will include each.

Awareness Presentations

Because information technology (hardware and software as well as network resources) changes so quickly and new tools are developed and refined (and adapted by skilled educators) so quickly, it is likely that options exist that even connected educators are not aware exist. The purpose of an awareness presentation is simply to introduce a technology or strategy to an educator (or group of educators). After an awareness presentation, those educators who are interested in the topic will have access to resources for further exploring the topic. Awareness presentations are characteristically:

- *Very brief* (10 minutes or so)- A show-and-tell session included in the agenda of a faculty meeting is common, as is a round-robin with several awareness presentations set up in one place and groups rotating through the individual presentations.
- *Allow for reflection*- Because the new tools introduced in awareness presentations will be perceived as "unnatural" to most teachers, the chance to hear others' perceptions is a chance to connect with the new ideas. Of course, the opposite may occur as well, and reflection may be the chance for educators to "gang up against" new ideas or tools.
- *Include a collection of resources*- By design, an awareness presentation gives the audience minimal (even no) experience actually using the tool. Because of that, there must be a way for interested audience members

can learn more about the tools after the presentation ends. Links to tutorial and tools is expected, but time for hands-one exploration is best practice.

Tutorials

Because upside-down classrooms are technology-rich places, teachers in these classrooms will have the need for continual instruction in using technologies. Tutors are individuals who provide one-on-one (or very small group) instruction to learners, and this type of support is helpful to those learning to use new technologies.

Many are familiar with math tutors who review with students how to do certain problems and who observe and troubleshoot the student's work. Tutorials for technology tools are similar. Whereas traditional tutors meet in-person (and in-person tutors can be effective to teach how to use technology tools), many technology tutorials are given via technology and the audience has control over when it is viewed and how often it is viewed. Tutorials are generally:

- *Intended for individual or small-group support-* Taking a large group through a tutorial is seldom effective as the tutor "goes too fast" for some while others are far ahead of the group.
- *Best when provided just-in-time* as the learner needs the information. This is one of the advantages of using IT to deliver tutorials. Users are relieved of the responsibility of remembering (or otherwise expending cognition) and the user tends to be motivated so they pay greater attention and retain more of the information.
- *Best for step-by-step tasks* in which the steps are either correctly

performed or incorrectly performed.

Online video has been a very useful tool for those who seek to provide tutorials. Individuals can use screen recording tools to demonstrate the use of software tools and those can be explained with audio captured with built-in computer microphones. Video created in this manner can be uploaded (at no cost) to *YouTube* and thus disseminated to audience near and far. In addition, several businesses sell access to their own databases of online video tutorials.

Institutes

Institutes bring a group of educators together for an extended time (typically measured in days) so they can participate in an intensive and immersive experience. For several days, educators dedicate extended time to (with guidance) conceptualize, draft, refine, and prepare instructional materials. This is very useful when first adopting an instructional model, and time is needed to prepare a foundation of materials to support initial efforts in the classroom.

Institutes combine several features:

- An *extended time* to focus on the model. Typically institutes last several days to weeks.
- *Consideration of theory-* Especially those institutes that include graduate credit for participants, the curriculum of the institute includes reading and experiences that help the participants understand why they are learning new models.
- *Expectation of product-* Participants should leave institutes with resources that will help them as they return to the classroom. Lesson plans, curriculum materials, and handbooks are all examples of the type

of products they take with them when the institute ends.

- *A cadre of leaders*, ideally those dedicated to the theory and experienced in the classroom to guide participants as they explore the theory and prepare for the practice of the model.
- *On-going support* to help participants assess their work and reflect on necessary changes after they return to the classroom.

Support at a Distance

Just as the upside-down classroom makes significant use of information technology to allow students to interact with the curriculum as well as with peers and teachers and experts in the local and the extended community. It can also be used to support educators who seek to teach in upside-down classrooms, including those educators who are separated in time and space. Many observe that this is perhaps more important than in-person professional development, as teachers who are interacting at a distance for their own professional learning are experiencing the potential and the difficulties of using virtual classrooms as a learner.

