The Mathematics Assessment Resource Services

(MARS) Toolkit:

Resources for Leaders in Mathematics Education

Lessons Learned from an Experiment to Develop Tools to Support Change Agents

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I. INTRODUCTION

"The Mathematics Assessment Resource Services (MARS) Toolkit: Resources for Leaders in Mathematics Education" was designed for change agents whose job it is to improve mathematics education across the nation. District math specialists, National Science Foundation (NSF) project leaders, and professional development providers are all engaged in the work of mathematics instruction at the local level. They are the not the people who teach mathematics; rather, they comprise what we call an improvement community for mathematics education.

The work of improving mathematics education is very difficult. While engaged in the work of systemic reform, change agents face challenges that are similar and often predictable in nature, even though their particular local contexts may differ. They may, for example, share the need to revise outdated courses of study, to resolve conflicts between district personnel policies and ambitious professional development plans, or to align curriculum and assessment, to name just a few of the challenges endemic to large scale mathematics education improvement efforts. A basic assumption underlying the rationale for this project is that these change agents need support. Specifically, they need and can benefit greatly from "tools" that are designed to address the problems and challenges that arise in the course of working to improve mathematics education. These "tools" may be intellectual or operational; they may vary from very general strategies to actual artifacts such as research articles or specific curriculum. A range of well-designed tools, it is argued, can empower mathematics leaders to do better, smarter and more effective work.

If "tools" are seen as useful for change agents, then it follows that it would be even more useful to create a "toolkit" targeted for the national mathematics improvement community. Such a toolkit would include tools of various types and in various forms, and would be gathered and organized in such a way as to assure easy access. In particular a web-based toolkit would provide the field with easy, constant and consistent access. A web based toolkit would also provide for interactive possibilities, allowing for the toolkit to evolve through the discovery of new needs and issues, through soliciting feedback, and through inviting members at large to contribute their knowledge and ideas, and possibly more tools. Thus by creating a web-based venue with tools and information for math improvement educators, the MARS Toolkit could potentially become a central, active "meeting place" for the national mathematics improvement community.

This Report

The purpose of the following report is two-fold. First, it is intended to describe the work and progress of the "MARS Toolkit for Change" project. Toward that end the report provides documentation and portrayal of the project from an outside perspective. The second and primary purpose of the report is to illuminate the lessons learned about the overall concept and design of tools intended to augment the work of members of the mathematics education improvement community.

The report is divided into four parts:

1) *"Introduction"* – We include descriptions of the original vision and rationale for the MARS Toolkit for Change, and a brief history of the genesis and evolution of the project

2) *"The Current Status of the MARS Toolkit for Change"* – We describe the major accomplishments of the project, with an emphasis on what the current Toolkit website looks like today. We also include a description of the key findings from expert reviewers, and how their feedback contributed to the final version of the website.

3) *"Inverness Research Associates' Reflections on the Lessons Learned"* – We delineate some of the lessons to be learned from this project's efforts to develop tools to support mathematics education change agents. We focus on lessons learned about the nature of the field, as well as lessons learned about design issues and challenges.

4) *"Summary Thoughts"* – We conclude the report with our own thinking about the value and significance of the Toolkit within the broader context of the mathematics education improvement.

The Genesis of the MARS Toolkit

The vision of the "MARS Toolkit: Resources for Leaders of Mathematics Education" stemmed from several previous decades of work by the "The Mathematics Assessment Resource Services" (MARS) team. While their efforts largely centered on improving mathematics assessments this team had the opportunity to learn about a wide range of issues central to the broader effort to improve mathematics education. Consisting of a collaboration of research and development groups at Michigan State University, the University of California at Berkeley, and the Shell Centre at the University of Nottingham in the UK, the team turned their attention from their previous assessment-centered projects, to how they might widen their scope to serve the field of mathematics education.

The MARS group set for themselves the challenge of finding ways to support those they had identified as "change agents" in the national landscape of mathematics improvement. They wished to identify this community, study it with the aim of understanding its needs, and then design tools that might help address these needs.

The central design challenge was this: How could this project, with limited resources, best support a large, diverse community of individuals who are often isolated from each other and scattered across the country? Because the background of the MARS team members was in the design of assessments and curriculum, and because they were interested in pursuing an engineering approach to educational improvement, the idea arose of providing 'tools' to this community. Like all tools, these tools would help the targeted audience better perform tasks that they were already engaged in. Since the concept of a "tool for change agents" was a new and innovative concept, the project had to explore and define exactly what they meant by "tools" in this context. What would be considered a tool? And what would not be considered a tool? For whom would a given tool be intended? How would the MARS team find and/or design appropriate, useful tools? What would be the balance of finding tools versus creating new tools? And how would tools, once created, be disseminated? How would people learn how to use these new tools? And, if the Internet were to be the repository of such tools, how should a site be designed so that it served as a true toolkit?

