TLC - R & D Activities (NSTC)

NSTC Committee for Education and Training
Sub-Committee on Research and Development for Education and Training

FY 1996 R&D PRIORITY ASSESSMENT AND BUDGET ANALYSIS EXECUTIVE SUMMARY

Objectives and Rationale

The Committee on Education and Training proposes a broad vision for American education and training:

> "To ensure all Americans access, anytime and anyplace, to quality education and training tailored to their individual learning and workplace needs."

This vision requires new environments for life-long learning that use technology to support learners of all ages and conditions. These learning environments extend beyond the confines of classroom walls to include the home, the community (e.g., museums, libraries, community centers), and the workplace. They support learning of complex content and complex approaches to problem solving. They will help alleviate the bottlenecks of the current instructional paradigm.

Unfortunately, we are devoting only limited resources to capitalize on our opportunities to achieve this Learning Productivity vision. Research and development in education and training amount to only 0.025% of all education and training activity. While workplaces and workers are taking advantage of our latest technological advances, education and training lag further and further behind. The Committee believes that a significant increase in our current level of federal investment in education and training R&D is required.

Goals

The following four Focus Areas support CET objectives and the Administration's R&D principles, goals, and priorities. They were outlined in the National Science and Technology Council's FY 1996 Research and Development Priorities Memorandum of 6 May 1994.

- Demonstrations of Innovative Technology and Networking Applications:

  Initiation of whole system programs using hardware, software, and the National Information Infrastructure to demonstrate advanced instructional systems that significantly increase the productivity of learning.

- Technology Development for High-Quality, Affordable Learning Tools:

  Development of high-quality, affordable learning tools and environments that use technology to increase the productivity of learning in all fields by all people in all settings including schools, workplaces, community resource centers, and homes.

- Development of New Models to Evaluate Learning Productivity:

  Development of new models and new assessment tools for evaluating and measuring learning and learning productivity.

- Research on Learning and Cognitive Processes:

  Research that improves understanding of the cognitive, instructional, and learning processes that underlie instruction and how they are best supported by technology.

Funding Analysis

The Committee recommends that funding for the Learning Productivity Priority Area be increased in FY 1996 by $88 million to be distributed among the four Focus Areas as shown in the last column of Table 1. Allocation of the requested increases in FY 1996 funding among the agencies is shown in Column 2 of Table 2. Additionally, CET recommends a FY 1995 "Quick Start" increment of $25 million for the Demonstration Programs Focus Area.

Table 1.
FY 1996 Shortfalls by Focus Area ($M)

Focus Area	FY 1996 Current	Recom-mended	FY 1996 Shortfall
Demonstration Programs	18	70	52
Learning Tools	152	182	30
Assessment Tools	15	21	6
Research	71	71	0
Total	256[a]	344	88

[a] Totals reflected are adjusted down from agency submissions and include only those programs that support Learning Productivity as defined in the OMB/OSTP memo of 5 August 1994.

Recommendations to Accommodate Shortfalls

The Committee believes that this initiative requires management that is quite distinctive in the domestic policy area. The Committee proposes that the Learning Productivity Initiative be overseen and coordinated by a new collaborative Interagency Technology Office (ITO), which will be located in the Department of Education for administrative purposes. It will serve the CET and its member agencies as an independent activity. This independent office will play a major role in shaping the Demonstration Programs Focus Area. The Office will: 1) Promote public-private sector collaboration, investments, and partnerships for learning productivity; 2) Coordinate activities, recommend policies, ensure evaluation and dissemination of results, and; 3) Coordinate efforts of the agencies chosen to undertake demonstration programs for the focused areas.

The Learning Productivity Initiative will establish sufficient private sector interest and momentum to create a market that attracts substantial investment and continually expands through follow-on private involvement in both R&D and mainstream commercialization. The infusion of new education and training capabilities that are now available from advances in learning technologies will ensure an acceleration of fundamental reform. It will provide nationally visible demonstrations of the value and practicality of learning

technology and the essentially of major paradigm shifts needed to ensure Learning Productivity for all Americans.

Table 2.
FY 1996 Funding Allocations among Agencies ($M)

Agency	FY 96 Currently Programmed for Learning Productivity	Recommended FY96 Increase
Department of Defense[a]	145	5
Department of Education[b]	40	0
TLC Program Office[c]	0	58
Department of Energy[d]	4	5
Department of Labor[e]	0	5
National Aeronautics and Space Agency[f]	5	5
National Science Foundation[g]	27	5
Smithsonian Institution[h]	0	5
Department of Health and Human Services[i]	33	0
Department of Transportation[j]	1	0
Department of Interior[j]	1	0
Total	256	88

Notes:

[a] The DoD has a long and successful history of R&D investment in Learning Productivity areas. This investment should be leveraged. An increase of $5 million is recommended to assist the DoD in transferring its R&D products to educational enterprises to ensure full use of immediately available technologies that support Learning Productivity programs.

[b] Of the $40M, most ($29M) DoEd Learning Productivity R&D is supporting research in basic cognitive processes, curriculum restructuring, and methods to effect institutional reform in schools. Of the remaining funding, $8M supports the development of learning tools and $3M supports development of assessment tools. Additionally, the DoEd has about $30M that will be applied to Learning Productivity, once it completes its restructuring of OERI and the allocation of these funds can be specified. The DoEd will operate the new Interagency Technology Office. Funding for the ITO is discussed in note c.

Table 2 Notes (continued):

[c] Aside from funds needed to support its own operations, the funding for the ITO will be disbursed among federal agencies in accordance with a strategic plan that is to be prepared and carried out under the oversight of the CET.

[d] Most ($5M) DoE Learning Productivity R&D is supporting development of learning tools. An increase of $5 million is recommended to assist the DoE in transferring its Learning Productivity products to the private sector and to other agencies to ensure full use of immediately available technologies that support Learning Productivity programs.

[e] An increase of $5 million is recommended to assist the DoL, Office of the American Workplace, in transferring Learning Productivity technologies from the federal laboratories. These technologies will enhance DoL funded workplace programs.

[f] Most ($4M) NASA Learning Productivity R&D is supporting development of learning tools. An increase of $5 million is recommended to assist NASA in transferring its Learning Productivity products to the private sector and to other agencies to ensure full use of immediately available technologies that support Learning Productivity programs.