The same models and technologies used to extend the upside-down classroom can be used to support educators at a distance. Teachers can watch experts present new ideas about teaching and learning, curriculum and content, learners and society. Teachers can share documents and ideas and provide feedback and encouragement using online discussions.

When creating support at a distance models of professional learning, school and technology leaders take advantage of asynchronous interactions for items such as :

- Tutorials which educators access as they find it necessary;
- Sharing ideas on blogs or similar publishing tools;

School and technology leaders also have a range of tools for synchronous professional learning. Of course, these tools are not unique for professional development relative to upside-down classrooms, but they are useful for this purpose. In synchronous professional development, the presenters and the audience are participating at the same time, but in these examples they may be interacting at a distance, but they are in different places:

- *Chat*- A chat room is a web page that contains two text boxes, one seen by the individual user and another shared by every user who is logged on to the chat room at a particular moment. When one types in their text box and click the “send” button next to it, the message is instantly displayed so everyone in the chat room can see it. Chat is built into most LMS.
- *Screen sharing*- As the title suggests, screen sharing is a technology that allows one to share their screen with others. Typically, the presenter will initiate the sharing and send a link to the audience so that they can point their web browser to a URL that displays the presenter's screen. This allows the presenter to demonstrate software or web site, or for a dispersed audience to focus attention on a single display. This can be combined with chat or audio over the Internet or the telephone for even more interaction.
- *Video conferencing* in which participants see and hear each other. Some platforms also allow for screen sharing and some allow for different users to take control of the mouse and keyboard of the presentation computer remotely. The best way to video conference is to be sure your computer (or mobile device) is connected to a wifi network (the systems do not work well over cellular connections) and for the participants on each side of the conference to be configured to use and to be logged on to the same video conferencing system.

Be aware that chat is electronic communication that is likely to be controlled by the Internet content filter in schools. Also, this communication is subject to the same archiving requirements the apply to email sent to and from school systems.

Habits

Educators abhor "reinventing the wheel;" they reason that someone somewhere has faced the same problem they face and that the others' solutions can be transferred into their school. Unfortunately, solutions do not transfer as reliably as educators would hope. While other educators' classrooms may be good places to begin looking for innovative curriculum and instruction for the upside-down classroom, those models must be refined and adapted to reflect the students and communities served by the teacher as well as the goals and resources specific to the school, and even the skills and knowledge (including the values) of the teacher. This section presents a small collection of habits and perspectives that can guide educators as they develop upside-down curriculum and as they approach the technology and support systems necessary to this model to be implemented.

Situational Awareness

Education is problem-solving that requires a mix of science and art, thus can be considered a craft. Well-crafted solutions can fail for many reasons, including those that could have been predicted and those that were unpredictable. In most cases, assessment and evaluation of those failures is biased. When educators develop *situational awareness*, they attempt to distance themselves from the failure and approach it from a different or unbiased perspective.

Situational awareness emerged as an important habit of mind for computer systems engineers as personal computers were entering the mainstream of business logistics and many business processes were first computerized. Landauer (1996) described the situation that was typical in the early years of software and information interface design: “a system is developed that performs, in a strictly technical sense, many functions imagined useful. Then an interface, a set of controls by which people can make it work, is attached” (172). When the function and interface imagined and designed by the engineers was implemented, however, the computer systems frequently failed to perform as expected. The typical response by engineers was to blame the user, when in reality the system was often to blame. IT designers quickly adopted situational awareness when designing systems. With that awareness, designers seek to accommodate users’ habits and needs and systems in which users adapted to the processes limit by and necessitated by the technology.

Situational awareness can be adopted by designers of any systems, but is particularly useful when designing solutions to wicked problems. Mehlenbacher (2010) observed,

> situational awareness thus embodies perceptual, cognitive, and situational abilities enabling people to see what is important in a given situation, to integrate the dynamics of the situation into a meaningful set of goals, and to project future states from one current state” (39).

This requires planners to focus on the essential factors of the activity at the center of the design process, and ensuring that those factors are addressed. In the IT-rich classroom, situational awareness will be a collaborative endeavor as many stakeholders are involved. Technicians must ensure that the computers can function and access necessary resources and educators must understand how to operate and use the systems designed by the technicians. Through this awareness, educators and technicians create more usable systems; also school and technology leaders meet the facilitating conditions necessary for creating and sustaining IT-rich learning environments.

