Connected Learning:
A Framework of Observation, Research and Development to Guide the Reform of Education

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The Center for Internet Research

In conjunction with:
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Contents

Preface

> *"If a society is to endure, it will need to develop a systematic way of passing on its culture from one generation to the next. This universal societal need for cultural transmission leads to some form of educational system in all societies."* (Ferraro, 2001)

As often happens in language, the common usage of a word becomes isolated from its actual definition. Such is the case with the word "education". For many, "education" is a process confined to classrooms, performed by "teachers" who, through formal methods of instruction, impart knowledge and skills to "students". This conception of education is correct, if somewhat limited, but also creates the potential for the misapprehension of the larger role that education plays in the construction, functioning and continuation of culture as well as the various roles, responsibilities and contributions of individuals to the process and outcome of education. If one allows "education" to belong to the broader process of "cultural transmission", then education becomes connected to all other dimensions of the social system, the classroom merely becomes one place where education occurs and all individuals within a culture have a stake and a role in the system of education.

The phrase "education reform" is similarly loaded with implicit meaning and is commonly assumed to be a relatively recent phenomenon. However, even a cursory review of the history of education reveals that the nature of education has been debated, critiqued and revised in various forms throughout Western history by such notable figures at Plato, St. Augustine, and Rene Descartes. Like education, education reform has a broader meaning and connection: as cultures evolve, adapt, advance and reinvent themselves, the problem of what and how to pass to the next generation changes as well. In this context, the phenomenon of education reform becomes one thread in the fabric of the culture change process and, therefore, deeply intertwined with the nature of education itself. Given these premises, it seems naïve to view education reform as the kind of problem that is "solved" once and for all.

Embedded in the concept of education – and tied to the imperative of education reform – are culturally-constructed templates, or ideals, of the well-adapted, contributing and successful participant in a culture *at that moment in time*. These ideals are both explicit and implicit, complex, contextual, and almost impossible to fully enumerate but, functionally, the relative success or failure of education is measured against these standards. In cultures as diverse as the United States, there is intense competition between ideals although certain traits of these ideals are generally accepted and relatively enduring. What should be noted is that education reform is driven as much by competing ideals arising from cultural heterogeneity as cultural evolution. Even when traits of these ideals are held in common, their relative priority and value may differ by context.

So what do we gain by examining education as a function of the broader process of cultural transmission, education reform as an ongoing process and a function of culture change, and standards of education as reflections of deeply-held, culturally-constructed ideals of being a person in this world? First and foremost, this is a view of education from the perspective of cultural anthropology, a view not often presented in the education debate but one that suggests some deeper reasons why certain problems arise in a large-scale system of education like the U.S. and why solving or even formulating a solution for these problems has been so difficult. Underlying these three concepts is the issue of change and how cultures respond. Interestingly, the education system is both a leading indicator and a trailing indicator of how change is managed by a culture. As a trailing indicator, for example, we only truly know how successful our education system has been by the successes or failures of the generations running our culture now. Finally, this discourse on education from a cultural perspective provides a foundation for what Connected Learning is and is not.

Section 1: The State of Education and Reform

To many observers, the report *A Nation At Risk: The Imperative For Educational Reform* (The National Commission on Excellence in Education, 1983) (abbreviated as *A Nation at Risk* throughout the rest of the text) was a watershed moment in the U.S. debate on education reform. Prior to 1983, reform movements and debate about the performance of the education system were a steady drum beat in the U.S. socio-political consciousness with peaks of concern and activity after WWII (the G.I. Bill and the concern by colleges about absorbing large numbers of potentially under-qualified students); the Civil Rights Movement (school integration; racial inequities in school funding, infrastructure, teacher qualification and student preparedness); and the Soviet launch of Sputnik (concerns over the nation's relative position in science, math and engineering occupations and education).

The report was commissioned by then-Secretary of Education T. H. Bell to address "the widespread public perception that something is seriously remiss in our educational system." (The National Commission on Excellence in Education, 1983) Blunt and damning in its language, the report states, "If an unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war." (The National Commission on Excellence in Education, 1983) A sampling of specific observations include:

- "International comparisons of student achievement, completed a decade ago, reveal that on 19 academic tests American students were never first or second and, in comparison with other industrialized nations, were last seven times.
- About 13 percent of all 17-year-olds in the United States can be considered functionally illiterate. Functional illiteracy among minority youth may run as high as 40 percent.
- There was a steady decline in science achievement scores of U.S. 17-year-olds as measured by national assessments of science in 1969, 1973, and 1977.
- Between 1975 and 1980, remedial mathematics courses in public 4-year colleges increased by 72 percent and now constitute one-quarter of all mathematics courses taught in those institutions." (The National Commission on Excellence in Education, 1983)

In the wake of *A Nation at Risk*, we have witnessed a flurry of reform movements, a profound increase in political activity on education reform at the national level in addition to state and local efforts, and an intensification of debate at all levels. What follows is a few of the many education reform activities since 1983.

"School Choice"

What many refer to as the "School Choice Movement" has gained momentum since the late 1980s. School voucher programs, first proposed by Milton Friedman in 1955 (The Milton and Rose D. Friedman Foundation for Educational Choice, n.d.), began in earnest at the local level in 1990 in Milwaukee and the federal level in 2004 with the creation of a program in Washington, D.C. The first charter schools were founded in Minnesota in 1991 and now educate more than one million students in 3,600 schools in 40 states (The Center for Education Reform, 2006). While firm statistics are difficult to obtain, an estimated 1 million students in the 2005 – 2006 school year were educated in home schools up from approximately 15,000 in the early 1980s (Home School Legal Defense Association, n.d.; Rudner, 1999).

National

Government and legal activities in education reform have occurred on a wide variety of fronts. The "Even Start" program was approved by the U.S. Congress in 1988 (U.S. Dept. of Education, 1998). This program combined both improved early childhood education with adult family literacy in an attempt to end the generational cycle of illiteracy in the U.S. In 1989, the Kentucky Supreme Court declared the entire state education system unconstitutional on the basis that the state was not providing minimally adequate education to which public school students

were constitutionally guaranteed (Franklin Pierce Law Center, n.d.). As of 2000, twelve other states including New Hampshire, Wyoming, Alabama and New Jersey faced and lost similar "adequacy-based" lawsuits (Hurst, Tan, Meek, & Sellers, 2003). In 1994, the U.S. Congress enacted "Goals 2000: Educate America Act", a bill intended to improve teaching and learning by creating a national framework for education reform, encourage high levels of academic achievement and "promote the development and adoption of a voluntary national system of skill standards and certifications" (U.S. Congress, 1994). Also in 1994, Proposition 187, passed in California in a general election referendum, banned undocumented immigrants from public education (Martin, 1995). In 1996, President Clinton in his State of the Union address, called for an end to the practice of "social promotion", a practice in which students are allowed to progress to the next grade level regardless of actual academic achievement (Clinton, 1996). And in 2001, the U.S. Congress passed the "No Child Left Behind" Act (NCLB) which, among other mandates, transformed voluntary "Goals 2000" national education standards to compulsory ones and made federal funding conditional on school performance. This "accountability" feature in NCLB reflected a growing trend through the 1990s at the states-level of instituting or expanding accountability systems (Hurst, Tan, Meek, & Sellers, 2003).

State and Local

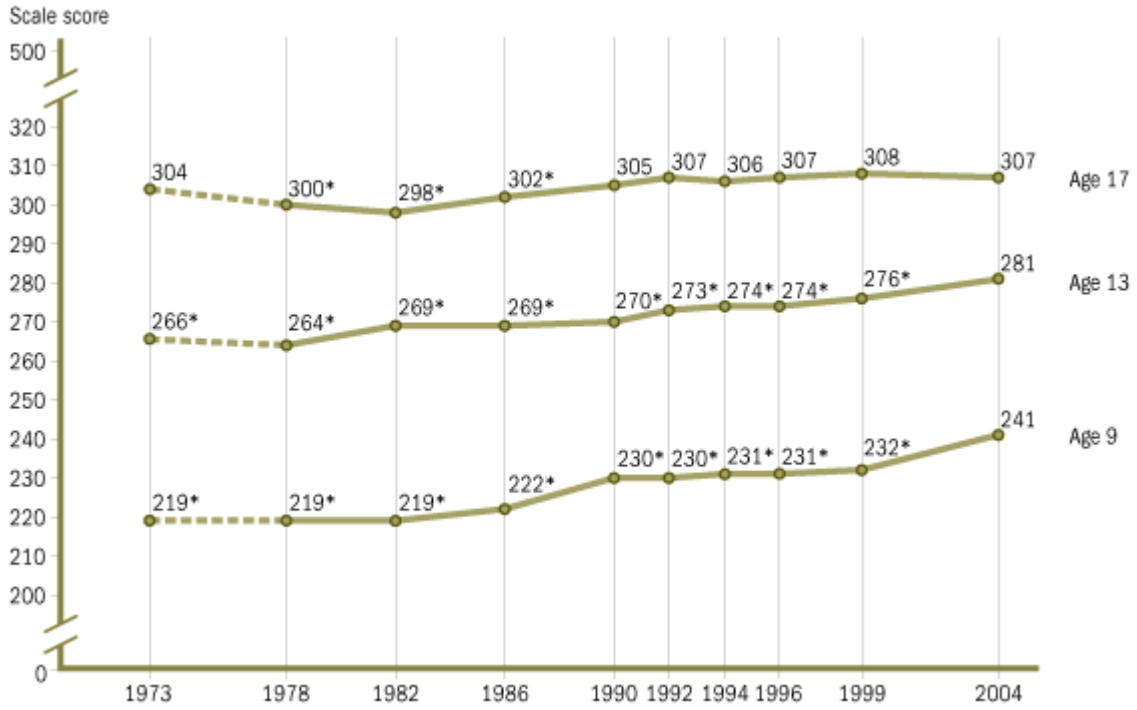
Across the country, numerous small-scale programs, teaching movements and pilot programs have been altering the education landscape. Overall, state-level reform efforts can be characterized as focusing on education outcomes (Hurst, Tan, Meek, & Sellers, 2003). As a result, nearly all states have raised their academic standards and instituted new assessment programs. As of 2004, twenty states added exit examinations to their high school graduation requirements (Méndez, 2004) up from 10 in 2001 (The National Center for Education Statistics, 2001). A perennial plank in the National Educators Association's platform has been reducing class size at all grade levels. Beginning in 1985, Tennessee's Department of Education launched the four-year, Student/Teacher Achievement Ratio (STAR) program to study the effects of classroom size on student learning at the kindergarten through 3rd grade. A follow-up study was conducted on the cohort in the 10th-grade (Finn, Gerber, Achilles, & Boyd-Zaharias, 2001). Wisconsin began the Student Achievement Guarantee in Education (SAGE) program in the 1996-1997 school year, a program aimed at maintaining student-teacher ratios at 15-1 or below for kindergarten through 3rd grade (Wisconsin Department of Public Instruction, 2006).

This selection of reform efforts is by no means comprehensive. Reform developments in pedagogy, technology, teacher education and qualification, school and classroom architecture, special education, higher education and more are clearly missing. Even so, this brief presentation demonstrates the intensity of education reform since 1983. After so much work, where are we now?

National Education Trends

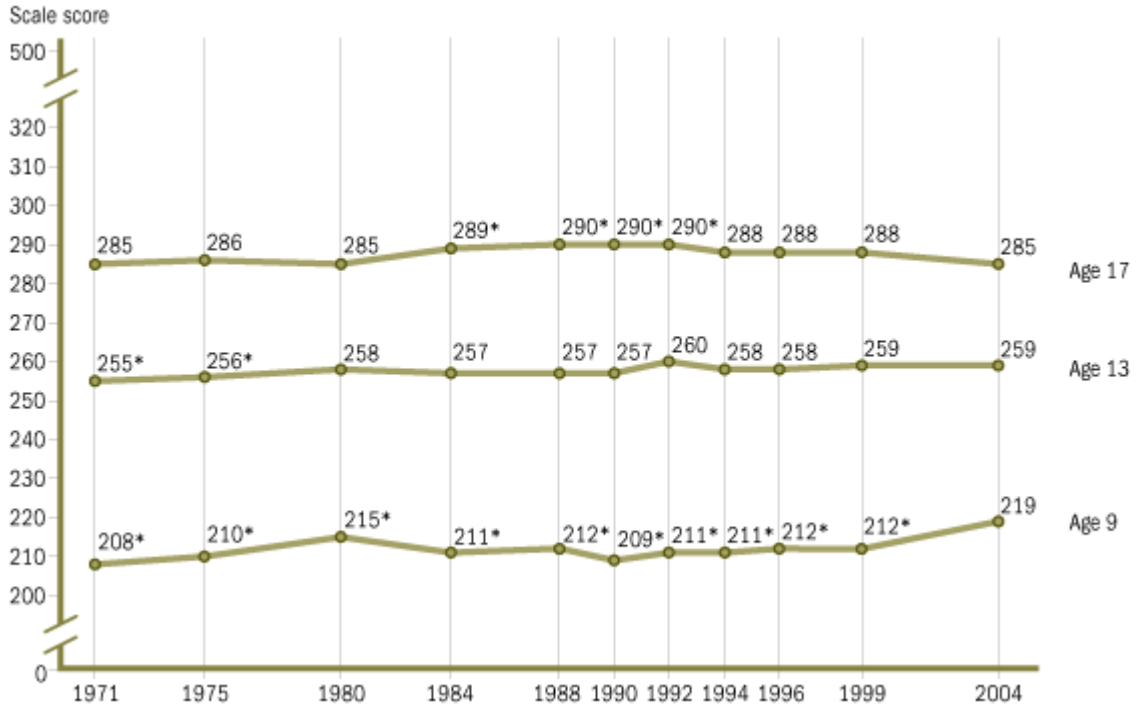
The National Center for Education Statistics (NCES), in conjunction with the Institute of Education Sciences and within the auspices of the Department of Education, is the primary entity for collecting and analyzing education data for the federal government. NCES maintains two parallel programs for measuring national progress in education: the National Assessment for Educational Progress (NAEP) Long-Term Trends (LTT) program and the "main" NAEP assessments program. The LTT program has employed the same assessment instruments and methodologies since inception, allowing for the direct comparison of results from year-to-year. The main NAEP program is subject to revisions as new priorities, content and methodologies emerge. Because the two programs differ significantly, it is not possible to directly compare results between programs. Figures 1 (LTTM), 2 (LTTR) and 3 (LTTS) show Long-term Trend Assessment scores in mathematics, reading and science respectively for approximately the past 30 years. The points along the trend lines are national averages of scale scores for ages roughly corresponding to 4th, 8th and 12th grade (Campbell, Hombo, & Mazzeo, 2000). Please take a moment to examine these graphs.