[g] Most ($15M) NSF Learning Productivity R&D is supporting development of learning tools. The remaining funds ($12M) are being spent in basic research on learning and cognitive processes. An increase of $5 million is recommended to assist the NSF in transferring its Learning Productivity products to the private sector and to other agencies to ensure full use of immediately available technologies that support Learning Productivity programs.

[h] An increase of $5 million is recommended to allow the Smithsonian Institution to lead a CET-sponsored, cross-agency team that will demonstrate the value of digitizing federal holdings for distribution to the public.

[i] The funds in HHS are directed toward basic research in learning and cognition for special populations and special areas. No additional funding is recommended.

[j] The funds in DoT and DoI are small (less than $1 million each) and directed toward specific applications unique to those agencies. While both of these are important and contribute to the goals of CET, no additional funding is recommended.

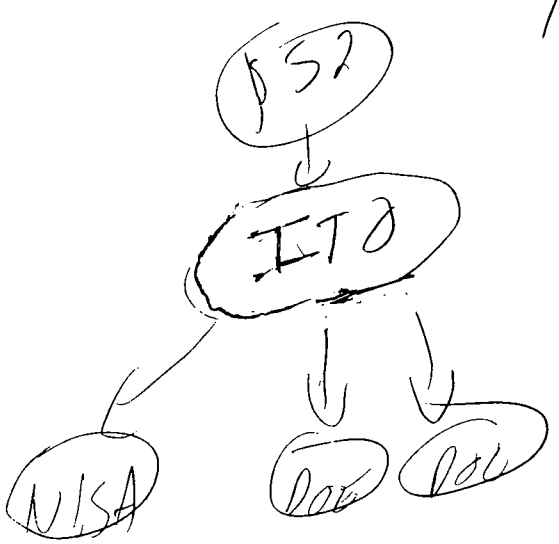
NASA - $100 million

$50 million - Earmarked

$25 million - Teacher Training, already committed

$25 million - special projects

If left in Agencies, How does ITO manage? under what authority?



NSTC Committee for Education and Training
Sub-Committee on Research and Development for Education and Training

FY 1996 R&D PRIORITY ASSESSMENT AND BUDGET ANALYSIS SUMMARY

This summary responds to the OMB/OSTP memorandum of 5 August 1994 requesting an assessment and budget analysis related to Learning Productivity, one of eight FY 1996 R&D Priority Areas. This priority area implements an objective established in the Clinton-Gore policy statement of 22 February 1993, "Technology for America's Economic Growth, A New Direction to Build Economic Strength," which calls for an initiative to "support the development and introduction of computer and communications equipment and software that can increase the productivity of learning in formal school settings, a variety of business training facilities, and in homes."

I. THE LEARNING PRODUCTIVITY ASSESSMENT AREA

A. Description: An Opportunity and Need

The nation is in the midst of a scientific and technological revolution of unprecedented proportions. To realize the benefits of this revolution, we must meet the education and training challenges it presents by absorbing the information it produces and using the information in economically and socially productive ways.

Fortunately, this revolution also gives us the means to meet these challenges. New research in teaching and learning points to improved curricula and pedagogy. New learning technologies are emerging, and they provide opportunities for universally accessible and effective life-long learning. Surveys of new technologies applied to education and training report time and cost savings to reach specified instructional objectives of about 30%. These surveys also report increases in achievement of about the same amount, 30%, when time and costs are held constant. Exploiting these capabilities and savings to allow tailoring of instructional pace, content, sequence, and style to the needs of individuals will create and sustain a society of life-long learners. Exploitation of the National Information Infrastructure will dramatically increase the accessibility of high-quality education and training materials for all Americans in schools, workplaces, community resource centers, and homes.

Unfortunately, we are devoting only limited resources to capitalize on these opportunities. Office of Technology Assessment accounting has indicated that research and development in education and training amount to only 0.025% of all education and training activity. This percentage is small relative to R&D investments found in other priority areas and to the overall percentage of U.S. gross national product invested in R&D (about 2.5%). While workplaces in business and industry are taking advantage of our latest technological advances, education and training -- the foundations of our workforce -- lag further and further behind. The Committee believes that a significant increase in our current level of federal investment in education and training R&D is required.

B. Vision and Goals

The Committee on Education and Training proposes a broad vision for American education and training:

> "To ensure all Americans access, anytime and anyplace, to quality education and training tailored to their individual learning and workplace needs."

This vision requires new environments for life-long learning that use technology to support learners of all ages and conditions. These learning environments extend beyond the confines of classroom walls to include the home, the community (e.g., museums, libraries, community centers), and the workplace. They reach beyond the traditional school-age population to encompass the life-long learning population from pre-school to incumbent workers. They support learning of complex content and complex approaches to problem solving. They will help alleviate the bottlenecks of the current instructional paradigm.

The Committee believes that increases in learning productivity require:

- Promoting inter-agency, intergovernmental, and public-private collaboration to increase the learning productivity of our education and training institutions;
- Exploiting the best of our existing information technologies for education and training applications;
- Identifying and funding new areas of research and development that significantly improve learning;
- Ensuring access to all learning resources by all Americans;
- Creating incentives for the commercial sector to enhance the quality and increase the affordability of learning materials.

Achieving these goals will be a continuing concern of the Committee and will be supported by the creation of the new Interagency Technology Office (ITO) as discussed in Section III.B. below.

C. Support for Goals and Policies

The following four Focus Areas support the Administration's R&D principles, goals, and priorities as outlined in the National Science and Technology Council's FY 1996 Research and Development Priorities Memorandum of 6 May 1994.

- Demonstrations of Innovative Technology and Networking Applications:

  Initiation of whole system programs using hardware, software, and the National Information Infrastructure to demonstrate advanced instructional systems that significantly increase the productivity of learning.

- Technology Development for High-Quality, Affordable Learning Tools:

  Development of high-quality, affordable learning tools and environments that use technology to increase the productivity of learning in all fields by all people in all settings including schools, workplaces, community resource centers, and homes. Such tools include synthetic learning environments, collaborative problem solving environments, software interfaces, instructional software development tools, interactive instructional systems, intelligent learning associates, and tools for searching multimedia data bases and digital libraries.

