Using the Design In the Classroom (DITC) Teacher Professional Development Materials: A Handbook For Teachers

Table of Contents

Overview of DITC

Design In the Classroom (DITC) is an NSF-funded teacher professional development project that has collected movies of different teachers using a variety of published design activities with middle-school students. DITC's materials aim to support middle-school science, tech ed and math teachers in using these activities by providing the classroom-ready tasks, tutorials on key ideas that underlie the activities, links to related teaching and content standards, and video interviews with teachers, students, curriculum authors, engineers, designers and educational researchers.

The DITC website (http://www.cc.gatech.edu/projects/DITC, and after November 1, 2004, http://ditc.missouri.edu) has four main sections:

• **Getting Started** – Gives hints for using and navigating through DITC, suggests not-to-be-missed items for science, tech ed, and math teachers, and provides a tutorial for making videos of your own class.

• **Use Design Task** - Gives access to videos of classroom scenes showing activities from five different design-based curricula. Tasks include designing-and-making: model parachutes, cardboard chairs, paper bridges, shopping bags, model vehicles, simple machines, pop-up books and other challenges. DITC materials provide a "video timeline" that can be helpful in planning lessons, samples of student work and typical misconceptions that may come up during class.

• **Learn About Design** - Explore an interactive map of design strategies, find out about different design models, learn about pedagogies and teaching strategies that can help make design tasks work in class, see links to state and national benchmarks and standards, and read summaries of relevant research from the learning and cognitive sciences.

• **DITC Resources** - At the top of each page, DITC provides links to other design-based curriculum and teacher training projects that use design tasks, gives access to a design bibliography, a single-page list of all DITC videos and Site Map of all DITC pages.

The DITC materials are based upon work supported by the National Science Foundation, project 99-86854. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

Software and Equipment Needed To Use DITC

The web version of DITC can be accessed over the Internet, via DVD-ROM or CD-ROM. Watch full-screen versions of DITC videos via its two DVD-movie disks, or VHS, hi8 and miniDV tapes. The equipment you need to play DITC depends on which form of DITC you will be using.

Software You Need to Run DITC on Your Computer

• **Web Browser** Any computer with a web browser (Netscape, Internet Explorer, etc.) can access DITC pages over the Internet.

• **Apple's QuickTime Player** - To play DITC movies, you will need to download onto your computer Apple's QuickTime video player from (www.apple.com).

• **Adobe Acrobat Reader** – To view and print out copies of student and teacher materials or research articles, you will need Adobe's Acrobat Reader software (www.adobe.com).

Accessing the Full Version of DITC: Online or On Disk?

With your computer, you can watch all of DITC's movies and read all of its pages of tutorials and related web links in three different ways. You can: (1) view it *online* by going to the project's website; (2) run DITC off of a single DVD-ROM disk; or (3) load DITC onto your harddrive. Request disk copies or tapes from the project's Principal Investigator, David Crismond. (Contact information available at the end of this pamphlet).

Here are more details on these processes:

DITC Online - To access DITC on-line, you will need access to a fast connection like cable modem or ethernet. If you use a phone modem, loading times for even one of DITC 130+ movies will be prohibitively slow. Consider running DITC off of your DVD drive or internal harddrive.

DITC on DVD-ROM - The easiest disk method for using DITC is to request the DVD-ROM version of the program on 1 disk. Your computer must have a DVD drive, however. By inserting this disk into your drive, you can run the entirety of DITC directly, without further installation. Follow the instructions for "Run DITC From Your DVD Drive" below to use the DITC program.

Loading DITC from CD-ROM to Harddrive - If your computer reads only CD-ROM disks, you will need to request DITC's 3 CD-ROM disk set. Because a CD's 700 MB capacity will not hold all of DITC, you will need to load DITC onto your computer's harddrive. Your computer must have 1.8 GB of free space to do this option, which will result in the best performance.