Figure 1 *(LTTM).* Long-term trend mathematics assessment, 1973-2004.



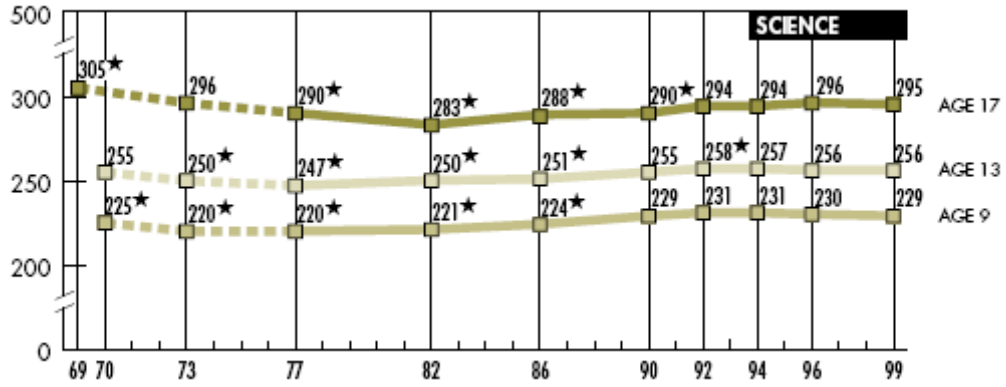
(Perie, Moran, & Lutkus, A. D., 2005, pg. 17)

Figure 2 *(LTTR).* Long-term trend reading assessments, 1971-2004.



(Perie, Moran, & Lutkus, A. D., 2005, pg. 10)

Figure 3 *(LTTS).* Long-term trend science assessments, 1969-1999.



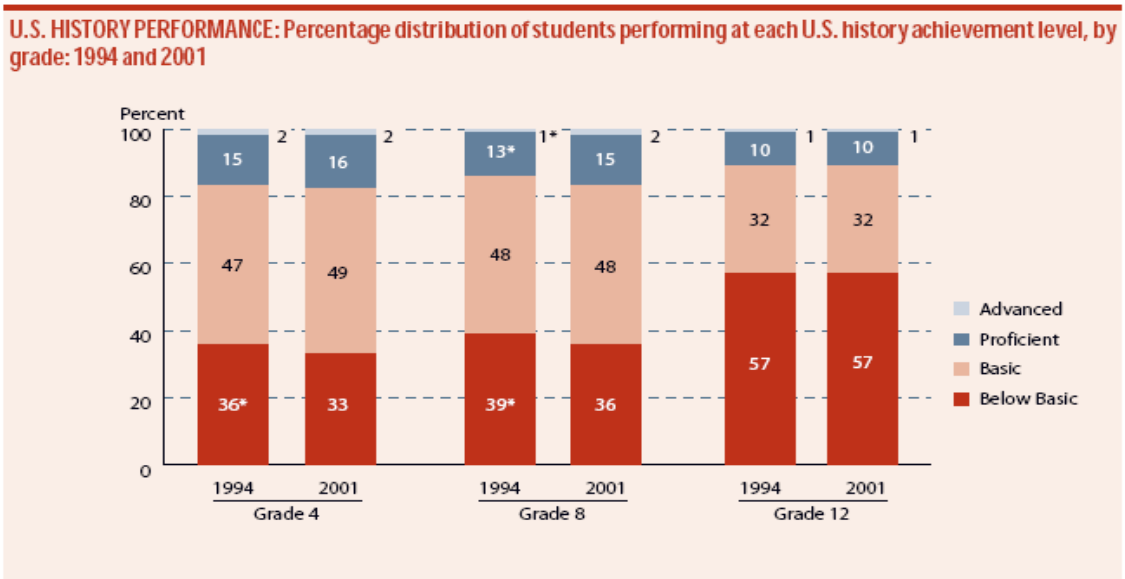
(Campbell, Hombo, & Mazzeo, 2000, pg. 9)

You may have noted that the trends express little change between the start and end points and minimal variation across the periods with three exceptions: mathematics scores for ages nine and thirteen show twenty-two and fifteen point gains respectively from 1973 to 2004; reading scores improved by nine points from 1971 to 2004.

Mathematics, science and reading represent “core” subjects in the NCES assessment strategy. However, NCES does conduct periodic assessments of other subjects including U.S. history, geography, art and music. Figures 4 (HIST) and 5 (GEOG) are charts from The Condition of Education Report 2003 and contain results from the first studies conducted in 1994 in U.S. history and geography and the most recent results from 2001. The methodology of these

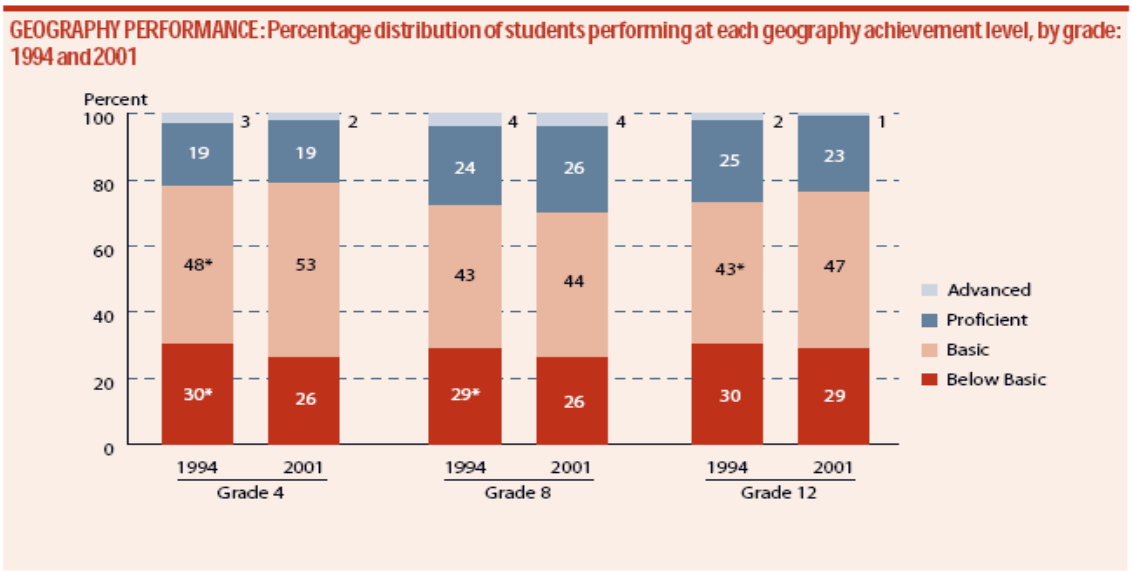
assessments is closer to the main NAEP than the LTT. The charts present achievement levels as a percentage; the full bar in each column represent 100 percent of each sample. Please take a moment to examine these charts in detail.

Figure 4 *(HIST).* A comparison of achievement in U. S. history, 1994 and 2001.



(Wirt, et al., 2003, pg. 35).

Figure 5 *(GEOG).* A comparison of achievement in geography, 1994 and 2001.



(Wirt, et al., 2003, pg. 34).

Like the LTT graphs, you may have observed modest changes between the two sets of assessments. Please note that in all grades, approximately one-third of all students were below basic standards in these subject areas with the exception of 12th grade U.S. history achievement in which over one-half were below basic standards.

Figures 6 (NAEPMAT) and 7 (NAEPSCI) are results compiled from main NAEP assessments in mathematics and science respectively from the years indicated. As discussed earlier, the main NAEP assessments evolve over time. Because the assessment methodologies remained relatively consistent from 1990 to present in mathematics and from 1996 to present in science, year-to-year comparisons can be made with a significant degree of reliability and validity. Like Figures 4 (HIST) and 5 (GEO), the primary feature of these charts are achievement levels by grade expressed as percentages of each sample. However, these charts express achievement levels as groupings, i.e. at or above Basic, etc., a style of presentation seen in most of the recent NAEP literature. Figure 7 (NAEPSCI) also provides a breakdown of scale scores by percentile. Please take a moment to examine these charts in detail.

Figure 6 *(NAEPMAT).* A comparison of main NAEP mathematics assessments by grade, various years from 1990-2005.

Grade and achievement level	1990[1]	1992[1]	1996[1]	1996	2000	2003	2005
Grade 4							
Below Basic	50.1	41.1	35.8	36.7	34.5	22.8	19.7
At or above Basic	49.9	58.9	64.2	63.3	65.5	77.2	80.3
At or above Proficient	12.7	17.9	21.3	20.8	23.8	32.5	36.3
At Advanced	1.2	1.7	2.3	2.2	2.5	3.9	5.0
Grade 8							
Below Basic	48.2	42.5	37.6	39.0	36.6	31.9	30.9
At or above Basic	51.8	57.5	62.4	61.0	63.4	68.1	69.1
At or above Proficient	15.3	20.9	23.8	23.3	25.7	28.8	29.8
At Advanced	2.0	3.1	3.8	3.7	4.7	5.4	6.0
Grade 12							
Below Basic	41.9	36.3	30.8	34.2	35.0	—	—
At or above Basic	58.1	63.7	69.2	65.8	65.0	—	—
At or above Proficient	11.9	14.7	16.3	16.0	16.8	—	—
At Advanced	1.4	1.6	1.9	2.0	2.3	—	—

— Not available.

[1] Testing accommodations (e.g., extended time, small group testing) for children with disabilities and limited-English-proficient students were not permitted.

NOTE: The 2005 National Assessment of Educational Progress (NAEP) assessment included a 12th-grade component, but at the time of this analysis, these data were not available. Beginning in 2003, the NAEP national sample was obtained by aggregating the samples from each state, rather than by obtaining an independently selected national sample. As a consequence, the size of the national sample increased, and smaller differences between years or between types of students were found to be statistically significant than would have been detected in previous assessments. See *supplemental note 4* for more information on testing accommodations, achievement levels, and NAEP.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1990–2005 Mathematics Assessments, previously unpublished tabulation (November 2005).

(Rooney, et al., 2006, pg. 136)

***Figure 7** (NAEPSCI).* A comparison of main NAEP science assessments by grade, various years from 1990-2005.

	Grade 4			Grade 8			Grade 12		
Percentile and achievement level	1996[1]	2000	2005	1996[1]	2000	2005	1996[1]	2000	2005
Average score									
Total	147	147	151	149	149	149	150	146	147
Percentile[2]									
10th	99	99	109	103	101	101	105	101	101
25th	125	125	130	127	126	126	128	124	125
50th	150	150	153	152	152	151	152	148	149
75th	172	172	173	174	175	174	174	170	171
90th	190	190	189	192	194	192	192	189	189
Percentage at achievement level									
Achievement level									
Below Basic	37	37	32	40	41	41	43	48	46
At or above Basic	63	63	68	60	59	59	57	52	54
At or above Proficient	28	27	29	29	30	29	21	18	18
At Advanced	3	3	3	3	4	3	3	2	2

[1] Testing accommodations (e.g., extended time, small group testing) for children with disabilities and limited-English-proficient students were not permitted on the 1996 science assessment.

[2] A percentile indicates the percentage of students whose scores fell at or below a particular score. Thus the 10th and 25th percentiles represent lower scoring students; the 50th percentile represents middle-scoring students; and the 75th and 90th percentiles represent higher scoring students.

NOTE: See *supplemental note 4* for more information on the National Assessment of Educational Progress (NAEP).

SOURCE: Grigg, W., Lauko, M., and Brockway, D. (2006). *The Nation's Report Card: Science 2005* (NCES 2006-466), figures 1 and 17 and previously unpublished tabulation (January 2006). Data from U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996, 2000, and 2005 Science Assessments.

(Rooney, et al., 2006, pg. 148)

Mathematics progress for the 4th grade shows significant improvement with a twenty percent decrease in below Basic achievement from 1990 to 2005. The data also suggests acceleration in the improvements made at the 4th grade level from 2000 to 2005. Smaller but noteworthy gains are exhibited in the 8th and 12th grade samples. Note the correspondence in trends between the main NAEP mathematics data and the LTT graphs. However, take notice of the fact that below Basic achievement in 2005 still ranges from twenty percent to thirty-five percent. In contrast, science achievement reveals little or no improvement from 1996 to 2005 and below Basic achievement ranges remain in the thirty to forty-five percent range. There is also correspondence between the main NAEP Science and the LTT Science trends although a comparison of three assessment intervals to two assessment intervals is far from conclusive.