Technology Acceptance

Educational technologists have identified a wide range of factors that are positively associated with increased and expanded use of technology in the classroom. For example, the International society for Technology in Education, the leading professional organizations for technology leaders in schools, has identified the Essential Conditions which includes 14 factors including those related to management and leadership as well as infrastructure and curriculum.

When faced with such a laundry list, many school and technology leaders seek to improve only one or two at a time as there are limited time and financial resources available to attend to all during the same school year. For some, this can lead to questions regarding the appropriateness of the goals that are selected or the completeness of any plans that focus on only a limited number of the conditions.

Interestingly, technology leaders in businesses and organizations other than K-12 education tend to use models with man fewer factors when seeking to increase and expand the use of IT in their organizations. An example of a widely-used model is the technology acceptance model (TAM) (Davis 1989) which identifies three factors associated with greater use of of technology in organizations:

- Perceived Ease of Use;
- Perceived Usefulness;
- Perceived Social Norms.

This means that users are more likely to use a particular technology for a particular use if they find it easy to use, useful, and others use it and expect it to be used. The TAM suggests steps taken increase in any of those factors, will lead to greater technology use. Those actions can include increasing the user's skill using IT, improving the users' attitude or affect towards IT, improving the fit between the technology and the task, or increasing awareness of social expectations relative to the technology. Steps taken to improve other aspects of technology use will have less influence on technology use than steps taken to School and technology leaders who use TAM to guide and measure technology use in K-12 communities have a greater chance of addressing deficiencies in systems than those leaders who focus on the many essential condition, or those who incorrectly select those that are most important in their communities.

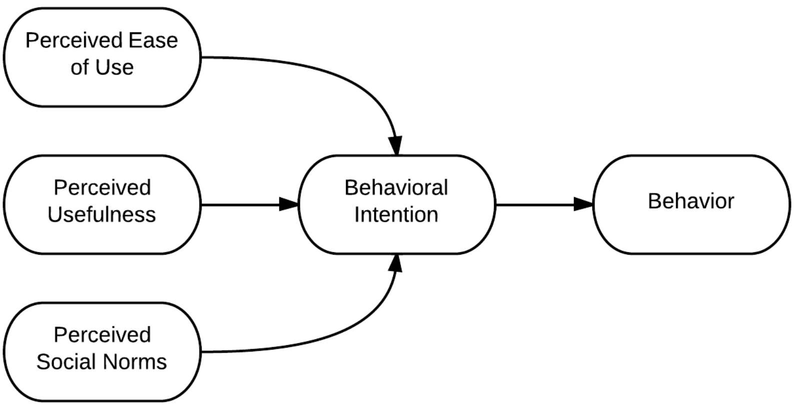

Figure 25: Technology acceptance model

Progressive Discourse

When communities seek to implement new models of practice, for example in those communities in which school and technology leaders seek to support educators who turn their classrooms upside-down, the greatest and most far-reaching and sustained changes in practice tend to occur in those communities in which there is a focus on progressive discourse. Progressive discourse (Bereiter

2002) is focused by several characteristics:

- *Conceptual Artifacts-* Progressive discourse begins with a well-established definition of specific actions that are described by the words being used. The actions in each realization form conceptual artifacts. A well-defined conceptual artifact prevents stakeholders from applying a too broad definition to the term. In this book, authentic learning is an example of a conceptual artifact.
- *Improvement-* All conceptual artifacts are incomplete and can be improved and the purpose of progressive discourse is to improve those concepts. It is also assumed the actions embodied in the concepts can be made better through the actions of the group.
- *Common Understanding*- In political discussions, it is often desired that participants agree. Reaching agreement frequently requires a group to comprise. In order to reach compromise, participants in political debates can diverge from common understanding; while agreeing on the language the participants disagree on the action being labeled. While this step can lead to agreement, it does violate the focus of progressive discourse on improving conceptual artifacts. For progressive discourse to continue, it is essential to preserve the conceptual artifact so modifying it to achieve political agreement is contrary to progressive discourse. Maintaining the integrity of the conceptual artifacts and the common understanding upon which those are built is more important in progressive discourse than political agreement.
- *Expand Fact-* In the vernacular, fact typically means information that is true and accurate; implicit also is the assumption that the fact is objectively defined so that every observer will agree on the both reality of the fact and the meaning of the fact. A more sophisticated view of