- Development of New Models to Evaluate Learning Productivity:

Development of new models and new assessment tools for evaluating and measuring learning and learning productivity.

- Research on Learning and Cognitive Processes:

  Research that improves understanding of the cognitive, instructional, and learning processes that underlie instruction and how they are best supported by technology.

These programmatic actions must be accompanied by a vigorous effort to publicize, scale-up, and disseminate the R&D products and information resulting from this initiative.

II. STRATEGY FOR MEASURING PROGRESS AND PERFORMANCE

The Learning Productivity Priority Area is defined by the four Focus Areas described above. Progress and performance in Learning Productivity will be measured by establishing goals and measuring performance in each of the Focus Areas.

Criteria for measuring progress and performance in the Demonstration Programs Focus Area include:

- Increases in instructional effectiveness and learning performance;
- Increases in access to education and training -- especially for underserved populations of learners;
- The degree to which the demonstrated technology-based learning systems are affordable and can be scaled-up to a broad set of populations and settings;
- The degree to which the demonstration programs promote linkages among all levels of education, the private sector, and communities;
- The degree to which the demonstration programs promote systemic education reform, support institutional change, and overcome barriers to the use of technologies for education and training.

Criteria for measuring progress and performance in the Learning Tools Focus Area include:

- Contributions to increased instructional effectiveness and learning performance;
- Extent of market adoption and commercialization of the learning tools;
- Success in creating new ways to communicate complex ideas and experiences;
- Success in promoting access to learning resources and expertise.

Measurement of progress and performance in the Assessment Tools Focus Area will depend on the extent to which the models and assessment tools:

- Provide valid measurement of learning effectiveness and learning productivity;
- Provide new ways to assess cognition and the progress of individual learning;
- Provide models of effective technology use;

- Assess the impact of learning productivity on schools, workplaces, and communities.

Measurement of progress and performance in the Research Focus Area will depend on the extent to which the research:

- Can be used to increase learning effectiveness and productivity;
- Provides basic insights into learning and cognition that are relevant to learning productivity;
- Identifies new paradigms for instruction and learning environments;
- Leads to curriculum structuring and re-structuring.

In carrying out its assessment of progress and performance, the CET will establish milestones for each focus area. These milestones will govern the formulation of plans, the assignment of responsibilities, and the commitment of resources. The Committee will track progress towards these milestones. Evaluations will measure individual project or program performance against the criteria we have suggested.

A panel of experts drawn from the private sector, the education and training communities, and the federal government will be convened periodically to advise on plans and assess progress. The panel will examine the progress of the initiative in light of the overall goal of increasing learning productivity and in terms of the Focus Area objectives.

III. FUNDING ANALYSIS SUMMARY

Because this area has been historically underfunded, CET recommends that funding for the Learning Productivity Priority Area be increased in FY 1996 by $88 million as shown in Table 1 and discussed below in Section III.A. This increase should be distributed among the agencies as shown in Table 4. Additionally, CET recommends a FY 1995 "Quick Start" increment of $25 million for the Demonstration Programs Focus Area.

In accordance with the CET Charter, this analysis focused primarily on R&D contributing to technology for education and training and to learning productivity in general. We did not include programs and resources devoted to such activities as in-service training for teachers, summer institutes, student travel, and graduate fellowships.

A. Funding Shortfalls

Table 1.
FY 1996 Shortfalls by Focus Area ($M)

Focus Area	FY 1996 Current	Recommended	FY 1996 Shortfall
Demonstration Programs	18	70	52
Learning Tools	152	182	30
Assessment Tools	15	21	6
Research	71	71	0
Total	256	344	88

The Demonstration Programs Focus Area has been identified as the cornerstone for this Priority Area because of the need to (1) transcend the wide disparity and fragmentation of education and training activities; (2) overcome institutional inertia and invigorate institutional reform; and (3) attract and promote private sector investment in developing high quality instructional applications and materials. While existing effort in the other Focus Areas (Learning Tools, Assessment Tools, and Research) will support work in the Demonstration Programs Focus Area, the Demonstration Programs will in turn identify, focus, and prioritize new R&D needed in these other Focus Areas.

The White House Task Force on Learning Productivity and representatives from CET agencies and departments have determined that a series of full-system demonstration programs is needed to effect a major paradigm shift and institutional reforms in Learning Productivity. These programs will focus on distinctive education and training needs such as school to work transition, continuing professional development, systemic school reform, and retraining for incumbent workers.

Each demonstration program requires $7 million per year for each of 5 years. Expenditures will emphasize different areas of investment in different years -- early years will emphasize development, integration, and deployment and later years will emphasize expansion, test, and evaluation in multiple sites. The Task Force determined that ten demonstration programs are needed to ensure that innovations in education and training are effected across all learning populations. The funding required for implementation and evaluation of the Learning Productivity Demonstration Programs is $70 million a year for each of five years.

As Table 1 shows, funding for the Demonstration Programs Focus Area falls far short of the recommended $70 million. $15 million of current funding is the result of a FY 1994 Congressionally directed DoD/OSTP partnership to effect the transfer of DoD learning technologies to the private sector. Additional demonstrations are needed in areas besides K-12 classrooms, particularly in environments that are credible and relevant to trainers of incumbent workers and developers of learning technology materials in the commercial sector.

Additionally, a "Quick Start" increment of $25 million for the Demonstration Programs Focus Area is needed in FY 1995. This funding will permit immediate initiation of demonstration programs in areas of obvious, available, and beneficial opportunity such as networked simulation, collaborative problem solving, student-centered learning, distributed instruction, and digital libraries. It will capitalize on current interest in Learning Productivity and rapidly build momentum for this R&D Priority Area.

Demonstration programs can be immediately launched given current technological opportunities and the state of the art. However, to be sustained as full system demonstration programs and to be scaled-up to serve many populations and sites equitably and fully, they must have supporting R&D in the remaining three Focus Areas both to fill gaps and to substantially improve the current state of the art.