The MARS Team and the Development of the Toolkit

In early 2003, the MARS team invited Inverness Research Associates to facilitate a conference in La Jolla, California where the team members could begin to think through and flesh out their new ideas. At the conference the team interviewed a group of change agents, probing their needs and current access to useful tools. From these deliberations preliminary plans were sketched out to create a "Toolkit for Change."

Over the following year, the MARS team—which then began to include members from our evaluation group, Inverness Research—met frequently to begin crafting the specifications for the content and structure of a web-based format for the Toolkit. This large group brainstormed extensively, determined to generate strategies and solutions that would meet the real-world needs of the hoped-for users of the Toolkit website. By 2004, small break-out teams within the MARS group were formed and these smaller teams began to create "strands" that would form the major structure of the toolkit. A "strand" consisted of three written pieces: a challenge or barrier to improving mathematics learning, one or more strategic responses to address the stated challenge, and tools which might be of use in the given context of both the challenge and strategy. Text was entered into a dynamic-database form, and rendered into many well organized and linked web pages on the website.

Beginning in winter 2005, the initial development of the MARS Toolkit for Change website was unveiled for the public, débuting at the National Council of Supervisors of Mathematics (NCSM) Conference that year. In this first phase, the website was a prototype that provided a basic structure and minimal model content in a format the MARS Toolkit team hoped would work well. The intent of this iteration was to probe initial design ideas as well as provide a first-order "proof of concept" of what the MARS team envisioned the Toolkit could eventually become.

The Inverness Research Team and Providing Feedback to the Developers

The major strategy we at Inverness Research used to provide formative feedback to the MARS development team during the course of multiple iterations of the Toolkit was gathering the responses of practicing change agents as well as experts in the field. We formed several panels of change agents and experts from the mathematics improvement community across the country, endeavoring to choose people whose roles reflected a broad spectrum of efforts. These reviewers included: district supervisors, university-based researchers, former members of TERC and Educational Development Center (EDC), as well as directors of NSF-funded Local Systemic Change (LSC) and Math Science Partnership (MSP) projects.

The protocol we developed to study the use of the Toolkit website had two major foci:

- The first was based on determining the 'user-friendliness' factor of the site. The 'ease of use' part of the protocol asked our reviewers to perform a series of tasks and searches using the website. They provided specific feedback regarding where their navigation path led them and any pitfalls encountered.

- The second focus centered upon assessing the content of the website itself, specifically its value and utility as a resource for leaders of mathematics improvement. Reviewers provided their views on the quality and potential utility of the challenges, strategies and tools included in the toolkit.

We captured the results of the reviews via several methods: detailed written feedback, phone interviews and group conference calls wherein the experts could hear and respond to their colleagues thoughts about the Toolkit. In turn, after review and analysis of what we had heard from the panel of experts, we brought back information to the MARS team via verbal debriefs at meetings, as well as a series of memos which provided details of the feedback.

From spring 2005 until spring 2006, we conducted two full-scale expert reviews of the website, with a smaller interim review conducted at the mid-point in the fall of 2005, which led the MARS team to make major revisions to the content of the website. Besides refining the navigation and user-friendliness of the web design, the feedback from reviewers spurred creative rounds of additions to all the strands within the Toolkit.

The Core Design Features of the MARS Toolkit

From the outset, the MARS team worked to identify a set of core design features that would shape the ultimate form and content of the Toolkit. These were not simply narrow definitions of website design, but referred to a broader set of considerations they felt would be necessary in creating a focus as well as setting boundaries on their very ambitious task.

We include a description of these original, core design features here for several purposes. First of all, these features help illustrate the purposes, goals and underlying rationales of the Toolkit project. Second, they set the direction for the development team, serving as major guideposts for critical decisions made along the way. At the same time, knowledge of these central, defining design features serves as the backdrop to a fuller understanding of the kinds of design issues and challenges that emerged as the Toolkit experiment progressed and which we will describe in some detail later in this report. In what follows we describe what we inferred to be the major underlying design principles that were set to guide the development of the Toolkit:

- **The Toolkit should focus on providing tools created, gathered, and grounded in the realties of the field.** The MARS Toolkit team was very committed to providing tools that addressed especially the challenges or hurdles faced by those in the field. In other words the MARS developers aimed to find tools that would help with the common problems faced by math improvement agents in the field.