facts recognizes the role that one's perspective exerts on how one senses and interprets facts. In science, a fact is any idea that can be tested; and some are refuted by tests while others are supported by tests. Those facts refuted by observation are probably inaccurate, and those supported by observation are more likely to be true and accurate.

- *Role of Criticism*- If it is to be driven by fact, progressive discourse relies on criticism of methods and results and interpretations of results. In science, such challenges lead to more and more detailed observations and empirical evidence to support fact; progressive discourse relies on similar criticism. This is another characteristic of progressive discourse that differentiates it from the consensus-reaching compromises common in political discussions. In a political discussion, participants may criticize ideas for any reason and the task of evaluating the criticisms is left to the judgment of the individual and collective audience. In progressive discourse, participants may only criticize ideas so that deeper understanding can be constructed and conceptual artifacts improved.
- *Nonsectarian*- If progressive discourse is to be fact-driven, then it cannot be designed or undertaken to support a political or economic conclusion that is established prior to beginning. Ignoring facts because they appear to violate one's political or religious sensibilities or that are contrary to those espoused by one who is more powerful is inconsistent with progressive discourse. Equally inconsistent is selecting facts so they conform to pre-conceived conclusions.

In education settings, the existing pedagogy is likely to be very entrenched and individuals will seek to adhere to those practices in a manner that is similar to how others adhere to political or religious beliefs. Observations can either support or refute the factual basis of continuing existing practice, but continuing existing practices "because that is how it is done" is an untenable position in progressive discourse.

Reflexivity

The term reflexive was originally used to describe the reciprocal and simultaneous effects between social science researchers and the subjects of their research. In the research focusing on the modern information technology and its role in creating the sociocultural context of the 21st century, the term reflexive is used to describe the reciprocal influences of technology devices on the tasks necessitating (and necessitated by) information technology and the individuals and groups who use that technology for those tasks.

While there is evidence K-12 classrooms are information-rich environments and IT is present, the reflexive forces that drive the evolution of IT and it use in society appear absent from those classrooms. It is not unusual for technology decisions to be made for purposes other than curriculum and instruction, and curriculum and instruction decisions are made without recognizing evolving and emerging information skills and knowledge. For 21st century school planners, this means that authentic curriculum, instruction, and technology will blur into one aspect of the classroom; the information we teach and the technology we use to search and access, consume and manipulate, create and share information will become increasingly interconnect and inseparable aspects of knowledge-building. This blurring of factors explains in large part the need to apply hermeneutic methods and the non-linear design methods that are typical when working with wicked problems. Collaborative design of learning environments by technologists and educators will adopt a reflexive approach; technology will influence curriculum and curriculum will influence technology.

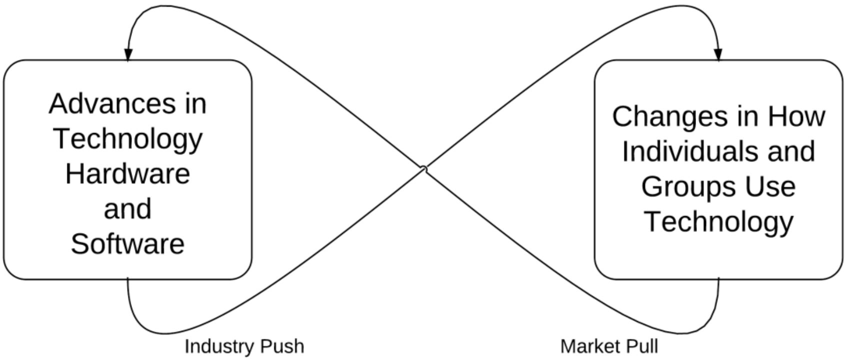

Figure 26: Reflexivity

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