The Learning Tools Focus Area is essential for education and training software development and market creation. As Table 3 shows, 117 million of the $152 million departments and agencies request is accounted for by the Department of Defense. These activities support the development of learning tools for specialized training in combat operations. The bulk of the remainder is accounted for by the Department of Education and the National Science Foundation. While these efforts are critical to the agencies' missions, they do not focus R&D on tools intended to serve as the basis for commercial products and services, scale-up for use by many populations and at many sites, or serve the needs of state and local agencies.

We believe that an additional $30 million R&D increase should be applied to accelerate the development of learning tools and the transfer of existing tools and capabilities to the private sector in order to create a vigorous market in high-quality, affordable learning tools. Particular emphasis should be placed on identifying and leveraging tools that have been developed by the National Laboratories. The recommended R&D investment would be allocated to DoEd, DoL, NSF, DoE, NASA, and the Smithsonian Institution as outlined in Table 4.

The Assessment Tools Focus Area addresses a major gap in education and training operations. The new learning environments sought by the Learning Productivity Priority Area as well as the skills and capabilities that are required by emerging state and national standards require assessment tools that are vastly different from those the nation has used for the past several decades. Since testing and assessments are powerful motivators for both education and training institutions and for students, it is critical that valid and reliable assessment systems be put in place. However, few tools and models now exist. The Assessment Tools Focus Area is expected to develop both models and assessment tools that can be initially used and validated by the demonstration programs and subsequently used more widely.

As Table 1 shows, very little R&D is being invested in Assessment Tools. Because of its embryonic nature, this Focus Area can absorb only limited R&D. Investments of $1 million per year in each of six existing centers capable of carrying out this R&D would yield significant returns.

The Research Focus Area is widely fragmented. The CET goal is to reduce the fragmentation of current research on learning and cognition by focusing it on increasing the Learning Productivity and providing a foundation for applying new technologies to education and training.

Much of the research reported in Table 1 is narrowly focused on many issues that are only tangentially related to Learning Productivity. Even though no increased funding in this area is recommended, much needs to be done to increase collaboration and coordination to ensure this R&D investment is directly applicable to the Learning Productivity Priority Area.

B. Recommendations to Accommodate Shortfalls

The Committee believes that this initiative requires management that is quite distinctive in the domestic policy area. The Committee proposes that the Learning Productivity Initiative be overseen and coordinated by a new collaborative Interagency Technology Office (ITO), which will be located in the Department of Education for administrative purposes. It will serve the CET and its member agencies as an independent activity. This independent office will play a major role in shaping the Demonstration Programs Focus Area. The Office will: 1) Promote public-private sector collaboration, investments, and partnerships for learning productivity; 2) Coordinate activities, recommend policies, ensure evaluation and dissemination of results, and; 3) Coordinate efforts of the agencies chosen to undertake demonstration programs for the focused areas.

The Learning Productivity Initiative will establish sufficient private sector interest and momentum to create a market that attracts substantial investment and continually expands through follow-on private involvement in both R&D and mainstream commercialization. The infusion of new education and training capabilities that are now available from advances in learning technologies will ensure an acceleration of fundamental reform. It will

provide nationally visible demonstrations of the value and practicality of learning technology and the essentially of major paradigm shifts needed to ensure Learning Productivity for all Americans.

Funding Allocations. The Committee recommends that the identified FY 1996 shortfall be allocated in the following manner:

- $58 million to the TLC Office to support the Demonstration Programs Focus Area, to support the Assessment Tools Focus Area and to provide external support to the Office.

- $5 million to the Smithsonian Institution to lead a cross agency team in demonstrating the value of digitizing federal holdings for distribution to the public in support of learning productivity.

- $25 million, in $5 million increments allocated directly to: DoD, NASA, DoE, NSF, and DoL. These amounts will be used to ensure transfer of existing learning tools from DoD, DoE, and NASA laboratories to support DoEd and DoL education and training programs.

These activities will be conducted by existing offices and departments with responsibilities for education and training development and applications within the participating agencies as shown in Table 4.

R&D on Learning Productivity will yield major improvements in current support for life-long learning and progress toward education and training institutional reform. The infusion of new education and training capabilities that are now available from advances in learning technologies will ensure an acceleration of fundamental reform. It will promote commercial interest in raising the quality and lowering the costs of learning materials. It will provide nationally visible demonstrations of the value and practicality of learning technology and the essentially of major paradigm shifts and institutional reforms needed to ensure Learning Productivity.

IV. SUMMARY OF AGENCY CONTRIBUTIONS

Contributions by Federal Agencies to R&D that have been judged relevant to the Learning Productivity Priority Area and that have been reported are shown in Table 2.

V. AGENCY PROGRAM CONTRIBUTIONS

The contributions of individual agencies to the Learning Productivity R&D Focus Areas are shown in Table 3.

Table 2.

Summary by Agency Contributions ($M)

Agency	FY 94	FY 95	FY 96	$M Change FY 95-96
Central Intelligence Agency	CL	CL	CL	CL
Dept of Agriculture	0	0	0	0
Department of Commerce	0	0	0	0
Department of Defense	160	143	145	+2
Department of Education	59	68	40	-28
Department of Energy	5	4	4	0
Department of Transportation	0	2	1	-1
Department of Health and Human Services	42	33	33	0
Department of Interior	1	1	1	0
Department of Labor	0	0	0	0
Environmental Protection Agency	0	0	0	0
National Aeronautics and Space Agency	5	5	5	0
National Science Foundation	27	27	27	0
National Security Agency	CL	CL	CL	CL
Smithsonian Institution	0	0	0	0
Total	299	283	256	-27

Notes:
CL = Classified Information

Table 3.