- **The target audience for the Toolkit should be the most active members of the national mathematics improvement community.** The improvement community consists of people at various levels and in various roles: some are at the state level, some at the district level, some are teachers and administrators at schools, and even parents might be interested. But the goal for the Toolkit would be to serve each of these sub-groups, whose individual members scattered across the nation might well be alone and isolated in their work, and in need of the kind of technical and intellectual support the Toolkit proposed to offer.

- **The Toolkit should be designed using the following format – "Challenges/Barriers - Strategic Tools – Implementation Tools." The Toolkit was meant to be educative, setting tools in the context of broader strategies and the challenges they might address, rather than merely a collection of tools.** The logic was to identify specific challenges change agents were likely to encounter, and then offer up strategies and tools which could help change agents address those challenges   In this way the development team envisioned a kind of scaffolding that would lead readers to the tools, and then help them understand the tools as mechanisms to support the implementation of broader improvement strategies.

  Roughly, the scaffolding was envisioned as a three step process and the Toolkit was structured into three main areas that were strongly linked to each other. First, there was the Challenges/Barriers section in which there were clear statements of a range of common problems and issues. Next, there was a section called Strategic Tools that provided broader strategies for dealing with a given problem which in and of themselves could be seen as tools; finally, there was a section called Implementation Tools which included the full array of tools that could be used to enact a strategy and resolve a challenge.

- **Even though it would have a wide audience and serve multiple purposes, the Toolkit should not attempt to be "all things for all people."** It became clear to the MARS team early on that the number of potential tools was very large. It also became clear that tools would take a considerable amount of effort to create and to work into the Toolkit format. Hence, there was no attempt to be comprehensive. The team planned to identify and then "vet" potential tool candidates for quality and utility. Most importantly, tools would be focused to address specific needs endemic to mathematics education reform. Moreover, tools would be selected on the basis of quality, potential utility and congruence with the NCTM standards.

- **The tool-kit should be web-based and the website's structure would provide multiple pathways to finding and accessing tools.** The website not only should contain tools, but it also should be more broadly educative about the processes of promoting improvement in mathematics education. The MARS team wanted change agents first of all to see there were multiple ways to approach a particular challenge, and that a particular tool or set of tools could be applicable to several different situations. They also wanted to illustrate strategic ideas, goals and tactics that might further the implementation of certain tools. Therefore, given this ambitious goal, they felt that they needed to provide a myriad of ways that a user could get to the Tools that interested them. Thus the team envisioned a tiered and linked matrix of web content pages that would allow users to both browse and learn, as well as to focus and target the information to their specific interest.

- **The "Toolkit for Change" should be ongoing, evolving, and have a permanent home.** Since it would be a website, a domain name needed to be purchased, and a website for the domain name would need to be set up on a permanent web server. In addition, some member of the team would need to be responsible for the technical development of this website and its future updating and maintenance.

- **Finally, the process of developing and refining the Toolkit should be iterative and reflect an engineering approach**. Given the ambitious nature of the design task they had set themselves, the sophisticated principles to which they wished to adhere, and the fact that they were producing the Toolkit as a website and not something more static, the MARS team knew that it was unlikely that they would "get it right the first time." Nor did they need to. The process of creating a website is inherently an iterative one, no matter the subject matter. But this became even more imperative with the demands of creating the structure and content of the Toolkit website. As a result, the team made an assumption that the work of producing the Toolkit would therefore be iterative in all aspects of its production. It would need to follow the basic principles of engineering: creation, testing, revision. They would produce content, revise it, publish it and get formative feedback and then respond to that feedback with more revisions and refinements. In turn this newly revised content would be refined and reformatted and more feedback sought.

II. THE CURRENT STATUS OF
THE MARS TOOLKIT FOR CHANGE

In the following section we describe what the MARS Toolkit for Change website looks like today. We also summarize the key findings from our change agents and expert reviewers to show how those contributed to the final version of the website. The current website not only reflects the major accomplishments of the project, but also holds implications for the broader potential of a web-based set of tools and resources for the mathematics improvement community.