An interesting pattern, or perhaps coincidence, emerges from a comparison of all three sets of data: 12th grade/age 17 academic improvements are the least significant between the three groups. Is this pattern real or a statistical anomaly? If the pattern is real, what might be the cause? A quick review of data from Kentucky and Colorado suggests that this pattern might be born out at the state level, too. This observation merits further study.

Switching gears, let us consider the premise that there was a net increase in the quantity of education reform since the publication of the *A Nation at Risk* report in 1983. To be clear, TCFIR is not yet aware of any study supporting this premise empirically. Rather, this premise is based on an *impression* formed in our own research of the literature. Let us also acknowledge that the phrase "education reform" suffers from a lack of a specific and generally agreed upon definition which further weakens the premise. However, it can be said with certainty that the statement "No education reform has taken place since 1983" is false. Let us consider a second premise: The education reforms that have been put into service since 1983 have been executed in good faith, backed by sound research and an expectation of success. Finally, let us consider the third premise: The assessment instruments and research programs evaluating both educational achievement and the effects of education reform have external and internal validity. The third premise is supported by at least one study (Dunbar, Koretz, & Hoover, H. D., 1991).

Let us consider an addition premise: There is no one "right" reform of education, no "magic bullet", nor can all reforms be "New Math". The effectiveness of reforms should be expected to fall along a range from relatively ineffective to relatively effective regardless of the

good faith intent of the designers of reforms. In fact, the effectiveness of the population of reforms would probably fall within a normal distribution if a metric for effectiveness could be created. But, given premise two, we might presume a negatively skewed distribution so that the mean effect of all reform efforts nationwide would result in an increase in the mean academic achievement. Simply stated, assuming that most reforms are at least mildly effective we should see some general improvement in academic achievement. Given these premises – and even allowing that the pace of education reform was unaffected by *A Nation At Risk* – do the graphs and charts above reflect the kind of academic achievement gains we would expect to see based on the sheer scale of efforts nationwide to reform education? Are we seeing an adequate return on our education investment? And if we are not, then why not?

Kentucky and the KERA Reform Effort

Can we see evidence of a positive effect of education reform on achievement at a smaller scale? Let us consider the case presented in Figure 8 (NAEPKEN). In 1989, the Kentucky Supreme Court ruled in the case of *Rose v. Council for Better Education* that the state's education system was unconstitutional. The suit contended that the education system failed the test of "efficiency" and "minimally adequate education" for all of the state's students (Franklin Pierce Law Center, n.d.). The Court ordered the state bring the education system into constitutional compliance within one year, forcing one of the most sweeping overhauls of a state education system in U.S. history. The Supreme Court took the unusual step of enumerating the characteristics of an efficient school system in eight of the pages within the decision. The Kentucky Education Reform Act (KERA) of 1990 "recreated the entire education system and included not only finance and governance changes, but also program changes". KERA established new education standards and the Kentucky Instructional Results Information System (KIRIS) assessment. The statewide education budget was increased by 32% from 1990 to 1999 (Hurst, Tan, Meek, & Sellers, 2003). Other effects and mandates of KERA included:

- Creation of the first online university in the nation.
- Decentralized decision making with major decisions shifting to the school level. The objective was to improve parent involvement and parent-teacher cooperation in issues related to instruction, curriculum and even personnel.
- The creation of a primary school program to replace the kindergarten through 3rd grade system that included multi-age, multi-ability classrooms.
- Major changes to teacher training and qualification requirements including the creation of a mentoring program for all novice teachers. (Walker, C. 2006; Hawpe, 2006)

Figure 8 *(NAEPKEN).* A comparison of NAEP assessment results, Kentucky vs. National, various years 1990-2005.

	Mathematics 2005		Science 2005		Reading 2005	
	Kentucky	National	Kentucky	National	Kentucky	National
Avg. Scale Score	274	278	153	147	264	260
Below Basic (%)	36	32	37	43	25	29
Basic (%)	42	39	33	30	45	42
Proficient (%)	19	23	28	24	28	26
Advanced (%)	3	6	3	3	3	3
	Mathematics 1990		Science 1996		Reading 1998	
	Kentucky	National	Kentucky	National	Kentucky	National
Avg. Scale Score	258	263	147	148	262	261
Below Basic (%)	57	49	44	43	26	28
Basic (%)	43	51	33	30	45	41
Proficient (%)	10	15	21	24	27	28
Advanced (%)	1	2	2	3	2	2

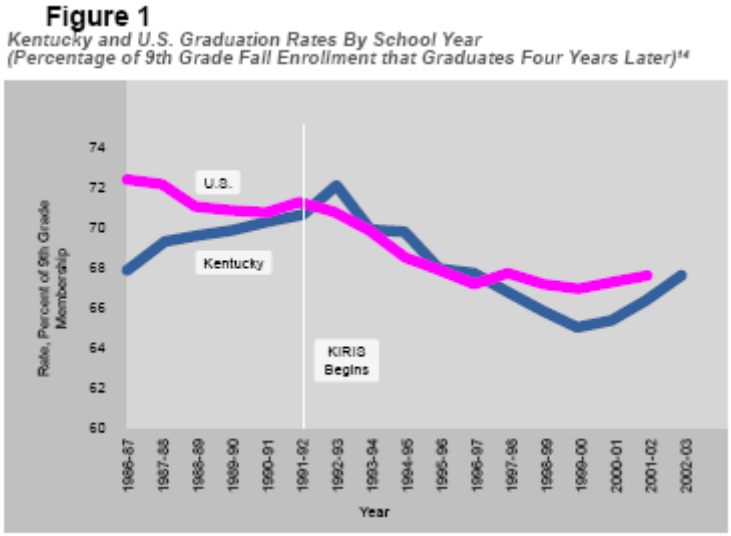
(Perie, Grigg, & Dion, 2005; Grigg, Lauko, & Brockway, 2006. Perie, Grigg, & Donahue, 2005; Reese, Miller, Mazzeo, & Dossey 1997; O'Sullivan, Reese, & Mazzeo, 1997; Donahue, Voelkl, Campbell, & Mazzeo, 1999)

KERA has drawn both strong praise and strong criticism. In the mid-1990's, the Ford Foundation and Harvard University awarded Kentucky the Innovations in Government Award

(Hawpe, 2006), Kentucky will receive 2006 Frank Newman Award for State Innovation from Education Commission of the States. The Department of Education has cited Kentucky in several NAEP reports for significant improvements in its mathematics and science education scores. Inspired by the precedent set by the *Rose v. Council for Better Education* decision, twelve other states have faced similar lawsuits and a number of states and municipalities including Arkansas (Ritter, 2003) and New York City have looked to Kentucky as a potential model of education reform (Reminder from the big apple, 2004).

On the other hand, critics have sited continuing inequities in funding due to formulas that fail to adequately fund schools with relatively small reduced- or free-lunch student populations (Day, 2003). A study in 2004 "suggested that Kentucky schools need $740 million to $1.2 billion more a year, on top of their current $4.1 billion allocation, to adequately fund the promises of KERA" (Reminder from the big apple, 2004) while parties from the *Rose v. Council for Better Education* suit have threatening new legal action (Hoff, 2003) based on these same funding concerns. Some education reform observers suggest that Kentucky now leads the nation in the rate of increase in non-public school enrollments, indicating that parents are giving up on KERA reforms (please note that that there is significant controversy over this finding). Another resource suggests that the Kentucky Department of Education was warned by American College Test, Inc. of problems with the reliability of KIRIS but suppressed the information until pressed by state lawmakers (Shedd, n.d.). Other questions have been raised about the reliability and validity of KIRIS especially in comparison to results from NAEP (Lee, 2000). In both cases, the implication is that KIRIS is overstating education achievement in the state. There are criticisms about Kentucky HB 178, a bill which redefined students awarded GEDs as successful graduates of the education system. Observers claim that the bill is in conflict with the stated goals of both KERA and NCLB and represents a manipulation of the statistics on the Kentucky Department of Education's actual performance. One report states, "Lawmakers are so concerned about the department's reports that they ordered an audit of Kentucky's dropout data in August 2003." (Innes, 2004).

Figure 9 *(GRAD).* A comparison of U.S. and Kentucky high school graduation rates.



(Innes, 2004, pg. 8).

The data presented in Figure 8 (NAEPKEN), Figure 9 (GRAD) and Figure 10 (COE2006KY) show mixed results. While NAEP data indicates a clear trend of improvement for Kentucky, the results can be characterized as bringing Kentucky within the range of the national scale score averages. The rate of gains over fifteen years in academic achievement place Kentucky in the top one-third of states in mathematics and science but in the middle of the pack

in reading. Perhaps more importantly, recent data shows a significant slowing in academic gains. As a "model" program, the Kentucky example raises important questions about the effectiveness of current education reform strategies.

Figure 10 (COE2006KY). Kentucky NAEP mathematics and science scores, rank position among the fifty states and Washington, D.C.

Ranking Kentucky Education

How does Kentucky compare to other states in mathematics and science educations after KERA?

- In 2005, 40 states had better 4th grade NAEP Mathematics scores than Kentucky while 33 states had better 8th grade scores.[1]
- In 1992, 26 states had better 4th grade NAEP Mathematics scores than Kentucky (9 states did not participate) while 27 states had better 8th grade scores with (13 did not participate).[1]
- From 1992 to 2005, 16 states had greater gains in 4th grade NAEP Mathematics scores than Kentucky (9 states did not participate). From 1990 to 2005, 8 states had greater gains in 8th grade NAEP Mathematics (13 did not participate).[2]
- In 2005, 8 states had better 4th grade NAEP Science scores than Kentucky while 19 states had better 8th grade scores.[3]

[1] NAEP mathematics scores were extracted from *The Condition of Education 2006* (National Center for Education Statistics, 2006) and sorted in Microsoft Excel.
[2] NAEP mathematics scores for 1992 and 2005 were extracted from *The Condition of Education 2006* (National Center for Education Statistics, 2006). 1992 scores were subtracted from 2005 scores and sorted in Microsoft Excel to produce a ranking of change in mathematics scores.
[3] NAEP science scores extracted from *The Condition of Education 2006* (National Center for Education Statistics, 2006) and sorted in Microsoft Excel.

International Comparisons

In the previous sections, we examined the effects of U.S. reforms represented in the national data and, on a smaller scale, the results of one of the most extensive state-level reforms in U.S. history: the KERA program in Kentucky. Let us turn our attention to international comparisons of academic achievement.

In the 20th century, the U.S. achieved an unparalleled global economic and political dominance due, in part, to high academic achievement relative to other nations and leadership in science, engineering and technology. With the advent of globalization and profound investments on the part of other nations such as Ireland, India, China, Singapore, Taiwan and Japan in the improvement of their education systems, the relative advantages in education that the U.S. once enjoyed have narrowed. Concerns in the U.S. over relative education quality are not new as the Sputnik-era reforms demonstrate. However, the problem of relative U.S. educational achievement has become especially acute as both the Indian and Chinese economies, representing over 2.5 billion people combined, grew in 2005 at a rate 7.6% (Central Intelligence Agency, 2006a) and 9.9% (Central Intelligence Agency, 2006b) respectively and both countries begin to supplant U.S. dominance in technology and manufacturing.

In light of these global changes, the Department of Education has participated in a number of programs to assess the relative quality of the U.S. education system. One such program, the Trends in International Mathematics and Science Study (TIMSS), is conducted by the International Association for the Evaluation of Educational Achievement (IEA). The third and most recent study was conducted in 2003 and is summarized below (Gonzales, et al., 2004):

Mathematics

- At the 4th grade level, the U.S. was 12th out of 25 countries with a score of 518 compared to the average score of 495 and the high score of 594 from Singapore. The U.S. score was unchanged from 1995. This, however, represents a reduction in relative standing.
- At the 8th grade level, the U.S. was 15th out of 45 countries with a score of 504 compared to the average score of 466 and the high score of 595 from Singapore. The U.S. score improved by 12 points from 1995 and represented an improvement in relative standing.

Science

- At the 4th grade level, the U.S. was 6th out of 25 countries with a score of 536 compared to the average score of 489 and the high score of 565 from Singapore. The U.S. score dropped 6 points from 1995 and represented a lower relative standing.
- At the 8th grade level, the U.S. was 9th out of 45 countries with a score of 527 compared to the average score of 473 and the high score of 578 from Singapore. The U.S. score improved by 15 points from 1995 and represented an increase in relative standing.

Reading literacy has been studied in a separate effort. The Progress in International Reading Literacy Study (PIRLS) was conducted by IEA in 2001 as the first in a five-year cycle of trend studies on reading literacy. The last comparable study was conducted in 1991 by IEA. PIRLS was administered in 35 countries to 9 year olds (the 4th grade in the U.S.). PIRLS is designed to measure reading ability related to enjoyment (the “literary experience”) and reading to acquire and use information, specifically the ways in readers construct meaning from text. The scale was set for 1000 with an average score of 500 and a standard deviation of 100. A summary of results are as follows (Ogle, et al., 2003):

- The U.S. ranked 9th in combined literacy with a score of 542 compared to the high score of 561 by Sweden.
- The U.S. ranked 4th in the literary subscale with a score of 550 compared to the high score of 559 by Sweden.
- The U.S. ranked 13th in the information subscale with a score of 533 compared to the high score of 559 by Sweden.
- U.S. Black and Hispanic combined literacy scores of 502 and 517 respectively were significantly below the U.S. average of 542.

- U.S. schools with a student body consisting of 75% or more free- or reduced-price lunch recipients had a combined literacy score of 485 compared to the U.S. average score of 542.