Summary of Agency Contributions by Focus Area ($M)

Agency	FY 94	FY 95	FY 96	$ Change FY 95-96
Department of Defense				
Demonstration Programs	35	15[a]	15	0
Learning Tools	117[b]	120	122	2
Assessment Tools	5	5	5	0
Research	3	3	3	0
Total	160	143	145	2
Department of Education				
Demonstration Programs	0	0	0	0
Learning Tools	11	12	8	-4
Assessment Tools	7	7	3	-4
Research	41	49	29	-20
Total	59	68	40	-28
Department of Energy[c]				
Demonstration Programs	0	0	0	0
Learning Tools	0	0	0	0
Assessment Tools	5	4	4	0
Research	0	0	0	0
Total	5	4	4	0
Department of Transportation				
Demonstration Programs	0	0	0	0
Learning Tools	0	0	0	0
Assessment Tools	0	1	0	0
Research	0	1	1	0
Total	0	2	1	-1
Department of Health and Human Services[d]				
Demonstration Programs	2	2	2	0
Learning Tools	2	2	2	0
Assessment Tools	3	3	3	0
Research	35	26	26	0
Total	42	33	33	0
Department of Interior				
Demonstration Programs	0	0	0	0
Learning Tools	1	1	1	0
Assessment Tools	0	0	0	0
Research	0	0	0	0
Total	1	1	1	0

Table 3 (Continued).

Summary of Agency Contributions by Focus Area ($M)

Agency	FY 94	FY 95	FY 96	$ Change FY 95-96
National Aeronautics and Space Agency				
Demonstration Programs	0	1	1	0
Learning Tools	5	4	4	0
Assessment Tools	0	0	0	0
Research	0	0	0	0
Total	5	5	5	0
National Science Foundation				
Demonstration Programs	0	0	0	0
Learning Tools	15	15	15	0
Assessment Tools	0	0	0	0
Research	12	12	12	0
Total	27	27	27	0

Notes:

[a] The additional $20 million in FY 1994 in DoD is due to a Congressionally directed OSTP/DoD partnership to transfer DoD learning technologies to K-12 education settings.

[b] Most DoD R&D on learning tools involves technologies directly related to the preparation of military personnel for combat duties and support of combat systems and require modification to be integrated into private sector programs.

[c] DoE has an additional $5 million of education and training R&D funds reported under the HPCC initiative.

[d] HHS responses were adjusted to accord more closely with the definitions of the Focus Areas.

Table 4.
FY 1996 Funding Allocations among Agencies ($M)

Agency	FY 96 Currently Programmed for Learning Productivity	Recommended FY96 Increase
Department of Defense[a]	145	5
Department of Education[b]	40	0
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Department of Health and Human Services[i]	33	0
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Notes:

[a] The DoD has a long and successful history of R&D investment in Learning Productivity areas. This investment should be leveraged. An increase of $5 million is recommended to assist the DoD in transferring its R&D products to educational enterprises to ensure full use of immediately available technologies that support Learning Productivity programs.

[b] Of the $40M, most ($29M) DoEd Learning Productivity R&D is supporting research in basic cognitive processes, curriculum restructuring, and methods to effect institutional reform in schools. Of the remaining funding, $8M supports the development of learning tools and $3M supports development of assessment tools. Additionally, the DoEd has about $30M that will be applied to Learning Productivity, once it completes its restructuring of OERI and the allocation of these funds can be specified. The DoEd will operate the new Interagency Technology Office. Funding for the ITO is discussed in note c.

[c] Aside from funds needed to support its own operations, the funding for the ITO will be disbursed among federal agencies in accordance with a strategic plan that is to be prepared and carried out under the oversight of the CET.

Table 4 Notes (continued):

d Most ($5M) DoE Learning Productivity R&D is supporting development of learning tools. An increase of $5 million is recommended to assist the DoE in transferring its Learning Productivity products to the private sector and to other agencies to ensure full use of immediately available technologies that support Learning Productivity programs.

e An increase of $5 million is recommended to assist the DoL, Office of the American Workplace, in transferring Learning Productivity technologies from the federal laboratories. These technologies will enhance DoL funded workplace programs.

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NSTC Committee for Education and Training
Sub-Committee on Research and Development for Education and Training

FY 1996 R&D PRIORITY ASSESSMENT AND BUDGET ANALYSIS SUMMARY

This summary responds to the OMB/OSTP memorandum of 5 August 1994 requesting an assessment and budget analysis related to Learning Productivity, one of eight FY 1996 R&D Priority Areas. This priority area implements an objective established in the Clinton-Gore policy statement of 22 February 1993, "Technology for America's Economic Growth, A New Direction to Build Economic Strength," which calls for an initiative to "support the development and introduction of computer and communications equipment and software that can increase the productivity of learning in formal school settings, a variety of business training facilities, and in homes."

I. THE LEARNING PRODUCTIVITY ASSESSMENT AREA

A. Description: An Opportunity and Need

The nation is in the midst of a scientific and technological revolution of unprecedented proportions. To realize the benefits of this revolution, we must meet the education and training challenges it presents by absorbing the information it produces and using the information in economically and socially productive ways.

Fortunately, this revolution also gives us the means to meet these challenges. New research in teaching and learning points to improved curricula and pedagogy. New learning technologies are emerging, and they provide opportunities for universally accessible and effective life-long learning. Surveys of new technologies applied to education and training report time and cost savings to reach specified instructional objectives of about 30%. These surveys also report increases in achievement of about the same amount, 30%, when time and costs are held constant. Exploiting these capabilities and savings to allow tailoring of instructional pace, content, sequence, and style to the needs of individuals will create and sustain a society of life-long learners. Exploitation of the National Information Infrastructure will dramatically increase the accessibility of high-quality education and training materials for all Americans in schools, workplaces, community resource centers, and homes.

Unfortunately, we are devoting only limited resources to capitalize on these opportunities. Office of Technology Assessment accounting has indicated that research and development in education and training amount to only 0.025% of all education and training activity. This percentage is small relative to R&D investments found in other priority areas and to the overall percentage of U.S. gross national product invested in R&D (about 2.5%). While workplaces in business and industry are taking advantage of our latest technological advances, education and training -- the foundations of our workforce -- lag further and further behind. The Committee believes that a significant increase in our current level of federal investment in education and training R&D is required.

B. Vision and Goals

The Committee on Education and Training proposes a broad vision for American education and training:

> "To ensure all Americans access, anytime and anyplace, to quality education and training tailored to their individual learning and workplace needs."

This vision requires new environments for life-long learning that use technology to support learners of all ages and conditions. These learning environments extend beyond the confines of classroom walls to include the home, the community (e.g., museums, libraries, community centers), and the workplace. They reach beyond the traditional school-age population to encompass the life-long learning population from pre-school to incumbent workers. They support learning of complex content and complex approaches to problem solving. They will help alleviate the bottlenecks of the current instructional paradigm.