The following are instructions for installing DITC using its 3 CD-ROM disks:

(1) Copy all contents of Disk 1 onto your harddrive into a folder called "My_DITC".

(2) Inside My_DITC, find the folder called "Movies".

(3) Copy the files of Disk 2 and then Disk 3 into the Movies folder.

Follow the instructions for "Running DITC From Your Harddrive" below to use the DITC program.

Running the DITC Program from Your DVD-ROM Disk or Harddrive

To start up your copy of DITC, you need to find the file with the folder "My_DITC" that is entitled "CLICK_HERE_TO_START.html". Open it with the web browser loaded onto your computer, which will take you to DITC's Home page.

Viewing Full-Screen Versions of DITC Movies - If the above options do not work for you, you have another set of options for viewing DITC movies. With these choices, however, you will have access only to some DITC movies, and you will not be able to read the explanatory pages found on its website. Viewing the text from the DITC website and watching the full-screen movies might be a viewing option worth exploring:

(1) **DITC DVD-Movies** - The highest quality viewing of DITC videos can be had by playing the two DITC DVD-movie disks using a standard DVD-movie player and television monitor. The remote associated with this technology invites slow-motion and frame-by-frame replay of movies. The two volumes follow the second and third tabs in the DITC website: Volume 1 "Use Design Tasks" has interviews with 5 curriculum developers, and gives overview movies of the 11 activities showcased in DITC.

(2) **DITC Videotapes** - Videotapes (VHS, hi8 or miniDV) of DITC movies can be requested. These allow users to view selected movies on a TV with the appropriate videotape player.

DITC Navigation & Page Layout

DITC's page layout is shown below. You can access DITC content by clicking on its three blue Main Tabs -- Getting Started, Use Design Tasks, and Learn About Design.

Main topics and design tasks appear in the purple Navigation Bar under the tab when clicked. Links to individual content pages appear in the teal Navigation Bar.

Additional DITC features can be accessed by clicking on the gold **Resource Links** at the top of any DITC page. These include a Movie List where you can view all DITC movies, Links to sites that deal with design in education and schools, a Bibliography of articles referenced in DITC, with full citation, a Movie Comparison pages where clips can be seen side-by-side, a Search engine and Site Map page.

Below the **Navigation Bars** lies the main content of a DITC page -- text with links to related pages or resources, and **QuickTime Movies** showing classroom teaching or interviews. Overview pages of the 11 design tasks provide lists of materials that teachers use to gather necessary materials for their students, and clickable links to **Adobe Acrobat** documents (PDF) that include student worksheets and teacher materials from curriculum publishers.

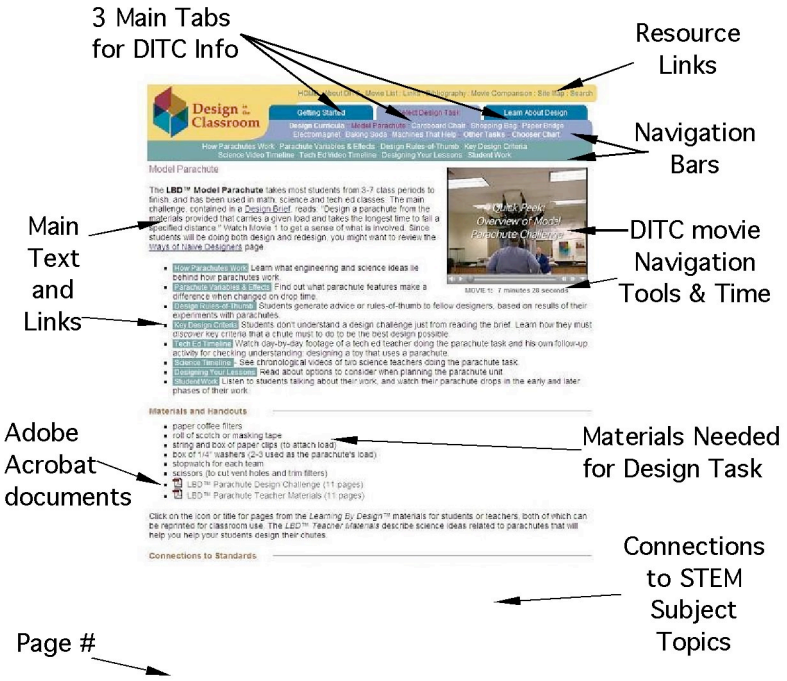

Figure 1 - Layout of a typical DITC page, Arrows note key features in page format.