As with the national data from NCES, the IEA assessments present a mixed picture of educational reform progress in the U.S. Most importantly, especially in light of the imperative of maintaining a strong position for the U.S. in the global economy, the U.S. does not lead in any of the three indicators of relative academic achievement. The literacy data also highlights the problems the U.S. has in addressing gaps in student education across ethnic groups. As one of the most ethnically diverse countries in the world, the failure to achieve parity in education among all ethnic groups represents at best a waste of "human capital" and a pivotal problem that the U.S. must overcome.

This year, the National Academies (2006) published *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (abbreviated as *Rising Above the Gathering Storm* throughout the rest of this text), a report commissioned by the Energy Subcommittee of the Senate Energy and Natural Resources Committee in May, 2005 for the purpose of assessing the current state of U.S. science and technology and making federal policy recommendations. The U.S. education system was one of several domains investigated by the National Academies. Among the report's findings were:

- "In 2003 the Organisation for Economic Co-operation and Development's (OECD) Programme for International Student Assessment (PISA) measured the performance of 15-year-olds in 49 industrialized countries. It found that US students scored in the middle or in the bottom half of the group in three important ways: our students placed 16th in reading, 19th in science literacy, and 24th in mathematics. In 1996 (the most recent data available), US 12th graders performed below the international average of 21 countries on a test of general knowledge in mathematics and science." (The National Academies, 2006)
- "Fewer than one-third of U.S. 4th grade and 8th grade students performed at or above a level called "proficient" in mathematics; "proficiency" was considered the ability to exhibit competence with challenging subject matter. Alarmingly, about one-third of the 4th graders and one-fifth of the 8th graders lacked the competence to perform even basic mathematical computations." (The National Academies, 2006)

The PISA results are consistent with the IEA studies, consistent with the main and Long-term Trend NAEP assessments and consistent as well with individual state-level achievement data. We believe that it is highly significant that international, national and state-level assessments –using different assessment methodologies – converge on roughly the same appraisal of U.S. academic achievement.

The National Academies report provides a body of interesting facts on higher education that depict another dimension of the state of the U.S. education system. These facts need to be quoted in whole (The National Academies, 2006):

- "In South Korea, 38% of all undergraduates receive their degrees in natural science or engineering. In France, the figure is 47%, in China, 50%, and in Singapore 67%. In the United States, the corresponding figure is 15%.
- Some 34% percent of doctoral degrees in natural sciences (including the physical, biological, earth, ocean, and atmospheric sciences) and 56% of engineering PhDs in the United States are awarded to foreign-born students.
- In the U.S. science and technology workforce in 2000, 38% of PhDs were foreign-born.
- Estimates of the number of engineers, computer scientists, and information technology students who obtain 2- 3-, or 4-year degrees vary. One estimate is that in 2004, China graduated about 350,000 engineers, computer scientists, and information technologists with 4-year degrees, while the United States graduated about 140,000. China also graduated about 290,000 with 3-year degrees in these same fields, while the US

graduated about 85,000 with 2- or 3-year degrees. Over the past 3 years alone, both China and India have doubled their production of 3- and 4-year degrees in these fields, while the United States production of engineers is stagnant and the rate of production of computer scientists and information technologists doubled.
- About one-third of US students intending to major in engineering switch majors before graduating.
- There were almost twice as many US physics bachelor's degrees awarded as in 1956, the last graduating class before Sputnik than in 2004.
- More S&P 500 CEOs obtained their undergraduate degrees in engineering than in any other field."

The output of the U.S. primary and secondary education system becomes the input to higher education and the workforce. As such, other factors not easily measured by national or state assessments in particular subject areas emerge as trends in higher education and the workplace. One area requiring additional research is how well academic standards and practices actually prepare students for the workplace and post-secondary education. Karl Zinsmeister (1997) states, "Employers, too, are distraught. Noting that 44 percent of the job-seekers who showed up at his office couldn't read at the ninth-grade level, Prudential Insurance executive Robert Winters mourned that 'they are 17 years old and virtually unemployable for life.'" According to Zinsmeister, 80 percent of job applicants fail a 5th grade mathematics and 7th grade English competency exam used by Motorola for factory employment. At the post-secondary level, 72.5 percent of four-year institutions and 99.4 percent of "at least two but less than four year" institutions provide remedial education services (Knapp, Kelly, Whitmore, Wu, & Gallego, 2003). In addition, recent reports on high school graduation rates suggest that state and national data is flawed and overstated (Innes, 2004; Chaddock, 2006; Thornburgh, 2006). And, given the facts provided by *Rising Above the Gathering Storm* (The National Academies, 2006), one must ask *w*hat is happening in primary and secondary education to divert graduates from scientific and technical higher education and career choices? The NCES *The Condition of Education 2006* (Rooney, et al., 2006) reports that:

- "The number of bachelor's degrees awarded increased by 33 percent between 1989-90 and 2003-04, while the number of associate's degrees increased by 46 percent.
- The sole decline among the top five most popular degree fields between 1989-90 and 2003-04 was in engineering and engineering technologies (5 percent decline)."

What is the number one major in the U.S.? According to the Job Outlook 2005 survey (National Association of Colleges and Employers, 2004), the answer is accounting. The issue, then, is not whether U.S. student are seeking higher education. The "leakage" in the pipeline through higher education away from technical disciples has profound implications for the future of the U.S. economy as do the questions about high school graduation rates and basic academic skill levels at the other end of the workplace spectrum. The National Academies (2006) report states that an estimated one-half of U.S. economic growth since World War II has been the result of technological innovation. Based on the rate of natural science and engineering degrees earned in other countries compared to the U.S., the probability of innovation-driven economic growth being centered outside the U.S. is high. The relative strength of the U.S. education system raises troubling questions about the future.

Concluding Notes on the State of Education and Reform

For more than two decades, reform of the U.S. education has been a "hot topic" and the focus of great effort at all levels and yet the results as measured by state, national and international assessments are mediocre. NCLB promises to raise academic achievement to near-universal standards of "proficiency" but the long-term trends suggest that the goal may be beyond reach within the current paradigms of education even while the short-term trends suggest that improvements are occurring. The sidebar "Then and Now" presents two quotes, one from *A Nation At Risk* and the other from *Rising Above a Gathering Storm*; the similarities are disturbing given their separation by more than two decades. Is it unfair to say that, like Alice in the Red Queen's court, we are running as fast as we can just to stand still?

For those who might ask whether we have a problem with our education system, the answer is an unequivocal, "Yes!" The "School Choice" movement is just one example that demonstrates frustration on the part of parents with public education by creating alternatives to a system some say is broken beyond repair, while lawsuits such as *Rose v. Council for Better Education* attack the system from within. In the realm of the social sciences, public perception is often recognized as a force which creates "facts" regardless of the data. The data on the education system says "maybe" but strong, vocal and active social factions are actively working to re-form education outside or on the margins of the system. This alone creates an imperative to reform education.

Then and Now

Then: *A Nation at Risk*
"Our once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world."
(The National Commission on Excellence in Education, 1983)

Now: *Rising Above the Gathering Storm*
"In a world where advanced knowledge is widespread and low-cost labor is readily available, U.S. advantages in the marketplace and in science and technology have begun to erode."
(The National Academies, 2006)

But the "averageness" of the U.S. education system in international comparisons draws us away from the domain of perception back to objective fact. The U. S. economy has benefited from the disparities between our educational, scientific and technological accomplishments and those of other nations through the 20th century. Other nations, looking to our example, are fast on our heels. If the future trends of the U.S. education system resemble the trends from the LTT data projected forward by thirty years, the U.S. will most surely slip behind. Maintenance of the status quo in academic performance equates to failure on the international stage. From anthropology, we learn that inter-cultural contact, and the resulting diffusion of ideas, technology, etc., is a major driver of cultural change. In this way, U.S. successes have diffused to the world and now we must compete with our own ideas uniquely transformed and reinvented by dozens of countries.

The situation is not all bad. Strides have been made in the educations system. Recognition of the importance of early childhood education and programs such as Head Start has improved the readiness of many children to be educated. The focus placed on removing institutional and social inequities in the education system have reduced performance gaps between genders and ethnics groups, although those gaps remain (Campbell, Hombo, & Mazzeo, 2000). For most of U.S. history, primary control of the education system existed at the state and local level, resulting in a diversity of standards, curricula and infrastructures that created challenges in addressing even the most basic issues of education reform (Hurst, Tan, Meek, & Sellers, 2003). While there are many criticisms of "standards-based education" and greater federal control of education, the U.S. for the first time has the potential to see the effect of education reforms by reducing this diversity to something more manageable while elevating accountability and measurement of academic performance to new levels of importance. For better or worse, NCLB has put the U.S. on the path of a grand experiment in education. The scale of this experiment will undoubtedly leave its mark in the record of education trends.

The need for education reform will not end even if NCLB is a stunning success. Many observers assert that the world is moving toward a “knowledge-based economy” although that term is as ill-defined as “education reform”. What is clear is that technology is transforming every aspect of the world and will continue to do so. Human knowledge continues to grow at a geometric, if not exponential, pace. If “knowledge” is the currency of both the present and future economy, the quality of the output of our education system can only increase in importance. Moreover, the ability to self-educate as well as transform data and information into productive knowledge may be a kind of “academic skill” more critical to both individual and national success than those particular skills and knowledge represented by current national standards.

There remain innumerable questions about why our education system is as it is. The U.S. has faced any number of challenges and produced remarkable results in relatively short periods of time as examples such at the economic response to World War II and the Apollo Project demonstrate. Given the talents we as a nation have demonstrated, why do thirty years of education performance data reveal such limited improvements? The KERA case study sheds light on the problems with translating a new vision into a working reality but the real answers are yet to be found or perhaps merely assembled into a story that makes sense. Whatever the reasons, the need to ensure that the U. S. education system is serving the needs of the nation in all its manifest diversity is clear.

The remainder of this whitepaper will discuss ideas for reforming education beyond, or perhaps within, the new standards-based education paradigm. You may find, as we at TCFIR have, that the story of Connected Learning is not about a new idea but the discovery that some answers to the problem of education reform are right there in front of us.

Section 2: An Overview of Connected Learning

Education is important. The quality of the U.S. education system directly affects the nation's economy through the quality of the workforce available to employers, the demographics of the consumer market, the productive capability of the economy, the pace of innovation, and the relative standing of the U.S. globally. The quality of education determines the life opportunities available to individuals and their ability to exercise their right to "life, liberty and the pursuit of happiness." And the quality of education influences the cultural and social fabric of every nation, even influencing such seemingly unrelated phenomenon like birth rates, marriage demographics, trends in religion and urbanization patterns. While NCLB represents a major overhaul of our nation's education system, the need to ensure that the education system is doing what it must do demands that we not wait to see whether the states can meet the NCLB targets. New ideas in education are as important and relevant now as they have ever been.

Connected Learning is a proposal for a framework and an organizing set of principles to guide educational research and development. The idea for Connected Learning coalesced around the observation that, despite large sums of money, bright ideas and energetic execution, gains in academic achievement are not what one would hope. In the Section 1, we presented evidence from state, national and international sources to support this observation. The data presented does show that some progress is being made. However, judgment of the success or failure of the education system is something that truly cannot be empirical; it rests with each person's dreams of the future and with the ideals of the nation. Whether the data from the previous section represents success, failure or some mixed state is up to you.

> "Today, many students enter college with poor study skills and habits – and it's not entirely their fault. The American educational system generally provides minimal instruction on good study techniques." (Weiten, 2004)

TCFIR has taken on education reform because, regardless of the judgment one might pass on the education system, we see many opportunities for improvement. Since the publication of *A Nation at Risk* in 1983, information technologies have transformed or influenced almost every dimension of our world, including education. But like the main body of reform efforts, information technology has manifested little strong positive effect on academic outcomes. We cannot point to any trend or set of data and say, "Here it is. Here is where information technology has improved education." Yes, parents and teachers exchange emails. Yes, multimedia in the classroom has moved far beyond the film strips and reel-to-reel projectors of days past. Yes, report cards and school assessments are available via the Web. Yes, computer science is part of the education curricula of most high schools. Yes, the Internet has placed within reach of everyone with a computer such vast quantities of information that it is almost unusable. And, yes, there have been innumerable developments in learning and teaching technology, from the LOGO programming language to computer-based learning programs and Blackboard to online classes. But despite these developments, information technology has not yet penetrated the core problem of helping students to learn better and teachers to teach better.

What is the main effect of information technology? Information technology is an enabler and facilitator of *human capability*, like a lever that allows a person to move loads far heavier than muscle power alone. Information technology manipulates data but data only becomes information and knowledge in the human context and by processes of the human mind. One example of the magnification of human capability can be found in an explanation of the long period of economic growth through the 1990s: information technology enabled dramatic increases in worker productivity as businesses found ways of exploiting the capability of personal computers and networks. In other vein, mathematical simulations of climate processes could be produced with pencil and paper, as human Computors once did in calculating books of navigation tables, but computers make it possible to view the results in hours or days rather than centuries and in charts, graphs and visual simulations far more useful than tables of raw data. Information

technology in the context of education has already enabled many things not previously possible. For example, the principle of accountability within NCLB is made practicable by information technology because data can be shared, aggregated and analyzed in ways not possible twenty years ago. But information technology must do more for education.

Bounding the entire Connected Learning framework is a question: how can information technology and Internet-enabled technology in particular, improve education? This is not a new question but it is a question that remains unanswered. Within the framework is an observation: hundreds of technologies, insights from research, methodologies and processes already exist that address *parts* of the problem of improving education. Binding the framework together is a premise: these existing pieces of technology, research, methodologies and processes can be integrated by organizing principles and additional research and development to create something new, unique and powerful in education reform. This is one meaning of the name “Connected Learning”.