The Committee believes that increases in learning productivity require:

- Promoting inter-agency, intergovernmental, and public-private collaboration to increase the learning productivity of our education and training institutions;
- Exploiting the best of our existing information technologies for education and training applications;
- Identifying and funding new areas of research and development that significantly improve learning;
- Ensuring access to all learning resources by all Americans;
- Creating incentives for the commercial sector to enhance the quality and increase the affordability of learning materials.

Achieving these goals will be a continuing concern of the Committee and will be supported by the creation of the new Interagency Technology Office (ITO) as discussed in Section III.B. below.

C. Support for Goals and Policies

The following four Focus Areas support the Administration's R&D principles, goals, and priorities as outlined in the National Science and Technology Council's FY 1996 Research and Development Priorities Memorandum of 6 May 1994.

- Demonstrations of Innovative Technology and Networking Applications:

  Initiation of whole system programs using hardware, software, and the National Information Infrastructure to demonstrate advanced instructional systems that significantly increase the productivity of learning.

- Technology Development for High-Quality, Affordable Learning Tools:

  Development of high-quality, affordable learning tools and environments that use technology to increase the productivity of learning in all fields by all people in all settings including schools, workplaces, community resource centers, and homes. Such tools include synthetic learning environments, collaborative problem solving environments, software interfaces, instructional software development tools, interactive instructional systems, intelligent learning associates, and tools for searching multimedia data bases and digital libraries.

- Development of New Models to Evaluate Learning Productivity:

Development of new models and new assessment tools for evaluating and measuring learning and learning productivity.

- Research on Learning and Cognitive Processes:

  Research that improves understanding of the cognitive, instructional, and learning processes that underlie instruction and how they are best supported by technology.

These programmatic actions must be accompanied by a vigorous effort to publicize, scale-up, and disseminate the R&D products and information resulting from this initiative.

II. STRATEGY FOR MEASURING PROGRESS AND PERFORMANCE

The Learning Productivity Priority Area is defined by the four Focus Areas described above. Progress and performance in Learning Productivity will be measured by establishing goals and measuring performance in each of the Focus Areas.

Criteria for measuring progress and performance in the Demonstration Programs Focus Area include:

- Increases in instructional effectiveness and learning performance;
- Increases in access to education and training -- especially for underserved populations of learners;
- The degree to which the demonstrated technology-based learning systems are affordable and can be scaled-up to a broad set of populations and settings;
- The degree to which the demonstration programs promote linkages among all levels of education, the private sector, and communities;
- The degree to which the demonstration programs promote systemic education reform, support institutional change, and overcome barriers to the use of technologies for education and training.

Criteria for measuring progress and performance in the Learning Tools Focus Area include:

- Contributions to increased instructional effectiveness and learning performance;
- Extent of market adoption and commercialization of the learning tools;
- Success in creating new ways to communicate complex ideas and experiences;
- Success in promoting access to learning resources and expertise.

Measurement of progress and performance in the Assessment Tools Focus Area will depend on the extent to which the models and assessment tools:

- Provide valid measurement of learning effectiveness and learning productivity;
- Provide new ways to assess cognition and the progress of individual learning;
- Provide models of effective technology use;

- Assess the impact of learning productivity on schools, workplaces, and communities.

Measurement of progress and performance in the Research Focus Area will depend on the extent to which the research:

- Can be used to increase learning effectiveness and productivity;
- Provides basic insights into learning and cognition that are relevant to learning productivity;
- Identifies new paradigms for instruction and learning environments;
- Leads to curriculum structuring and re-structuring.

In carrying out its assessment of progress and performance, the CET will establish milestones for each focus area. These milestones will govern the formulation of plans, the assignment of responsibilities, and the commitment of resources. The Committee will track progress towards these milestones. Evaluations will measure individual project or program performance against the criteria we have suggested.

A panel of experts drawn from the private sector, the education and training communities, and the federal government will be convened periodically to advise on plans and assess progress. The panel will examine the progress of the initiative in light of the overall goal of increasing learning productivity and in terms of the Focus Area objectives.

III. FUNDING ANALYSIS SUMMARY

Because this area has been historically underfunded, CET recommends that funding for the Learning Productivity Priority Area be increased in FY 1996 by $88 million as shown in Table 1 and discussed below in Section III.A. This increase should be distributed among the agencies as shown in Table 4. Additionally, CET recommends a FY 1995 "Quick Start" increment of $25 million for the Demonstration Programs Focus Area.

In accordance with the CET Charter, this analysis focused primarily on R&D contributing to technology for education and training and to learning productivity in general. We did not include programs and resources devoted to such activities as in-service training for teachers, summer institutes, student travel, and graduate fellowships.

A. Funding Shortfalls

Table 1.
FY 1996 Shortfalls by Focus Area ($M)

Focus Area	FY 1996 Current	Recommended	FY 1996 Shortfall
Demonstration Programs	18	70	52
Learning Tools	152	182	30
Assessment Tools	15	21	6
Research	71	71	0
Total	256	344	88

The Demonstration Programs Focus Area has been identified as the cornerstone for this Priority Area because of the need to (1) transcend the wide disparity and fragmentation of education and training activities; (2) overcome institutional inertia and invigorate institutional reform; and (3) attract and promote private sector investment in developing high quality instructional applications and materials. While existing effort in the other Focus Areas (Learning Tools, Assessment Tools, and Research) will support work in the Demonstration Programs Focus Area, the Demonstration Programs will in turn identify, focus, and prioritize new R&D needed in these other Focus Areas.

The White House Task Force on Learning Productivity and representatives from CET agencies and departments have determined that a series of full-system demonstration programs is needed to effect a major paradigm shift and institutional reforms in Learning Productivity. These programs will focus on distinctive education and training needs such as school to work transition, continuing professional development, systemic school reform, and retraining for incumbent workers.

Each demonstration program requires $7 million per year for each of 5 years. Expenditures will emphasize different areas of investment in different years -- early years will emphasize development, integration, and deployment and later years will emphasize expansion, test, and evaluation in multiple sites. The Task Force determined that ten demonstration programs are needed to ensure that innovations in education and training are effected across all learning populations. The funding required for implementation and evaluation of the Learning Productivity Demonstration Programs is $70 million a year for each of five years.