The **Connections To Standards** section describe links between the activity being discussed and National Standards in math, science and technology education. These can be helpful for meeting teachers' long-term planning needs.

Page # - In the lower left-hand corner of all DITC pages is a series of numbers separated by hyphens. These page numbers represent items to click in the navigation bar area. For example, 3-7-4 stands for blue tab 3 (Learn About Design), purple navigation bar item 7 (Teaching Controversies), and teal navigation bar item 4 (What Makes For a Good Design Challenge?).

Select Design Tasks

Under the middle “Select Design Task” tab, you can find videos, descriptions and copies of the activities showcased in DITC. You can also watch interviews of authors of the 5 curricula found in DITC, or access a Chooser Chart to help you select a task to use with your students.

Here are the design tasks featured in the DITC:

- **Model Parachute** - Students use coffee filters, string, tape and weights to create a parachute that falls the slowest with a given load. (Learning By Design™ 3-7 days)
- **Cardboard Chair** - Students investigate paper as a building material and, working in groups, scale up model designs to create a full-scale cardboard chair that can hold a 70-kg (150-pound) person sitting and leaning back on it. (Developed by Ed Goldman of Brooklyn Tech HS 5-7 weeks)
- **Shopping Bag** - Students collect and sort a wide variety of shopping bags, test them to see which designs are strong and where they fail when loaded, and then redesign them into their own shopping bag. (Stuff That Works! 2-5 days)
- **Paper Bridge** - Students use the minimum of material from a single sheet of paper to make the lightest "paper bridge" that holds 1 or 3 nearly full liter-water bottles for 10 seconds. (Challenges In Physical Science 3-5 days)
- **Crane** - Watch teachers at an EDC workshop build a motorized crane that lifts as many nails in a cup as possible. (Design It! 3-5 days)
- **Electromagnet** - With simple materials, students attempt to build the strongest electromagnet, measured by lifting the greatest number of nails placed in a plastic cup. (Challenges In Physical Science 3-5 days)
- **Baking Soda** - Students combine vinegar and baking soda as a replacement for yeast to make bread rise, with no residue or aftertaste. (Challenges in Physical Sci 4-7 days)
- **Simple Machines** - Students investigate simple machines and design a device that enables a user to lift a heavy weight with the small force transmitted through a single strand of cotton thread. (LBD™ 2-4 weeks)

Three other design tasks that get less treatment in DITC are:

- **Parade Float** - This activity has the UK's equivalent of middle-school tech ed students building a wooden model of a parade float that advertises a student-selected product and employs a cam in its drivetrain. (Nuffield Design & Technology 5-10 weeks)
- **Vehicles In Motion** - In this Learning By Design activity, students investigate, test and combine propulsion systems for a model car that must climb 2 test hills and travel as far as possible beyond them. (LBD™ 4-8 weeks)
- **Pop-Up Books** - Brooklyn Tech’s Ed Goldman designed this unit that introduces students to paper engineering and has them produce a book using a number of pop-up book elements for student presentations at a "pop-up book trade show". (5-9 weeks)

Learn About Design

In this section of DITC, you can learn about what designing means and involves, explore the learning kids do when they design, and see teaching techniques that enhance this learning:

- **What Is Design?** - Probably the most important part of Learn About Design is the interactive Generic Design Model -- a clickable map that explains the design basic strategies. This section also introduces 7 different design models, which can help you see how your students do and don't design. One key page - the "Ways of Naive Designers" - describes pitfalls that beginning designers often stumble over and teaching strategies that address them.
- **Design Pedagogy** - What approaches best work in supporting students who are learning when designing? Techniques include: using the "design brief", having students conduct "product histories" and "product comparisons" to learn about prior art or previous designs, do "scavenger hunts" and conduct fair-test experiments.
- **Teaching Strategies** - Describes ways to initiate design tasks, supporting students' group work, helping students manage their time and make "informed design decisions".
- **Design Cases** - Everyone designs; not everyone knows it when they are doing it. See cases of everyday designing involving classroom teachers, curriculum developers and people without special training in design. Listen to a language that describes how and when people engage in when designing.
- **Assessment** - Learn to do formative and authentic assessment, focus on students' explanations for design decisions, and use transfer tasks to check student understanding.
- **Standards** - Read about national and selected state standards and how they relate to design and technology investigations showcased in DITC.
- **Teaching Controversies** - Design generates controversies for students, teachers and researchers. Hear researchers talk about gender and design, what makes for good design challenges, and discuss the struggle of balancing teacher control versus student autonomy, and breadth versus depth of coverage.
- **Learning/Cognitive Sciences** - Read summaries of the research from the Learning and Cognitive Sciences that supports using design activities and its pedagogies. Topics include the differences between: novice/expert performance, near/far transfer, short-/long-term memory, memorizing/understanding, and finding versus solving a problem.

DITC Highlights

Here are some highlights and key features that can be found throughout the DITC program:

- **Video Timelines** - Planning to teach a new activity for the first time can be overwhelmed, especially if you are using a new type of curriculum. Teachers have reported that the Video Timelines, which show the day-to-day implementation of a design activity, help in everyday planning and anticipating what's in store when using design activities.
- **Movie Comparison** Sometimes the fastest way to learn about a novel teaching approach is to compare two teachers doing the same activity. By going to the Movie Comparison page, view select DITC movies side-by-side, which allows for easier comparisons.
- **Design Process** DITC's Generic Design Model pages hold an interactive map with movies that talk about the individual strategies that make up designing. DITC also presents a collection of seven design models to compare.
- **Key Concepts** Every device has related science and engineering concepts -- you need to know these to do "informed designing." Activities showcased in DITC have pages that address Key Concepts, and include tutorials on how devices being designing work, which design variables most affect a product's performance, and associated misconceptions.
- **Design Pedagogy –** When you first teach design, you probably will anticipate some of the Ways of Naive Designers and not others. This section presents strategies that you can employ when using design activities with kids -- including encouraging good time management, dealing with designs that fail, and safely using tools.

Hints on Watching DITC Movies

Videos have been used in teacher professional development since the 1960s. Some lessons have been learned over the years about what works and doesn't with using this medium for professional development. These include:

- **Many viewers assume that all classroom videos demonstrate excellent teaching practice.** Why else were these lessons videotaped? But the reality is that lessons are recorded for different purposes and in different settings, and not all of them were intended to model instances of best practice. In general, every classroom video should be reviewed in light of the teacher's goals, students' learning needs and the quality of the resulting learning. In short – every video is a starting point for a careful examination and discussion of the multiple facets of teaching and learning, and is not a model to mimic.
- **Videos are better watched with a colleague**. Teaching and learning are complex cognitive and social activities, and your analysis of classroom videos can benefit from exchanging ideas with others and the examination of different points of views. Discussing videos with colleagues affords you the opportunity of articulating instructional themes and developing a deeper and more comprehensive understanding of teaching and learning.
- **Teaching can be described by student learning**. Teachers who work with videos over a period of time initially focus their attention on teachers' actions and moves, but with more experience they shift towards focusing on students' learning and the many ways instructional strategies and content presentations affect student learning.
- **Everyone can benefit from analyses of classroom videos.** Although it was found that experienced teachers recognize more patterns of behavior and layers of classroom instruction than beginning teachers, all teachers can benefit from watching classroom videos. An expert teacher watching the classroom videos with novice teachers can provide scaffolding and open their eyes to the many connections between teaching and learning.