Technology, then, is the foundation of Connected Learning and an Archimedes Lever by which to move the world of learning. The remainder of the Connected Learning framework can be described in a series of principles.

- The education process must become learner-centered.
- Assessment – diagnostic, formative and summative – must be improved and deeply integrated into the learning and teaching process.
- National and state academic standards must be met or exceeded.
- Ethnic academic achievement “gaps” must be addressed and eliminated.
- Learning must become more active.
- The formation of life-long learning behaviors must be facilitated.
- Education reform must be guided by empiricism.
- Well-designed, technology-enabled education reform will be self-improving, self-reforming and self-documenting.
- Teaching and learning content must be of the highest possible quality, current and relevant.
- Proven pedagogical methodologies and the best research from all fields with a bearing on learning and teaching must be integrated into education.
- The needs of all stakeholders (students, teachers, parents, administration, government, business, etc.) must be served.
- Reform must also address the need to improve the formation and achievement of vocational goals by students.
- Where minimum standards exist, the goal must be near-universal mastery rather than a standard distribution of achievement.

These principles, written as imperatives, sound like inflexible goals but they are in fact standards by which to assess the various activities within the Connected Learning framework. Each principle is drawn from research but also reflects a consensus opinion within TCFIR. In addition, these principles represent hypotheses and, as such, are subject to falsification by scientific method and by consensus of the larger scientific and educational community. In total, the goal implied by the principles of Connected Learning is ambitious and perhaps even unattainable. But there are too many examples of great successes arising from impossible-sounding ideas to be deterred from attempting an ambitious proposal. Even partial success has the potential to significantly advance education. For example, what is the benefit to education and to the U.S. if technology and methodologies could be produced that resulted in near-universal mastery of minimum standards? What would be the outcome of identifying to a high degree of “certainty” those pedagogical methods that produce the best results? At present, one can only guess at an answer to either question.

That is why Connected Learning is called a framework based on questions and principles. Clearly, the job of education is complicated and difficult if for no other reason than the fact that we are only just beginning to understand the human mind. The problem of reforming education is even more complicated and difficult because, in addition to not clearly understanding

the object (the mind) on which the processes of education operate, there is the *system* of education made up of people in roles and social structures that perform and manage education and the *consequences* of getting it wrong (or right). To paraphrase Donald Rumsfeld, we do not know what we do not know. Therefore, Connected Learning is also a journey of discovery.

As briefly discussed in the preface, education is connected to all dimensions of society and the individual. Therefore, the methods and perspectives used to develop Connected Learning will come from any and all disciplines. We submit that education reform must be interdisciplinary to be both effective and practicable. However, interdisciplinary research and development, in and of itself, will present a great challenge because the sum of human knowledge is large and by necessity has become fractured into specialties and sub-specialities. How an epistemologist might relate to computer programmer and a political scientist on a problem of education is a serious question and a significant challenge. But if information technology is to be crafted into a form that promotes the acquisition of human knowledge and implemented within a large bureaucracy, such a meeting of minds will have to happen and be productive. Let us now turn to a brief description of the principles of Connected Learning enumerated above.

The Principles of the Connected Learning Framework in Brief

The education process must become learner-centered.
The Learner-Centered Model (LCM) of education is described in Appendix A.

Assessment – diagnostic, formative and summative – must be improved and deeply integrated into the learning and teaching process.

Assessment against national academic standards is a major principle of NCLB and recent state-level reform efforts. Assessment methods are generally categorized according to three types: diagnostic, formative and summative. The summative method of assessment is the most common type and includes quizzes, exams, writing assignments, reports, etc. but also include the various NAEP instruments and high school exit exams (Boston, 2002). The distinguishing characteristic of summative assessment is that it is typically used after a period of learning and represents a judgment about the learning that has taken place. In practice, each judgment is represented by a grade with each grade over a period of time, i.e. a semester, trimester, school year or career (as in the high school and college level grade point average), aggregated into a summation of each student's relative mastery of the body of learning. Within the current education paradigm, summative assessment is usually the end of the learning process for a unit or body of material; the teacher moves to the next unit in the lesson plan and students remain at whatever level of achievement they have demonstrated in the assessment. In contrast, formative assessment may employ similar instruments as the summative method but is used during the instructional process to provide feedback to both the teacher and learner. Information from formative assessment guides further learning and teaching activities and, in an ideal education environment, provides a basis for guiding all students to a uniform mastery of each unit of learning. Diagnostic assessment has a less concrete definition than the summative and formative types. In this whitepaper, diagnostic assessment has two meanings: first, a method of assessment used prior to a unit or body of learning to determine what preexisting knowledge and skills students have, and two, assessment used to determine traits of each student that influence learning. In the first meaning, "diagnostic assessment" includes both summative and formative assessment methods as each method, in a dynamic context, provides information useful to subsequent teaching and learning.

A subtype of assessment important to Connected Learning is certainty assessment. Certainty assessment adds a dimension of data in summative and formative assessment methods by including student self-assessment of the certainty with which they have answered a question. Certainty assessment is currently employed by the company Knowledge Factor in their proprietary industrial learning systems and in the United Kingdom by researchers and universities in a variety of settings. In formative assessment, certainty ratings allow both the learners and teachers to understand qualitatively how well discrete units of knowledge and skill are apprehended. In combination with formative assessment processes overall, certainty assessment facilitates precise adjustments to pedagogy, focused remediation of material not mastered and an

empirical base to guide the pace and direction of a lesson plan. In addition, certainty-informed diagnostic, formative and summative assessment provides detailed information about "delta" (change over time) in the student that may be used to formulate a new "grading system" if one is deemed necessary.

The importance of improving and deeply integrating assessment into the teaching and learning process cannot be overstated. Simply stated, one cannot understand, control or improve what one cannot measure. Improved assessment methods bring empiricism into the classroom and provide a precision, efficiency and productivity to the education system that has previously been missing. In a psycho-social context, improved assessment methods facilitate learner-centered practices by promoting a partnership between teacher and learner; reduce or eliminate the need for "high stakes" assessment like high school exit exams because a student's progress through the body of education standards will be well known; potentially reduced stresses associated with assessment, i.e. "test anxiety", by a) increasing student preparedness for summative exams and b) habituating students to assessment as a means of learning; and possibly reduce or eliminate social stigmas attached to grades and academic achievement as the meaning of assessment is different in this approach.

Finally, because detailed information along multiple dimensions will be developed by an improved assessment system, other practical uses for this information will be discovered. One potential use is helping students with the process of identifying and accomplishing academic goals related to vocation.

National and state academic standards must be met or exceeded.

Any reform effort that ignores or seeks to bypass the current paradigm of standards-based education is doomed to failure because NCLB is the law of the land. A common criticism of education standards coupled with accountability practices is the potential to narrow the scope of education to only that which produces the best assessment results. Regardless of this and other criticisms, standards are a reality that must be embraced. The principles of Connected Learning – especially improved assessment, learner-centered practices and appropriate uses of technology – are, as a body, intended to produce reform that helps the U. S. education system meet the targets set by NCLB. But Connected Learning in its full prospective manifestation has the potential to move academic achievement beyond national standards and address latent needs for adaptive life-long-learning, workplace achievement, critical thinking, metacognitive skills useful in a "knowledge-based" economy and relative national economic competitiveness.

Ethnic academic achievement "gaps" must be addressed and eliminated.

The persistent quality of the disparity in academic and socio-economic achievement between ethnic groups in the U. S. despite numerous, targeted reform efforts suggests that there is a "structural" problem with the education system. Learner-centered practices show promise in addressing the ethnic achievement gap but multiple lines of new research and development may also be required. In addition, the technological base of Connected Learning leads to a problem in addressing the ethnic achievement gap: the prevalence of computers and high-speed Internet connections are lower in non-White ethnic groups and in low socio-economic status schools and districts. Regardless of the challenges, demographic shifts in the U. S. population make addressing the ethnic achievement gap more important than ever.

Learning must become more active.

There are numerous justifications for this principle but one will suffice to communicate the point. If we the accept the premises that 1) conditions are changing rapidly in technology, the workplace, within the economy, etc., and 2) the pace of change is unlikely to abate, 3) current concepts such as the "knowledge-based economy" and "knowledge worker" are valid and tokens of actual processes in action, and 4) a major adaptive trait of individuals in these conditions is the ability to self-educate, then "active learning" is a concept that has great value both in the post-education setting and in the education setting as "simulation" of the environment that students will face upon entering the knowledge-driven workplace. In this practical justification, active learning is equated with self-education although the two are not synonyms: active learning most aptly applies to structured or guided learning settings while self-learning is a superset of active learning

but descriptive of any self-directed learning in any learning context. In this perspective, active learning can be offered as an ideal of the learner "self-educating" even within the context of the classroom. Active learning, however, requires some knowledge of both learning and thinking on the part of the learner, areas addressed in the cognitive and metacognitive domain of the Learner-Centered Psychological Principles (LCP) (APA, 1997) presented in Appendix A, Figure 11.

Consider for a moment your own experience within the education system and then answer these questions. Were you ever taught strategies for thinking or problem solving? Were you ever given explicit methods for effective study or research? Were you ever presented with opportunities to connect pieces of the knowledge or skills you acquired to other pieces or explore applications of your knowledge in a variety of contexts? Most likely, your answer is "no" to all three questions and yet these active learning skills are fundamental to all effective learning and to the application of academic experience to life.

The formation of life-long learning behaviors must be facilitated.

Life-long learning is a generative and creative process driven by curiosity and exemplifying the power of intentionality in learning. In the context of our change-driven world, life-long learning is adaptive. The principle of life-long learning shares the same set of justifications as active learning. A large body of research exists on life-long learning but anecdotal evidence alone from discussions with educators suggests that life-long learning behavior is a relatively rare trait. This principle is included in the Connected Learning framework as a guide to additional research to identify those factors in the current education system that discourage the acquisition of life-long learning behaviors and discover those factors which promote life-long learning.

Education reform must be guided by empiricism.

Improving and integrating assessment into the education process is but one part of promoting empiricism in education. The Learner-Centered Model (LCM) and LCP represent two other dimensions of empirical education reform. Simply stated, empiricism in education reform means replacing all ineffective parts of the education system with new parts validated by research as effective. To do this, interdisciplinary research is demanded because the system of education, its parts and its connectedness to the larger social system contain manifold dimensions that influence the outcome of the current education system and any reformed system one might envision. No one scientific discipline contains a perspective which encompasses all dimensions of the system of education. Empiricism is a core value of the Connected Learning framework.

Well-designed, technology-enabled education reform will be self-improving, self-reforming and self-documenting.

"Education reform" is a never-ending process driven, in part, by culture change. Just as the principles of active learning and life-long learning have value to the individual in a dynamic society, so to can an education system benefit from technology that facilitates adaptation to the needs of the society it serves. Improved assessment systems provide information that both teacher and learner can use to "reform" the learning process on the micro-scale. Aggregated assessment data tied to students, student populations, learning content, lesson plans, curricula, schools, districts, states and the national education system can produce new and continuously updated data to assess and reform the system at the mezzo- and macro-scale. Internet-enabled communities and communication can promote collaboration and further reform development. Technology can facilitate the shift from episodic reform to continuous, organic reform much in the same way that "continuous quality improvement" has influenced industry.

Teaching and learning content must be of the highest possible quality, current and relevant.

The Internet is a strange phenomenon, both over-hyped and under-exploited. However, it can be said without hyperbole that within the Internet is more information about everything than any one person can apprehend. Separating canon from apocrypha is another matter. Harnessing the Internet as a dynamic source of educational content is a principle focus of Connected Learning. The intersection between the topics of educational content and the Internet is vast, therefore only a few points will be developed here.

Education content across the entire U.S. education system suffers from the same heterogeneity as funding, infrastructure, student and teacher demographics, etc. Well-funded school systems have better content than "poor" systems. Internet content has the potential to replace or supplement traditional content thereby equalizing content quality across the nation. Content quality is further improved by access to new material as it is developed and to alternative content that can facilitate learner-centered practices. Integration of improved assessment practices with Internet-enable technologies results in the potential to assess, learn and teach simultaneously and even non-invasively. Internet-enabled teaching technologies have the potential to streamline administrative tasks such as lesson planning by providing teachers with access to existing, successful (i.e. empirically validated via diagnostic, formative and summative assessment data) lesson plans and support materials developed by Internet communities.

TCFIR is currently preparing a report on educational content from the perspective of the Connected Learning framework.

Proven pedagogical methodologies and the best research from all fields with a bearing on learning and teaching must be integrated into education.

This principle is related to the principle of empirical education reform but is presented separately because it speaks specifically to empiricism applied to the dynamics of teaching and learning. Even a relatively brief survey of education literature reveals a great diversity in the theories and practices of education and yet the core model if U.S. education has remained relatively unchanged for several decades. There is a disjunction between educational theory and research, and the execution of education within the current system; traditions persist despite superior alternatives and numerous reform efforts.

A new survey of the body of educational theory and research – in combination with a review of related, interdisciplinary material – is being undertaken by TCFIR with the goal of presenting this work to scholars for critical analysis. It is expected that certain patterns and insights will emerge to guide a subsequent process of research and development with the ultimate goal of identifying additional "best practices".

The needs of all stakeholders (students, teachers, parents, administration, government, business, etc.) must be served.

This principle is an extraordinary challenge but one that is necessary if reform is to succeed. TCFIR is developing a paper which will elaborate on this principle.

Reform must also address the need to improve the formation and achievement of vocational goals by students.