As Table 1 shows, funding for the Demonstration Programs Focus Area falls far short of the recommended $70 million. $15 million of current funding is the result of a FY 1994 Congressionally directed DoD/OSTP partnership to effect the transfer of DoD learning technologies to the private sector. Additional demonstrations are needed in areas besides K-12 classrooms, particularly in environments that are credible and relevant to trainers of incumbent workers and developers of learning technology materials in the commercial sector.

Additionally, a "Quick Start" increment of $25 million for the Demonstration Programs Focus Area is needed in FY 1995. This funding will permit immediate initiation of demonstration programs in areas of obvious, available, and beneficial opportunity such as networked simulation, collaborative problem solving, student-centered learning, distributed instruction, and digital libraries. It will capitalize on current interest in Learning Productivity and rapidly build momentum for this R&D Priority Area.

Demonstration programs can be immediately launched given current technological opportunities and the state of the art. However, to be sustained as full system demonstration programs and to be scaled-up to serve many populations and sites equitably and fully, they must have supporting R&D in the remaining three Focus Areas both to fill gaps and to substantially improve the current state of the art.

The Learning Tools Focus Area is essential for education and training software development and market creation. As Table 3 shows, 117 million of the $152 million departments and agencies request is accounted for by the Department of Defense. These activities support the development of learning tools for specialized training in combat operations. The bulk of the remainder is accounted for by the Department of Education and the National Science Foundation. While these efforts are critical to the agencies' missions, they do not focus R&D on tools intended to serve as the basis for commercial products and services, scale-up for use by many populations and at many sites, or serve the needs of state and local agencies.

We believe that an additional $30 million R&D increase should be applied to accelerate the development of learning tools and the transfer of existing tools and capabilities to the private sector in order to create a vigorous market in high-quality, affordable learning tools. Particular emphasis should be placed on identifying and leveraging tools that have been developed by the National Laboratories. The recommended R&D investment would be allocated to DoEd, DoL, NSF, DoE, NASA, and the Smithsonian Institution as outlined in Table 4.

The Assessment Tools Focus Area addresses a major gap in education and training operations. The new learning environments sought by the Learning Productivity Priority Area as well as the skills and capabilities that are required by emerging state and national standards require assessment tools that are vastly different from those the nation has used for the past several decades. Since testing and assessments are powerful motivators for both education and training institutions and for students, it is critical that valid and reliable assessment systems be put in place. However, few tools and models now exist. The Assessment Tools Focus Area is expected to develop both models and assessment tools that can be initially used and validated by the demonstration programs and subsequently used more widely.

As Table 1 shows, very little R&D is being invested in Assessment Tools. Because of its embryonic nature, this Focus Area can absorb only limited R&D. Investments of $1 million per year in each of six existing centers capable of carrying out this R&D would yield significant returns.

The Research Focus Area is widely fragmented. The CET goal is to reduce the fragmentation of current research on learning and cognition by focusing it on increasing the Learning Productivity and providing a foundation for applying new technologies to education and training.

Much of the research reported in Table 1 is narrowly focused on many issues that are only tangentially related to Learning Productivity. Even though no increased funding in this area is recommended, much needs to be done to increase collaboration and coordination to ensure this R&D investment is directly applicable to the Learning Productivity Priority Area.

B. Recommendations to Accommodate Shortfalls

The Committee believes that this initiative requires management that is quite distinctive in the domestic policy area. The Committee proposes that the Learning Productivity Initiative be overseen and coordinated by a new collaborative Interagency Technology Office (ITO), which will be located in the Department of Education for administrative purposes. It will serve the CET and its member agencies as an independent activity. This independent office will play a major role in shaping the Demonstration Programs Focus Area. The Office will: 1) Promote public-private sector collaboration, investments, and partnerships for learning productivity; 2) Coordinate activities, recommend policies, ensure evaluation and dissemination of results, and; 3) Coordinate efforts of the agencies chosen to undertake demonstration programs for the focused areas.

The Learning Productivity Initiative will establish sufficient private sector interest and momentum to create a market that attracts substantial investment and continually expands through follow-on private involvement in both R&D and mainstream commercialization. The infusion of new education and training capabilities that are now available from advances in learning technologies will ensure an acceleration of fundamental reform. It will

provide nationally visible demonstrations of the value and practicality of learning technology and the essentially of major paradigm shifts needed to ensure Learning Productivity for all Americans.

Funding Allocations. The Committee recommends that the identified FY 1996 shortfall be allocated in the following manner:

- $58 million to the TLC Office to support the Demonstration Programs Focus Area, to support the Assessment Tools Focus Area and to provide external support to the Office.

- $5 million to the Smithsonian Institution to lead a cross agency team in demonstrating the value of digitizing federal holdings for distribution to the public in support of learning productivity.

- $25 million, in $5 million increments allocated directly to: DoD, NASA, DoE, NSF, and DoL. These amounts will be used to ensure transfer of existing learning tools from DoD, DoE, and NASA laboratories to support DoEd and DoL education and training programs.

These activities will be conducted by existing offices and departments with responsibilities for education and training development and applications within the participating agencies as shown in Table 4.

R&D on Learning Productivity will yield major improvements in current support for life-long learning and progress toward education and training institutional reform. The infusion of new education and training capabilities that are now available from advances in learning technologies will ensure an acceleration of fundamental reform. It will promote commercial interest in raising the quality and lowering the costs of learning materials. It will provide nationally visible demonstrations of the value and practicality of learning technology and the essentially of major paradigm shifts and institutional reforms needed to ensure Learning Productivity.

IV. SUMMARY OF AGENCY CONTRIBUTIONS

Contributions by Federal Agencies to R&D that have been judged relevant to the Learning Productivity Priority Area and that have been reported are shown in Table 2.

V. AGENCY PROGRAM CONTRIBUTIONS

The contributions of individual agencies to the Learning Productivity R&D Focus Areas are shown in Table 3.

Table 2.