Practical hints for watching videos using Apple's QuickTime Player in DITC:

- **Watch the videos straight through** on the first run. Then use the Slide bar button to review portions of videos.
- **See videos in slow motion**, forward or back by clicking on Frame-By-Frame button.
- **Use the Timecode** in the lower right-hand corner of the QuickTime movie screen to refer to a portion of a video that you want to return to or discuss with a colleague.
- **Use the Page #** in the lower left-hand corner of each page to refer to a specific webpage (e.g., 2-2-4 would refer to Main Tab 2 (Using Design Task) – Purple Navigation Bar Item 2 (Model Parachute) – Teal Navigation Bar Item 4 (Key Design Criteria).

As you watch the scenes of design activities being used in workshops or in the classroom, try to:

- **Review the questions** found on the DITC page where your movie is located before watching the sequence. These questions can also be found at the end of some videos.
- **Infer and question the underlying assumptions** of teachers you see on DITC. Then reflect on your own assumptions about teaching and student learning.
- **Look for student misconceptions**, since these ideas are often "case-hardened" and are resistant to direct instruction.
- **Try out and adapt approaches** you see on DITC so that they soon can become your own. Just as some designers are averse to taking risks, so also teachers can be reluctan to experiment with certain aspects of their teaching.
- **Shoot your own classroom videos** and compare your teaching to videos on DITC
- **Show selected movies to your classes** (slow-motion to see product performance, students working in groups)
- **Read research articles** that accompany DITC interviews with education experts and designers.

Three Scenarios for Using DITC

The following three scenarios illustrate how different middle-school STEM teacher can use DITC – use these stories as roadmaps for your own exploration. In the first scenario, an eighth-grade tech ed teacher uses DITC to find out more about the design process and teaching techniques, so that she can include more about designing in her pre-engineering course. In Scenario 2, a seventh-grade physical science teacher uses DITC to get more information about the Model Parachute design challenge created for Georgia Tech's Learning By Design curriculum. Scenario 3 describes a sixth-grade math teacher's use of DITC to prepare his lessons for the Shopping Bag challenge from the *Stuff That Works!* curriculum.

Scenario 1: Tech Ed Teacher Using the Cardboard Chair Challenge

Shela is a second-year tech ed teacher who wanted to learn more about designing, and broaden her collection of design activities for his classes. She first got the DITC DVD-movie disk by mail, and then requested the DVD-ROM disk to view DITC's webpages on her computer.

Shela navigated DITC website using its Site Map at the top of DITC's pages. When leaving a new page within DITC, she would return to the Site Map by clicking on his browser's back arrow.

1. Getting Started - Once Shela got an overview of DITC by looking at the Site Map, she turned to the "Highlights for Teachers" (page 1-4), and then the page for Tech Ed Teachers (1-4-2).

2. Watching Quick Peek Movies - Shela first viewed the Quick Peek movies for DITC's tech ed-oriented design tasks, including Cardboard Chair, Shopping Bag, Parade Float, Pop-Up Books, Machines That Help and Model Parachute. Since she wanted to have a long-term task that addressed graphic literacy, structures, and scaling, Cardboard Chair seemed like the best choice.

3. Learn About Design - After picking Cardboard Chair, Shela visited the Design Cases section under the Learn About Design tab. She found designers talking a language she herself wanted to speak -- about Designing a Waterfall (3-4-1), teachers making their own design tasks (3-4-4), and the FIRST Design Competitions (3-4-5). Another page of interest to Shela was on Informed Designing (3-2-10) and Authentic Assessment (3-5-3), where students' final projects are evaluated by non-teaching adults. Had she known about it, Shela might have watched movies on how teachers act as designers (3-4), create assessments via "backward designing" (3-4-2), and on Designing Curriculum (3-4-3).