Extraordinary pressure is placed on today's students to make good decisions about education and vocation. While a high school diploma once served as the base for a spectrum of career choices that could produce a middle-class lifestyle, a four-year college degree has become the new de facto standard. Seventeen years of education (kindergarten through a four-year diploma) represents an enormous investment just to meet a minimum standard of qualification to enter the workforce beyond minimum wage. The consequences of making a bad decision are considerable. While meeting the targets of NCLB should improve the academic skills that are the base of any vocational choice, NCLB mandates no reform that would improve the assistance that students might receive in identifying their interests and aptitudes and translating these insights into clear (and attainable) vocational goals. Trends, such one-third of engineering students changing their majors before graduating, support the need to address this issue.

In combination, the principles of Connected Learning should address many important dimensions of vocational selection. The enriched feedback of improved assessment methods may provide new kinds of information to students, parents, teachers and guidance councilors. Learner-centered education and active learning practices should promote engagement and the intimacy of contact with all subjects thereby improving learners' understanding of their choices. However, additional research and development will be conducted by TCFIR to explore this issue.

Where minimum standards exist, the goal must be near-universal mastery rather than a standard distribution of achievement.

The meaning of this principle rests with an understanding of “minimum”. Minimum academic standards imply a body of knowledge and skills that everyone must have to function and participate in society. One can debate the meaning of an ill-defined phrase like “function and participate in” as it might relate to individual fulfillment or national need and the responsibility society has, through the education system, to serve this need. However, the intent of such a statement is clear: education must serve students so that they are at least minimally prepared for life. This is the implication of “no child left behind”.

Earlier, we argued that the expectancy of a standard distribution of academic achievement in any population of students represented a tacit acceptance of failure but this is only true based on the relationship between the mean of the distribution relative to a minimum standard, and in the context of a mass-education paradigm where there is little done to address the needs of students on the left side of the distribution. Human variation ensures that no population of students can be made uniform in their academic accomplishments. Reforming education so that all students have certain basic academic abilities, while also enabling students to reach the highest level of their native abilities beyond those minimum standards, is possible in the context of a system which emphasizes the development of students over student populations.

Section 3: Conclusion

Connected Learning is an enormous and ambitious framework for educational reform. In this whitepaper, we have presented a summary of the current education system and only the broadest of outlines of Connected Learning as an alternative. Neither topic has been treated to any great level of detail. As the purpose of this whitepaper is to serve as an introduction to both topics – even to those familiar with the education system and reform – the impression developed by its content should suffice. In addition, Connected Learning is a work-in-progress awaiting new research, insights, contributions and criticisms. Therefore, more detail about specific dimensions of the framework will be presented in topic-specific papers.

Two points should stand out above all others: the current education system is not a failure nor is it serving the needs of our nation, and Connected Learning is not a completely original idea but it is unique in its attempt to organize and develop disparate, existing pieces into a powerful, effective whole. Our efforts depend on a level of interdisciplinary research and development that has rarely been attempted but the need to incorporate the best insights from every field of science that has studied education is clear. Creating a system of education that truly ensures no child is left behind demands that no stone is left unturned.

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Appendix A: The Learner-Centered Model of Education

1.1 The Learner-Centered Model in Context

Social systems develop in a socio-historical context. Social systems, and elements of social systems, often persist long after the original context has changed. For example, summer vacation from education arose from a need for farming families to have their children contribute to the operation of the farm in the peak of the growing season. Today, the tradition of summer vacation remains in many school systems even though the need that summer vacation addressed has largely disappeared. The advent and spread of year-round school schedules demonstrates the ongoing evolution of the education system in response to changing socio-cultural conditions.

As with the tradition of summer vacation, current education practices developed in a socio-historical context. The story of the evolution of the education in the U.S. is too long and complex to develop in this whitepaper so it must suffice to note that there are socio-historical justifications for every element of the education system. But, just as summer vacation is being replaced by year-round school schedules, so too may the traditions of education practice need to change. The justifications are there to take a look at every aspect of education: the existence of education reform as a large-scale socio-political phenomenon and reform activities at every other level of society; the congruence between *A Nation At Risk* and *Rising Above the Gathering Storm* – reports commissioned by the federal government and separated by more than two decades; and the relatively modest improvements in academic achievement depicted in Section 1. In this spirit, let us ask some pointed questions and make discomforting observations about education as it is practiced today.

First, it should be restated that NCLB has assumed the position of being the dominant movement in current education reform activities. NCLB subsumed goals developed independently by the many states with formal academic standards and accountability practices being the most notable. Federalizing these extant trends caused all states to converge on a set of solutions with many similar features but one common goal: ensuring that all students reach grade-level "proficiency" by 2014. This is a challenging task and one that some observers say is improbable if not impossible within the current system of education practices. Before reacting negatively to what might be viewed as an unjustified condemnation of a system that has been an integral part of the rise of U.S. preeminence, consider the following elements the education system and how these elements define the set of possible outcomes.

- The basic model of education is a one-to-many distribution of content; a teacher teaches to a classroom of students.
- Lesson plans and curricula are developed for groups of students; one lesson plan or curriculum is assumed to fit the needs of many students.
- The one-to-many distribution model coupled with the time allocated to each lesson limits how much time and effort can be spent ensuring that all students understand the material.
- Assessment of student progress is largely summative; the teacher uses quizzes, exams, writing assignments, etc. to measure progress at the end of a section of learning.
- Historically, empirical baselines have been not established for each student at any point in their education career with a few exceptions: the admissions process for higher education, evaluations for placement in special education or "gifted" programs and prerequisite tests for admission into specific courses. In 2005, the Secretary of Education instituted a pilot program for Growth Models which track student progress from year-to-year facilitated, in part, by assessments in 3rd through 8th grade and once in high school for reading/language arts and mathematics. Currently, Tennessee and North Carolina are the only states to have approved programs (U. S. Department of Education, 2006). Despite these recent developments, assessment of academic progress is predominantly summative and without the guidance of diagnostic or formative assessment. As a result, relative mastery of academic goals can be assessed but progress is largely inferential and individual traits that influence academic achievement are missing entirely.

- In any population of students it is assumed that academic achievement will fall along a distribution; some will fail, many will do okay, some will excel. Failure is tacitly accepted by the simple act of continuing with the lesson plan even though all students have not mastered the material. “Social promotion” is the logical extreme of this process. Grade-level proficiency standards and Growth Models alter, but do not eliminate, this attribute of the education system.
- Individual feedback to students is delayed by inefficiencies in the assessment process. The delay varies by the type of assessment, the size of the class, the level of education (e.g. primary, secondary, university), available infrastructure, etc. Because assessments are typically summative and teaching continues between the assessment and the receipt of feedback, students, teachers and parents are often only aware of problems after new material is introduced. This delay in feedback increases the likelihood of additional problems arising later as most material builds on the mastery of earlier content.
- The current process of subdividing and promoting students through a system of age-grades is predicated on the idea that students at each grade-level are sufficiently comparable in academic, cognitive and socio-emotional traits and achievement to create curricula and lesson plans that are “grade appropriate”. Some accommodations for actual variation in the student population exist in the system including special education classes, “gifted” programs and denial of promotion to the next grade but, in practice, the education system is designed to meet the needs of the “average student” at each age-grade.

With approximately 45 million students to educate per year as of 2005, the U.S. primary/secondary education system has a “volume of production” greater than all but the largest corporations. Characterizing current education practices as “mass produced” or noting that education shares characteristics with manufacturing sector should not be viewed as unfairly judgmental. The volume demands placed upon education have required a focus upon the development of student populations rather than individual students. Despite these demands, the U.S. education system has been instrumental in the success of our nation. But, once again, the socio-cultural context of education has changed not only because of NCLB but also because of other factors like globalization, international competition and technology.

It is NCLB, however, that throws down a gauntlet to anyone considering the issues of education reform. The phrase “no child left behind” has an internal logic that belies a mass-production paradigm of education. Group accountability and education methods at best mean “most children won’t be left behind”. If “no child left behind” is to be more than bold political rhetoric, the academic performance of each and every student must become the standard by which the success or failure of the education system and its parts is measured. Taken literally, “no child left behind” is a paradigm for an even more fundamental reform of education than that mandated by NCLB.

We submit that the mass-production paradigm of education is close to its maximum level of production efficiency. While NCES statistics contain indications of improvement in academic achievement nationwide, we believe that current education practices will hit a “ceiling” short of the stated goal of “grade-level proficiency” by 2014. Reaching NCLB achievement goals is also complicated by a persistent inability to close ethnic achievement gaps relative to whites and Asians coupled with the increase in the proportion of “non-white” students in the population. National standards, accountability practices and Growth Models address some of the challenges of meeting NCLB goals but do not address a core issue that a mass-production paradigm of education will have difficulty in being able to overcome: human variation.

Every scientific field with humanity as its object of study acknowledges and investigates human variation. Every application of science and technology applied to humanity is confounded by, and must account for, human variation. Human variation in every trait that can be measured is a fact of both science and common experience that is beyond argument. That human variation is of critical importance to the process of education is less certain but well-supported scientifically. The current education system is not unresponsive to human variation but the demands placed upon education by the volume of students served, in combination with the limits of the tools and methods historically and currently available to educators, has reinforced the tendency to focus upon the needs of the “average” student. The system of subdividing and promoting students by

age-grade is a reflection of this necessity as it is based on an assumed general homogeneity in the student population at each grade level. But, as any educator will tell you, not even the population of a single class is homogenous. Overcoming heterogeneity in the classroom is a substantial part of the art of teaching within the current education paradigm.

The Connected Learning framework begins with questions about the role of information technology in education reform. However, the highest priority is the academic achievement of each and every student; information technology solutions that do not serve or facilitate this goal have no value. Information technology has the highest potential to address key aspects of human variation in the educational setting but only in a larger context in which students, rather than student populations, are the focus of the education process. While Connected Learning has a technological base, the core "human" element of the framework is the Learner-Centered Model (LCM) of Education substantially developed by Dr. Barbara McCombs, noted learning and motivation psychologist. A contributor to the Connected Learning framework, McCombs identifies the key processes involved in developing learner-centered principles and practices as:

- "Building ways to meet learner needs for interpersonal relationships and connections;
- Finding strategies that acknowledge individual differences and the diversity of learner needs, abilities, and interests;
- Tailoring strategies to differing learner needs for personal control and choice; and
- Assessing the efficacy of instructional practices to meet diverse and emerging individual learner and learning community needs" (McCombs, 2006).

As an overriding principle within Connected Learning as informed by LCM, not only is it necessary to look for the match or mismatch of instructional practices with learning principles, but also their match or mismatch with learners and their diverse needs. A balance of personal and technical supports can then be provided with a variety of learning opportunities, content requirements, and communities of learning. By embracing human variation in the learner-centered paradigm, education moves that much closer to the goal of leaving no child behind (McCombs, 2006).

1.2 Defining "Learner-Centered"

The remainder of Appendix A has been provided by Dr. McCombs from her published and unpublished work on learner-centered education. Non-standard bracket citations indicate the source of a body of text. Citations made within McCombs' work have been transferred to the bibliography of this text to ensure that proper credits are given. McCombs has given permission for this use of her research.

[McCombs, 2001]

In 1990, the American Psychological Association (APA) appointed a special Task Force on Psychology in Education, one of whose purposes was to integrate research and theory from psychology and education in order to surface time tested general principles that can provide a framework for school redesign and reform. The resulting document originally specified twelve fundamental principles about learners and learning that, taken together, provide an integrated perspective on factors influencing learning for all learners (APA, 1993). This document, revised in 1997 (APA,1997), now includes fourteen principles, with attention to diversity and standards. These principles are presented on the next page in Figure 11.

Figure 11. **The Learner-Centered Psychological Principles (LCP)** (APA, 1997)
The fourteen learner-centered principles are categorized into four research-validated domains important to learning: metacognitive and cognitive factors; affective and motivational factors; developmental and social factors; and individual difference factors. An understanding of these domains and the principles within them establishes a framework for designing learner-centered practices at all levels of schooling. It also defines what "learner-centered" means from a research-validated perspective [McCombs, 2001].

Cognitive and Metacognitive Factors

Principle 1: Nature of the learning process.
The learning of complex subject matter is most effective when it is an intentional process of constructing meaning from information and experience.

Principle 2: Goals of the learning process.
The successful learner, over time and with support and instructional guidance, can create meaningful, coherent representations of knowledge.

Principle 3: Construction of knowledge.
The successful learner can link new information with existing knowledge in meaningful ways.

Principle 4: Strategic thinking.
The successful learner can create and use a repertoire of thinking and reasoning strategies to achieve complex learning goals.

Principle 5: Thinking about thinking.
Higher-order strategies for selecting and monitoring mental operations facilitate creative and critical thinking.

Principle 6: Context of learning.
Learning is influenced by environmental factors, including culture, technology, and instructional practices.

Motivational and Affective Factors

Principle 7: Motivational and emotional influences on learning.
What and how much is learned is influenced by the learner's motivation. Motivation to learn, in turn, is influenced by the individual's emotional states, beliefs, interests and goals, and habits of thinking.

Principle 8: Intrinsic motivation to learn.
The learner's creativity, higher-order thinking, and natural curiosity all contribute to motivation to learn. Intrinsic motivation is stimulated by tasks of optimal novelty and difficulty, relevant to personal interests, and providing for personal choice and control.

Principle 9: Effects of motivation on effort.
Acquisition of complex knowledge and skills requires extended learner effort and guided practice. Without learners' motivation to learn, the willingness to exert this effort is unlikely without coercion.

Developmental and Social Factors

Principle 10: Developmental influence on learning.
As individuals develop, they encounter different opportunities and experience different constraints for learning. Learning is most effective when differential development within and across physical, intellectual, emotional, and social domains is taken into account.