Summary by Agency Contributions ($M)

Agency	FY 94	FY 95	FY 96	$M Change FY 95-96
Central Intelligence Agency	CL	CL	CL	CL
Dept of Agriculture	0	0	0	0
Department of Commerce	0	0	0	0
Department of Defense	160	143	145	+2
Department of Education	59	68	40	-28
Department of Energy	5	4	4	0
Department of Transportation	0	2	1	-1
Department of Health and Human Services	42	33	33	0
Department of Interior	1	1	1	0
Department of Labor	0	0	0	0
Environmental Protection Agency	0	0	0	0
National Aeronautics and Space Agency	5	5	5	0
National Science Foundation	27	27	27	0
National Security Agency	CL	CL	CL	CL
Smithsonian Institution	0	0	0	0
Total	299	283	256	-27

Notes:
CL = Classified Information

Table 3.

Summary of Agency Contributions by Focus Area ($M)

Agency	FY 94	FY 95	FY 96	$ Change FY 95-96
Department of Defense				
Demonstration Programs	35	15[a]	15	0
Learning Tools	117[b]	120	122	2
Assessment Tools	5	5	5	0
Research	3	3	3	0
Total	160	143	145	2
Department of Education				
Demonstration Programs	0	0	0	0
Learning Tools	11	12	8	-4
Assessment Tools	7	7	3	-4
Research	41	49	29	-20
Total	59	68	40	-28
Department of Energy[c]				
Demonstration Programs	0	0	0	0
Learning Tools	0	0	0	0
Assessment Tools	5	4	4	0
Research	0	0	0	0
Total	5	4	4	0
Department of Transportation				
Demonstration Programs	0	0	0	0
Learning Tools	0	0	0	0
Assessment Tools	0	1	0	0
Research	0	1	1	0
Total	0	2	1	-1
Department of Health and Human Services[d]				
Demonstration Programs	2	2	2	0
Learning Tools	2	2	2	0
Assessment Tools	3	3	3	0
Research	35	26	26	0
Total	42	33	33	0
Department of Interior				
Demonstration Programs	0	0	0	0
Learning Tools	1	1	1	0
Assessment Tools	0	0	0	0
Research	0	0	0	0
Total	1	1	1	0

Table 3 (Continued).

Summary of Agency Contributions by Focus Area ($M)

Agency	FY 94	FY 95	FY 96	$ Change FY 95-96
National Aeronautics and Space Agency				
Demonstration Programs	0	1	1	0
Learning Tools	5	4	4	0
Assessment Tools	0	0	0	0
Research	0	0	0	0
Total	5	5	5	0
National Science Foundation				
Demonstration Programs	0	0	0	0
Learning Tools	15	15	15	0
Assessment Tools	0	0	0	0
Research	12	12	12	0
Total	27	27	27	0

Notes:

[a] The additional $20 million in FY 1994 in DoD is due to a Congressionally directed OSTP/DoD partnership to transfer DoD learning technologies to K-12 education settings.

[b] Most DoD R&D on learning tools involves technologies directly related to the preparation of military personnel for combat duties and support of combat systems and require modification to be integrated into private sector programs.

[c] DoE has an additional $5 million of education and training R&D funds reported under the HPCC initiative.

[d] HHS responses were adjusted to accord more closely with the definitions of the Focus Areas.

Table 4.
FY 1996 Funding Allocations among Agencies ($M)

Agency	FY 96 Currently Programmed for Learning Productivity	Recommended FY96 Increase
Department of Defense[a]	145	5
Department of Education[b]	40	0
TLC Program Office[c]	0	58
Department of Energy[d]	4	5
Department of Labor[e]	0	5
National Aeronautics and Space Agency[f]	5	5
National Science Foundation[g]	27	5
Smithsonian Institution[h]	0	5
Department of Health and Human Services[i]	33	0
Department of Transportation[j]	1	0
Department of Interior[j]	1	0
Total	256	88

Notes:

[a] The DoD has a long and successful history of R&D investment in Learning Productivity areas. This investment should be leveraged. An increase of $5 million is recommended to assist the DoD in transferring its R&D products to educational enterprises to ensure full use of immediately available technologies that support Learning Productivity programs.

[b] Of the $40M, most ($29M) DoEd Learning Productivity R&D is supporting research in basic cognitive processes, curriculum restructuring, and methods to effect institutional reform in schools. Of the remaining funding, $8M supports the development of learning tools and $3M supports development of assessment tools. Additionally, the DoEd has about $30M that will be applied to Learning Productivity, once it completes its restructuring of OERI and the allocation of these funds can be specified. The DoEd will operate the new Interagency Technology Office. Funding for the ITO is discussed in note c.

[c] Aside from funds needed to support its own operations, the funding for the ITO will be disbursed among federal agencies in accordance with a strategic plan that is to be prepared and carried out under the oversight of the CET.

Table 4 Notes (continued):

[d] Most ($5M) DoE Learning Productivity R&D is supporting development of learning tools. An increase of $5 million is recommended to assist the DoE in transferring its Learning Productivity products to the private sector and to other agencies to ensure full use of immediately available technologies that support Learning Productivity programs.

[e] An increase of $5 million is recommended to assist the DoL, Office of the American Workplace, in transferring Learning Productivity technologies from the federal laboratories. These technologies will enhance DoL funded workplace programs.

[f] Most ($4M) NASA Learning Productivity R&D is supporting development of learning tools. An increase of $5 million is recommended to assist NASA in transferring its Learning Productivity products to the private sector and to other agencies to ensure full use of immediately available technologies that support Learning Productivity programs.

[g] Most ($15M) NSF Learning Productivity R&D is supporting development of learning tools. The remaining funds ($12M) are being spent in basic research on learning and cognitive processes. An increase of $5 million is recommended to assist the NSF in transferring its Learning Productivity products to the private sector and to other agencies to ensure full use of immediately available technologies that support Learning Productivity programs.

[h] An increase of $5 million is recommended to allow the Smithsonian Institution to lead a CET-sponsored, cross-agency team that will demonstrate the value of digitizing federal holdings for distribution to the public.

[i] The funds in HHS are directed toward basic research in learning and cognition for special populations and special areas. No additional funding is recommended.

[j] The funds in DoT and DoI are small (less than $1 million each) and directed toward specific application unique to those agencies. While both of these are important and contribute to the goals of CET, no additional funding is recommended.