4. Select Design Task - Shela got the background he wanted on how cardboard chairs work by reading the materials provided in Cardboard Chair's main project page (2-3) and its Key Concepts section (2-3-1). Shela spent the bulk of her time reviewing the Chair's chronologically arranged Video Timeline to help her plan her lessons. Shela noticed that many of the Ways of Naive Designers (3-1-3) were addressed by how the Chair task was structured. Shela found the setting of the Final Presentation videos (2-3-2-7), where students made presentation to a panel of outside judges, was relevant to her course. Shela's final use of DITC came when she found the last section in DITC's Learn About Design: the "Cognitive/Learning Science" sub-section presented her with research to support the use of design tasks with her students.

Scenario 2: Science Teacher Using the LBD Model Parachute Task

Wendy has taught physical science for nearly a decade and wanted to tackle the "technological design" objectives she read about in her state's science standards. She got the DITC disk from a colleague, copied it onto her computer, and did the following:

1. Watch Quick Peek Movies - Wendy wanted to sample all of DITC activities without diving too deeply into any one of them. She clicked on the "Select Design Task" tab, and then clicked on each of the design tasks found in the purple Navigation bar, starting with Model Parachute and ending with Simple Machines. Watching those short movies gave her a sense of each task. She chose the Model Parachute challenge because she wanted a hands-on activity that involved students designing their own experiments and addressed Newton's 1st and 2nd Laws of Motion.

2. Get Background on LBD - Before jumping into the Model Parachute section, Wendy clicked on the "Design Curricula" link to visit the Learning By Design page. ("I'm not just going to dive into the first link I see – I tend to get lost doing such things.") Here she heard LBD's creator, Janet Kolodner, talk about how LBD uses design tasks that can be linked to science ideas. She also found and printed out a set of LBD Design Diary pages that she distributed to her students.

3. Learning About Model Parachutes - Wendy then returned to the Model Parachute section, where she visited the following sections.

- **How Parachutes Work** - Wendy listened to an engineer and a parachute instructor talk about how real parachutes work, and then read about Newton's 1st and 2nd Laws, the different chute types, lift and drag force, and terminal speed.
- **Design Rules-of-Thumb** - In LBD, students take experiments and generate advice or rules-of-thumb to fellow designers. Wendy read some typical parachute rules-of-thumb that students made, found out how they can conflict with one another, and that this can become a key point of debate to build better rules-of-thumb and student understanding.
- **Video Timelines** - To prepare her lesson plans, Wendy first viewed the chronologically ordered videos of two science teachers doing Parachute. She then watched the day-by-day footage of a tech ed teacher doing the same task She compared the ways each did demos differently, discussed variables, ran final chute drops, and checked for learning.
- **Designing Your Lessons** - Wendy read over the advice on this page while planning her parachute unit. She used questions she found there to test her students' understanding.
- **Parachute Variables & Effects** - Wendy read this section and watched its movies to find out which parachute features that make a difference in performance -- including the canopy's surface area and vent holes, number of canopy layers, and weight.
- **Key Design Criteria** - Designers learn important lessons by *observing* the ways their products behave. They learn *less* efficiently is by focusing too much on what can be measured; e.g., the time of descent for chutes, the load the shopping bag carries. Wendy learned that a discover period in early designing can involve *inquiring* into and deciding on the performance criteria that was key in parachute design. Should the chute go straight down or at an angle? Sway side-to-side or drift down with little swaying? How important is it that the chute remains inflated at all times?
- **Student Work** - Wendy reviewed drawings and reports other students wrote on their parachutes early and late in their work. She also watched videos of drops for different parachute designs to anticipate what she would be seeing in her own classes.

4. Learn About Design - Wendy wanted to learn a bit more about designing, and so pages under the "Learn About Design" tab. These included the "Generic Design Model" (page 3-0), the "Ways of Naive Designers" (3-1-3), which alerted her to pitfalls that student design groups might fall prey to, and "Student Design Talk" (3-1-5).