Principle 11: Social influences on learning.
Learning is influenced by social interactions, interpersonal relations, and communication with others.

Individual Differences Factors

Principle 12: Individual differences in learning.
Learners' different strategies, approaches, and capabilities for learning are a function of prior experience and heredity.

Principle 13: Learning and diversity.
Learning is most effective when differences in learners' linguistic, cultural, and social backgrounds are taken into account.

Principle 14: Standards and assessment.
Setting appropriately high and challenging standards and assessing the learner and learning progress—including diagnostic, process, and outcome assessment—are integral parts of the learning process.

[McCombs, 2001, cont.]

From an integrated look at the principles, the following definition emerges:

> "Learner-centered" is the perspective that couples a focus on individual learners—their heredity, experiences, perspectives, backgrounds, talents, interests, capacities, and needs—with a focus on learning—the best available knowledge about learning and how it occurs and about teaching practices that are most effective in promoting the highest levels of motivation, learning, and achievement for all learners. This dual focus then informs and drives educational decision making. Learner-centered education is a reflection in practice of the Learner-Centered Psychological Principles—the programs, practices, policies, and people that support learning for all. [Summarized from the APA Work Group of the Board of Educational Affairs (1997, November). Learner-centered psychological principles: Guidelines for school reform and redesign.Washington, D.C. American Psychological Association.]

This definition of "learner-centered" is based on an understanding of the Learner-Centered Psychological Principles as a representation of current knowledge on learners and learning. The principles apply to all learners, in and outside school, young and old. Learner-centered is also related to the beliefs, characteristics, dispositions, and practices of teachers—practices primarily created by the teacher. When teachers derive their practices from an understanding of the principles, they (a) include learners in decisions about how and what they learn and how that learning is assessed; (b) value each learner's unique perspectives; (c) respect and accommodate individual differences in learners' backgrounds, interests, abilities, and experiences; and (d) treat learners as cocreators and partners in the teaching and learning process.

Others who have used the term "learner-centered" (e.g., Darling-Hammond, 1996; Sparks and Hirsh, 1997) refer to learning new beliefs and visions of practice that are responsive to and respectful of the diverse needs of students and teachers as learners. All learning, for students and teachers, must support diverse learners, provide time for reflection, and offer opportunities for teachers and students to co-create practices that enhance learning, motivation, and achievement. This view of "learner-centered" is a research-validated paradigm shift that transforms education— including how best to design programs to support the new vision (cf. Sparks and Hirsh. 1997).

"Learner-centeredness" is not solely a function of particular instructional practices or programs (McCombs, 2000; McCombs and Lauer, 1997; McCombs and Whisler, 1997). Rather, it is a complex interaction of qualities of the teacher in combination with characteristics of instructional practices, as perceived by individual learners. That is, "learner-centeredness" is in "the eye of the beholder": it varies as a function of learner perceptions, which in turn are the result of learners' prior experiences, self-beliefs, and attitudes about schools and learning as well as their current interests, values, and goals. The quality of "learner-centeredness" does not reside in programs or practices by themselves, no matter how well-designed the program may be.

When learner-centered is defined from a research perspective that includes the knowledge base on both learning and learners, it also clarifies what is needed to create positive learning contexts and communities. When this approach occurs at the classroom and school levels, it increases the likelihood of success for more students and their teachers. It can also increase clarity about the requisite dispositions and characteristics of those in service to learners and learning—particularly teachers. From this perspective, the learner-centered principles can become a foundational framework for determining how to assess the efficacy of existing programs and practices in enhancing the teaching and learning process. Learner perceptions of how well programs and practices meet individual cognitive, social, and emotional needs are part of the assessment of ongoing learning, change, and improvement.

1.3 The Learner-Centered Model in Practice

[McCombs, 2006]

When translated into practice, the LCM consists of a variety of materials, guided reflection, and assessment tools that support teacher effectiveness and change at the individual and school levels. The LCM, which is based on the LCPs, includes staff development workshops and videos exemplifying learner-centered practices in diverse school settings. As an additional support for teachers changing their practices, one of us (McCombs), in collaboration with colleagues (McCombs, 2001, 2003; McCombs & Lauer, 1997, 1998; McCombs & Whisler, 1997) developed a set of self-assessment and reflection tools for K-20 teachers, the Assessment of Learner-Centered Practices (ALCP). The ACLP includes surveys for teachers, students, and administrators which facilitate reflection and a willingness to change instructional practices. The teacher survey offers an opportunity for teachers to discover how our personal beliefs about learners, learning, and teaching might agree or disagree with the knowledge base underlying the LCPs.

In our more than 10 years of research with the LCM and its associated professional development tools, the ALCP teacher and student self-assessment and reflection tools, we have verified the benefits of learner-centered practices at the school and classroom levels. Research with the ALCP self-assessment surveys for teachers and students from K-12 and college classrooms confirms that what defines “learner-centeredness” is not solely a function of particular instructional practices or programs (McCombs & Lauer, 1997; McCombs & Whisler, 1997). Rather, learner-centeredness is a complex interaction of the programs, practices, policies, and people as perceived by the individual learners (McCombs, 2003, 2004). The LCPs serve as the foundation for determining how to use and evaluate programs and practices that provide instruction, curricula, and personnel to enhance the teaching and learning process.

1.4 The Outcomes of Learner-Centered Educational Practices

[McCombs, 2006]

For decades, educators and researchers have argued that the basic approach to education should be one that strives to meet unique and fundamental human needs (Patterson, 2003). For example, William Glasser, author of choice theory and Quality Schools, has maintained that we will not have more motivated students who work harder and learn more, or we will not have lower dropout rates, until we create more need-satisfying schools. When schools are more personalized and need-satisfying, and not aimed at controlling students, we will be able to avoid tragedies such as the violence at Columbine High School. These new kinds of schools will provide environments where students can really get to know their peers and teachers and develop a sense of trust. When the focus is on standards and coverage of materials, students are bored and they know the system isn’t about them. What is essential is that students have an opportunity to study real world problems and learn for understanding in self-directed ways. In the new school paradigm, Patterson (2003) argues that decisions will be made based on what makes educational and personal sense for students rather than on administrative and teacher convenience or tradition.

We believe that the type of paradigm needed is one based on research validated psychological principles of learning, motivation, development, and individual differences. It builds on research such as that reported by Fredrickson and Losada (2005) who studied the ratio of positive to negative affect in an effort to quantify what it means to flourish (live within the optimal range of human functioning that connotes superior functioning, generativity, growth, and resilience). Finding ways to enhance positive affect is critical based on research demonstrating that it is associated with enhanced attention, intuition, and creativity – in addition to other positive behavioral outcomes.

This is the type of transformational learner-centered paradigm that can help students develop into the critical thinkers, self-directed learners, problem solvers, time managers, and lifelong learners needed in our complex society. As Darling-Hammond (1997) has argued, despite decades of school reform efforts, we still structure schools in the mechanistic factory

model/assembly line paradigm that was influenced by behaviorism and reductionistic theories of the last century. Bracey (2002) has also argued that current reform strategies are superficial and fragmented, limited to improving individual achievement while increasing gaps between groups. Further, they are lacking in theoretical coherence, and inadequate to define or address current educational and social challenges.

In addition to those who argue that a traditional liberal education contributes to the development of citizenship in a democratic society, Vanhuysse (2006) contends that a general education contributes to the development of creativity and the role of the future in education. He contends that Albert Einstein defended generalism in schools over a half-century ago on the basis that it promotes better adaptability to change when it is the foundation of cultural life, including specialized knowledge. Those who study creativity in artistic and scientific endeavors such as Csikszentmihalyi (1996) have also argued breakthroughs depend on linking information that is usually not thought of as related by having a breadth of general knowledge beyond the limits of a specific knowledge domain. Vanhuysse (2006) points to general or classic education as a way that the scientific and intuitive orientations of the human mind can avoid being kept separate as their cross-fertilizing both relate to the creation and production of knowledge. He argues that knowing about and critically debating our past allows students to learn a flexible openness to and ability to cope with what is new. He states (2006, p. 12), “A related and more positive argument in favor of a generalist or classic education is that because it captures better and more recognizably the essence of human life, and perhaps because it is mediated via esthetic or other emotions, the classics simply are conducive to better learning.” As shown by Simon (1983), traditional liberal arts curriculum help students learn better and remember longer in that they can attend to issues longer and think harder about them, leading to deeper impressions that last longer, particularly when this curriculum is taught in the context of critical dialogue.

In national studies being conducted by the Just for the Kids organization, the number one key is to focus on the student, followed by high-quality teaching and research-based instructional practices. Another indicator is that teachers are given the materials, training, and support they need and the time to plan together, discuss student progress, and reflect on best practices (Just for the Kids, 2003). In one such high performance school in Los Angeles, teachers work together to help students take risks so that they develop character and the skills to succeed in life (Mathews, 2004, January 20). As with Deborah Meier who formed Central Park East School in East Harlem in 1974, the key to the success of that school and its students was the positive educative relationships between students and adults (Mathews, 2004, February 17). Students were taught to develop their minds by weighing evidence, seeing other ways of looking at the same data or situation, comparing and contrasting, seeking patterns, conjecturing and arguing – skills to use their minds powerfully (Meier, 2002). Current policies that do not ask students to engage in intellectual rigor and instead use their minds for factual recall will only add to the already growing dropout rate, particularly among disadvantaged and minority students (Wagner, 2003).

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Appendix B: Knowledge Technology

"Teaching without learning is just talk." (*Unknown)*

Any discussion about educational reform must establish a working concept of knowledge and how education serves the acquisition of knowledge.

> Master said, "Yu I shall I teach you what knowledge is? When you know a thing, to recognize that you know it, and when you do not know a thing, to recognize that you do not know it. That is knowledge!" (Confucius 551-479 BC)

Compare this to a modern concept of knowledge acquisition:

1. Unconscious incompetence: I am ignorant and therefore without any ability.
2. Conscious incompetence – I am acquainted with the knowledge but my abilities require great conscious effort with many mistakes.
3. Conscious competence – I am familiar with the knowledge and my abilities are natural but still deliberate.
4. Unconscious competence – I have mastered the knowledge, my abilities are fully developed and require little or no conscious management (Unknown).

In the first example, Confucius contemplates knowledge as a duality of knowing verses ignorance mediated by awareness of one's internal state in relation to this duality. The use of knowledge is implied but not central. In the second example, knowledge contains both information and action. The usefulness of knowledge is assumed and central to the concept. In contrast to Confucius, the modern concept contains a transitory conscious awareness of knowing and focuses on the processual nature of learning; true knowledge is mastery beyond deliberate thought. "Certainty" is an unspoken element of both concepts of knowledge and a key element of facilitating the acquisition of knowledge within the Connected Learning framework. Technology applied to the acquisition of knowledge is referred to as Knowledge Technology (KT).

1.1 Certainty

Knowledge provides order to our lives. On a personal and social plain, the things that we hold to be correct with certainty provide a framework on which we build predictability and develop action. Knowledge predicates control or, in the absence of control, adaptation. The notion of certainty, as a component of knowledge, has been discussed by philosophers and scientist for centuries. (e.g. Confucius, Aristotle, Auden, Russel, and McCombs). Despite the ubiquitous understanding that certainty plays a role in knowledge, it is only recently that science has attempted to investigate this domain. In the realm of education, certainty has been ignored because the tools to assess this domain did not exist. Current computer technology remedies this by providing robust data management, analysis and storage. These are the necessary elements of Certainty Based Assessment (CBA). This will be elaborated later.

1.2 True or Correct

Entire sections of libraries are devoted to discussions of truth and correctness. This epistemological discussion is not a subject we need to address. In the context of educational reform, "No Child Left Behind" (NCLB) has provided an operational framework that defines what is true or correct implicitly within the structure of "National Standards", "Expected Outcomes" and, "Units of Practice". Each subject area is defined in detail. To meet or exceed these standards is the goal of all educational reform. Connected Learning is no exception.

1.3 Unconscious Competence and Retrieval

Imagine a student in the 5th grade who must count on his or her fingers and toes to answer the question, "What is the sum of 9 + 9?" A priori, we know that mastery has not been achieved in basic addition since one of the goals of knowledge is to quickly render fundamental

facts and skills accessible. In the language of the second example of knowledge at the beginning of this section, this student has not acquired “unconscious competence”. Standardized tests, such as SAT, GRE, MAT, ACT and a host of state-specific assessments, attempt to evaluate the accessibility of knowledge as a dimension of mastery by placing time restraints on the test. Unfortunately, these tests are administered at the end of a learning cycle, or outside the context of learning entirely, and the opportunity for improve ones mastery has expired.

To facilitate mastery, latency of response time is a measurable phenomenon with the aid of computer technology. There is an axiom in business that says, “You cannot manage, what you can’t or don’t measure”. In knowledge acquisition, this axiom not only applies but is crucial. Our project contemplates and addresses the fundamental issues in knowledge acquisition by proposing technology-based methods for measuring, storing and analyzing the learning process in real time.

1.4 Assessment of Knowledge Acquisition

At the beginning of this section we quoted the statement, “Teaching without learning is just talk.” The way we assess whether learning is in fact taking place is some sort of “testing”. In the best of all possible worlds, testing should result in a realistic measurement of both teaching and learning. However, the current educational environment tends to skew measurement with the weight being placed on the learner side of the equation.