Wendy also wanted to explore how design was connected to science, and so watched the videos on Design Versus Inquiry (3-1-4), and to help her reach goals related to designing and conducting of scientific tests she read pages on "Fair-Test" Experiments (3-2-4) and Product Comparisons (3-2-7).

Scenario 3: Math Teacher Using the Stuff That Works! Shopping Bag Task

Meryl is a math teacher who wanted to use design tasks as an authentic and memorable context to which her students could anchor the skills they learned in her class. She had also heard good things from Illinois colleagues who had joined an after-school math video club for their professional development. Meryl got DITC's web address from Google, and requested a 3-disk CD-ROM version of DITC, which she loaded onto her harddrive at school.

1. Getting Started - Given her interest in video clubs, Meryl's first visited DITC's page on Taping Your Class (see page 1-3). Using her school's equipment, except for a shotgun microphone that she bought, she started taping her own classes while using DITC. She then visited the Professional Development Planner page (1-5), where she followed a link on Formative Assessment that led to a movie where Paul Black talked about research on formative assessment and described in a pamphlet found in DITC, "Inside The Black Box".

2. Select Design Task - To find an appropriate design task, Meryl visited the Chooser Chart (2-11). She reviewed all Quick Peek movies for tasks that could be done in less than 2 weeks, and picked the Shopping Bag task as something about which her students had some prior knowledge.

Meryl wanted to explore how mathematics her students could use to talk about "design tradeoffs", which designers must consider all of the time. She had just finished a unit on geometric shapes, surface area and volume, and also wanted to see if her students could apply their recent lessons to making shopping bags. An avid mall shopper, Meryl had her own collection of shopping bags and visited the following pages to find out how they worked:

- **How Shopping Bags Work** - Meryl learned about stresses that act on filled shopping bags, how forces concentrate in materials, and how to predict where failures will occur.
- **Bag Types & How They Fail** - Meryl learned about 3 main types of shopping bags and watched slow-motion movies showing how different bags failed when fully loaded. She thought these videos would help her develop diagnostic reasoning in her students.
- **Shopping Bag Video Timeline** - Meryl watched scenes of the SB activity as done by two Atlanta classrooms, and a *Stuff That Works!* teacher workshop held in LA in 2003.

3. Learn About Design - As a math teacher, Meryl was interested in what educators said about teaching and learning. She visited Teaching Strategies and the Teaching Controversies, and liked the side-by-side video comparisons on Introducing Design Tasks (3-3-1). Other pages included:

- **Drawing & Sketching** - Drawings can help designers see and judge ideas without having to build them, and do mathematical analysis of bag designs. (3-3-6)
- **Develop Kids Metacognition** - She watched a teacher help her students become more self-reflective about their design work. (3-3-7)
- **Supporting Creativity in Kids** - Meryl heard about how creativity is not for the elite few, and how to support students to be more creative when they are designing. (3-3-8)

In the "Teaching Controversies" section, Meryl heard educators articulate issues she had long wondered about when thinking about using design tasks with her students:

- **Gender & Design** - Meryl got animated by the interviews with researchers and teachers as they talked about male and female designers doing design tasks. (3-7-3)
- **What Makes for a Good Design Challenge?** - Meryl heard from curriculum designers and teachers talking about key features of great design activities. (3-7-4)

4. Bibliography - Meryl finally visited the Bibliography link found at the top of all DITC web pages. She found citations for the McTighe and Wiggins' book, Understanding By Design, which connected with her interest in assessment, and noted Architecture and Engineering by architect and educator Mario Salvadori as a way to learn more about structures.

Contact Info For Getting Copies of DITC

For more info or to request copies of DITC (available in VHS tape, DVD-movie, a single DVD-ROM disk or 3 CD-ROM disks), contact DITC's Principal Investigator, Dr David Crismond:

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