Before addressing the different types of assessment, it is instructive to delineate assessment’s purposes. Kellough & Kellough (1999) state that the purpose of assessment is:

1. “To assist student learning.
2. To identify students’ strengths and weaknesses.
3. To assess the effectiveness of a particular instructional strategy.
4. To assess and improve the effectiveness of curriculum programs.
5. To assess and improve teaching effectiveness.
6. To provide data that assist in decision making
7. To communicate with and involve parents.”

Please note that students are mentioned only twice. Five of the seven purposes of assessment are related to the system of education that supports student learning. As a whole, this description of the purpose of assessment is another base from which to approach learner-centered principles in education as developed by Dr. Barbara McCombs and others (see Appendix A for a brief introduction to McCombs’ work on the Learner-Centered Model (LCM) and its context within Connected Learning).

While in principle there is general agreement in the education community that the focus of the education system is the academic development of individual students, actually applying learner-center principles is difficult if not impossible within the current model of education. How, for example, do you develop and execute individualized learning plans for thirty students in a classroom? The simple answer is that, in the absence of new technologies and methodologies to improve both teaching and learning, you cannot. While many other tools are required to support a learner-centered education environment, dramatically improved assessment methods are the keystone. Sections 1.5 through 1.7 describe the three domains of assessment within the Connected Learning framework.

1.5 Diagnostic Assessment

A great many tools exist to map individual abilities and differences but diagnostic test are typically used episodically such as when a teacher suspects that a student has a learning disability. Episodic diagnosis has at least three consequences. First, without baseline diagnostic information, it is not possible to empirically construct individualized learning plans. Second, problems with student learning are typically not caught until the problem becomes acute and remediation to catch up with the class becomes extraordinarily difficult. Third, marginal problems in student performance remain undiagnosed and often are explained away as a normal variation in performance that fits within the standard distribution of a class.

Diagnosis of the aptitudes, abilities and progress of each student must be unambiguous, anticipatory, timely, frequent and dynamic. Just as content changes, learners change as the result of physical, social, personal, familial and a myriad of other circumstances. Diagnostic assessment enables the education system and the student to anticipate and solve problems.

1.6 Formative Assessment

There are several extant definitions of formative assessment. Operationally, formative assessment is periodic evaluation of student performance for the purpose of improving instruction. The outcome of formative assessment can be summarized in two extremes: continuing the lesson using alternative instruction methods, examples, etc. until each student masters the material or bypassing a portion of the lesson plan if student mastery is quickly achieved. In combination with diagnostic assessment, whole lesson units may be skipped entirely or reviewed only in brief if a student already demonstrates mastery.

While it is common in many classrooms to use low-stakes assessments such as quizzes to broadly assess relative performance, low-stakes assessments mainly serve as an early warning system for later high-stakes tests such as mid-term and final examinations. Dylan William, director of the Learning and Teaching Research Center at the Educational Testing Service, states "What I mean by formative assessment is not assessment that takes place every five to six weeks, but assessment that takes place every 10 seconds." (Sausner, 2006) Rick Stiggins at the Assessment Training Institute argues that improving scores on standardized tests and learning overall depends on instructing teachers how to conduct assessments on a daily basis (Chappuis, Stiggins, Arther, & Chappuis, 2001). However, William and Black (1998) note that formative assessment is not something that can be "tacked on" to current teaching methods; ideally, teaching, learning and assessment are an integrated whole.

The power of diagnostic and formative assessment is seen in the results from North Topsail Elementary in Hampstead, North Carolina. Principal Sylvia Lewis (Sausner, 2006) was quoted as saying, "Formative assessments catapulted the Title 1 school's proficiency rating from just below 80 percent to 98.4 in a handful of years." The means to integrate formative assessment into teaching methodology currently exists. The missing pieces are user-friendly tools to easily create assessments, and capture, store and analyze the data. This is one of the goals embodied in Connected Learning.

1.7 Summative Assessment

Summative assessment is the process of evaluating student achievement after a unit of learning, e.g. quizzes, examinations, writing assignments, etc., and represents the primary way that student achievement is evaluated today. Summative assessments typically rely upon objective testing methods such as true/false, multiple-choice and matching. Other methods such as fill-in-the-blank, short answer and essay are used with less frequency. While objective testing methods are convenient and often benefit from the use of technology such as Scantron response card readers, they are subject to test taking strategies which compromise the validity of the assessment and are severely limited in what dimension of learning they evaluate. In fact, human learning is far too complex to be relegated to simple forced choice examinations. Funderstanding (n.d.) developed an alternative to current summative assessment strategies within a concept referred to as Authentic Assessment. Funderstanding claims that Authentic Assessment accomplishes the following goals:

- "Requires students to develop responses rather than select from predetermined options.
- Elicits higher order thinking in addition to basic skills.
- Directly evaluates holistic projects
- Synthesizes with classroom instruction.
- Use samples of student work (portfolios) collected over an extended time period.
- Stems from clear criteria made known to students.
- Allows for the possibility of multiple human judgments.
- Relates more closely to classroom learning Teaches students to evaluate their own work" (Funderstanding, n.d.).

TCFIR has not had an opportunity to evaluate these claims. However, the goals of Authentic Assessment illustrate a set of alternatives to current summative assessment methods that should be considered if a full understanding of student development is to be accomplished. Not all of the assessment methods embodied in Authentic Assessment are amenable to automation. However, by utilizing technology where applicable, more time can be liberated to conduct assessments that require human intervention.

1.8 Certainty-Based Assessment (CBA)

In the start of Appendix B, we present confidence or certainty as a key element of knowledge. The pioneering work of A.R Garner-Medwin at University College London forms the basis for our proposals in the domain of certainty-based assessment (CBA). Simply described, CBA adds a "certainty" dimension to technology-mediated assessment, i.e. the student is required to place a value on how confident they are in their answers. Correct answers receive extra credit based on the certainty value given to the answer. Incorrect answers are penalized based on the certainty value.

> "Automated assessment suffers from two problems that are considered here. Firstly, it seldom makes use of information about how confident a student is in the answer given, which is part of what we take into account in assessing students person-to-person. Secondly, it often involves the construction of complex questions to ensure that students cannot get good marks by a combination of partial knowledge and guesswork." (Gardner-Medwin, A.R., 1995)

Through the coordinated efforts of several medical schools in London, a project was initiated under the name of the London Agreed Protocol for Teaching (LAPT) in 1994. The resulting CBA system currently contains over 10,000 questions and processes more than one million graded questions per year at the University College London alone. TCFIR offers a demonstration of CBA technology at http://tcfir.org/lapt/sys/options.cfm. Gardner-Medwin (1995; University College London, 2005) states that CBA provides several distinct advantages over current assessment methods, including:

- Mitigating the effects of guessing on standardized tests.
- Providing immediate feedback of results for teachers and learners.
- Facilitating remediation.
- Providing a system for practice.

It should be noted that certainty assessment is not an assessment domain like the diagnostic, formative or summative methods. Rather, CBA is a methodology of assessment design that can be incorporated in each of the domains as appropriate.

1.9 Bringing the Elements of Assessment Together

By enriching summative assessment with certainty data, and adding diagnostic and formative assessment methods, the Connected Learning framework proposes a "learning lifecycle" approach to assessment that addresses all seven purposes for assessment presented in Section 1.4. Starting conditions in the learning ecology are revealed through diagnostic assessment, enabling the development of lesson plans targeted to individual students. Formative assessment provides ongoing feedback during the learning process to both teacher and student, making it possible to alter the lesson plan based on student performance. Summative assessment is then transformed into the role of a confirmation of the success of the lesson plan rather than the primary means of assessing the learning process. All assessment methods provide additional diagnostic data for the next lesson plan. Testing the certainty with which students hold knowledge provides a qualitative, diagnostic dimension to that enables even more precise fine-tuning of teaching and learning. With additional technology relating student performance to particular teaching methods and materials, parents, teachers and administrators

alike can evaluate the effectiveness of the learning ecology with more and better data than is produced currently. Assessment becomes the means not only for enabling significantly higher levels of student achievement but is also instrumental in the Connected Learning principle of developing a self-reforming, self-improving and self-documenting system of education.

1.10 Applying Technology-Mediated Assessment

High standards for assessment are critical in the Connected Learning framework. Based on what we have developed in this section about knowledge, and diagnostic, formative and summative assessments, let us speculate for a moment about where technology-mediated techniques can apply.

Knowledge Acquisition

1. Present standards-based content to know
    a. Computer generated multi-media presentation in all subject areas.
    b. Repetitive practice in all subject areas.
    c. Consistent high quality.
2. Assess certainty in answers
    a. Most easily implemented in fill-in-the-blank, matching, multiple-choice and true/false.
    b. Possible to implement with other test types.
3. Measure actionable mastery
    a. Possible for all of the above by measuring and recording answer latency.
    b. More subtle measures of performance may be developed, e.g. relating time spent reading a section of material to formative assessment results thereby deriving overall reading traits like speed and comprehension.

General Purposes of Testing

1. To assist student learning.
    a. Provide immediate feedback in real time
    b. Provide graphic representation of progress
    c. Record question level granularity
    d. Make it fun
2. To identify students' strengths and weaknesses.
    a. Subject level granularity will clearly reveal level of success and failure
3. To assess the effectiveness of a particular instructional strategy.
    a. Question level granularity will reveal teaching effectiveness
    b. Agglomeration of class data will discriminate individual or systemic failures
4. To assess and improve the effectiveness of curriculum programs.
    a. Question level granularity will reveal teaching effectiveness
    b. Agglomeration of class data will discriminate individual or systemic failures
5. To assess and improve teaching effectiveness.
    a. Granularity will reveal instructional quality
    b. Granularity will reveal teacher preparation
6. To provide data that assist in decision making
    a. Provide classroom management with intricate detail
7. To communicate with and involve parents.
    a. Graphic presentations will aid in communicating with parents
    b. Details based on small-scale evaluations will help parents understand the unique characteristic of their child
    c. Progress measurement will aid in earlier intervention when there is a problem

Summative / Authentic Assessment

1. Requires students to develop responses rather than select from predetermined options
    a. It is possible to merge content presentation with assessment
    b. It is also possible to offer multiple presentation and assessment options.
2. Elicits higher-order thinking in addition to basic skills

    a. Simulations can be created that stimulate both deductive and inductive reasoning.
    b. Connecting subject areas for a more elaborate and enriched understanding, e.g. how developments in timekeeping devices,
3. Directly evaluates holistic projects
4. Synthesizes with classroom instruction
    a. Tools can be created to accomplish this integration
5. Uses samples of student work (portfolios) collected over an extended time period
    a. Student data of an objective nature can be store easily and can be used to form both a quantitative and qualitative map
6. Stems from clear criteria made known to students
    a. Based on empirically derived data individual learning plans can be created and modified as needed.
    b. Progress against those plans can be accessed in real time
7. Allows for the possibility of multiple human judgments
    a. Clever assessments can be created that test judgment
8. Relates more closely to classroom learning Teaches students to evaluate their own work
    a. Certainty assessment require the student to self-assess

Curriculum Design

1. Analysis of patterns revealed by associating assessment data with lesson plans, learning/teaching materials, teaching methodologies, etc. coupled with Internet-enabled pooling of data create opportunities to identify effective education elements.
    a. Proven lesson plans, i.e. those associated with high assessment results, could be accessed and used by teachers as a whole or in parts.
    b. Diagnostic data could be used to form “student types”; lesson plans and curricula could then be associated as effective with certain student types.
2. Data-enabled curriculum design; assessment and standards integration via technology would allow for more complex approaches to subjects while still meeting education standards.
    a. Integrated, multi-subject designs.
        i. Theory-to-application, e.g. geometry/trigonometry and applications in navigation, construction, engineering.
        ii. Connections designs, e.g. how a watch, sextant and GPS receiver can be the basis for exploring history, physics, geography, mathematics, etc.
    b. Bounded self-study designs.
    c. Collaborative designs.

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Appendix C: Knowledge Technology – Content

1.0 Overview

As stated on several occasions within this work, our project is not attempting to reinvent the wheel. The community of scholars engaged in various elements of the solution is astounding. A recent survey by TCFIR indicates every Colorado University is engaged in an advanced project involving teaching, learning or both. This appears to be a trend throughout the U.S. This research has produced a plethora of projects and processes that portend solutions. These projects are very often unaware of similar projects in close proximity. The result is a scattered and fragmented set of solutions without a holistic organization.

We have described "Connected Learning" as a framework so that we can incorporate the body of these efforts into a cohesive system of practices that reflects the best of the best. Content standards, in all disciplines, reflect the vetted thinking of a vast network of subject matter experts. We are incorporating these standards in toto, because:

1. The full potential of standards based pedagogy has not been exploited.
2. We have arbitrarily chosen to adopt and then make adaptations later, based on empirical data.
3. The establishment of these standards was authored by both educators and subject matter experts and for the purposes of this project we will not challenge their soundness.
4. Our empirical methodology requires establishing constants so as to demonstrate the validity of certain other variables and methods.

2.0 Methods

Any technology, method and content will be thoroughly tested and empirically validated against the intended purpose and national standards.

1. Individualization through portal technology with security a primary goal
2. Online library and reference sources
3. Simulations and examples of real world phenomenon. Alternative presentation based on individual learner profile
4. The multi-media technology of "Electronic Games" as a capable vehicle for learning and teaching content.
5. Assessment and content in real time for formative feedback.
6. Storage and analysis of learning data in real time. This would include graphic representations for classroom and individual performances.
7. Secure access and content. The popularity of computer resources, among young learners, can be leveraged to engage and motivate students, i.e blogs, content chat groups for study and multimedia content.
8. Advancement through performance not assumption, age or grade.
9. Accreditation method and content.
10. All modules available for repletion of practice in randomized form.