The MARS Toolkit for Change Web Site

At the culmination of the five year development process the MARS team produced a website available to the public. This final MARS Toolkit for Change website uses a navigation model that assumes leaders in the field have specific challenges that they wish to address. In response, the website offers a series of strategies and implementation tools that work toward possible resolutions. The website is organized in to the following major categories which correspond to the main tabs shown horizontally across the website:

- Home
- Challenges/Barriers
- Strategic Tools
- Implementation Tools
- Search & A-Z Index

The core content of the MARS Toolkit resides in the Challenges/Barriers, Strategic Tools, and Implementation Tools pages. Within each of these three categories, main entry-point pages titles are listed under the major sub-categories of: Standards and Assessment, Curriculum, Diagnosis, Teaching, System, and Parents.

Below is a brief tour of the MARS Toolkit website. This website is available on the World Wide Web at the domain address www.toolkitforchange.org.

Home: Besides the Home page, there are 6 other pages of information (the links that appear in the left column) that cover important introductory topics such as how to get started using the Toolkit, a debrief on who the MARS team is, a Comments and Contributions page, Editorial Policy page, and a "Frequently Asked Questions" page.

The screen capture below displays the Home page.
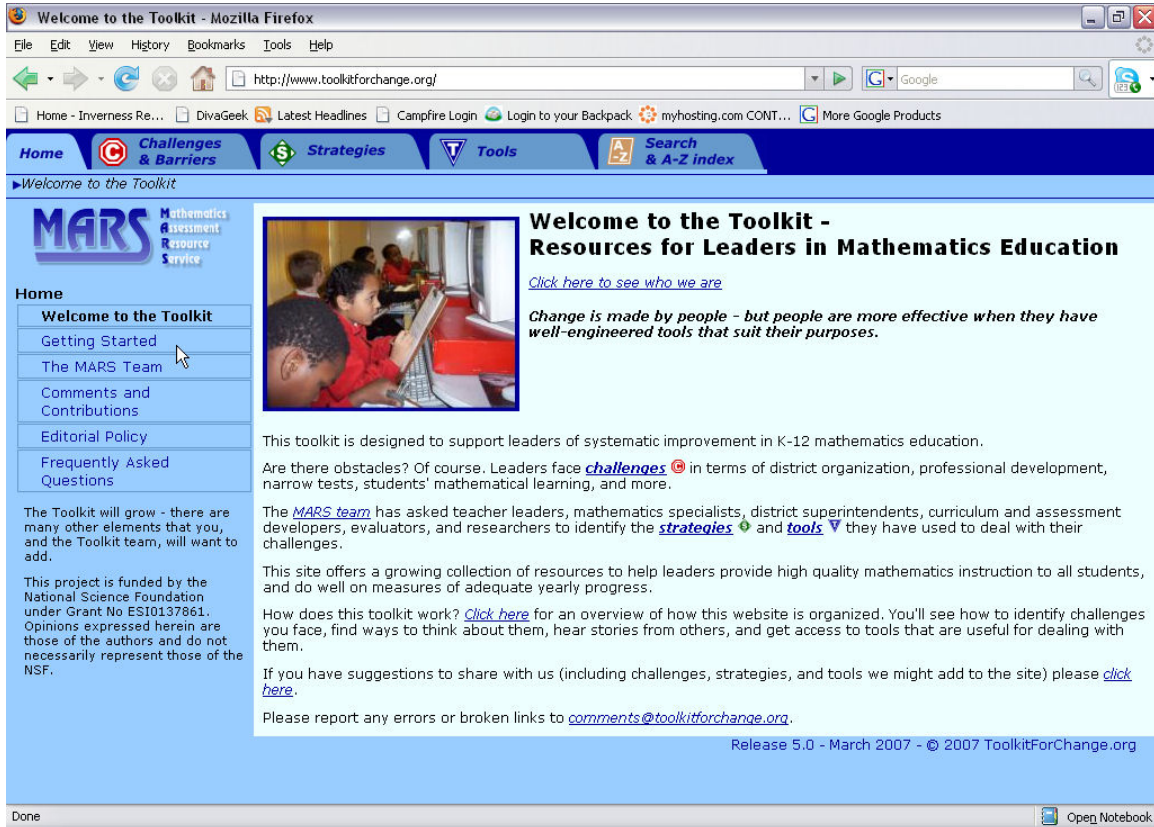
Challenges/Barriers: There are 27 separate pages of challenges and barriers faced by those who seek to improve mathematic learning. Each Challenge/Barrier title appears as a link.

The screen capture below is the Challenges/Barriers page.
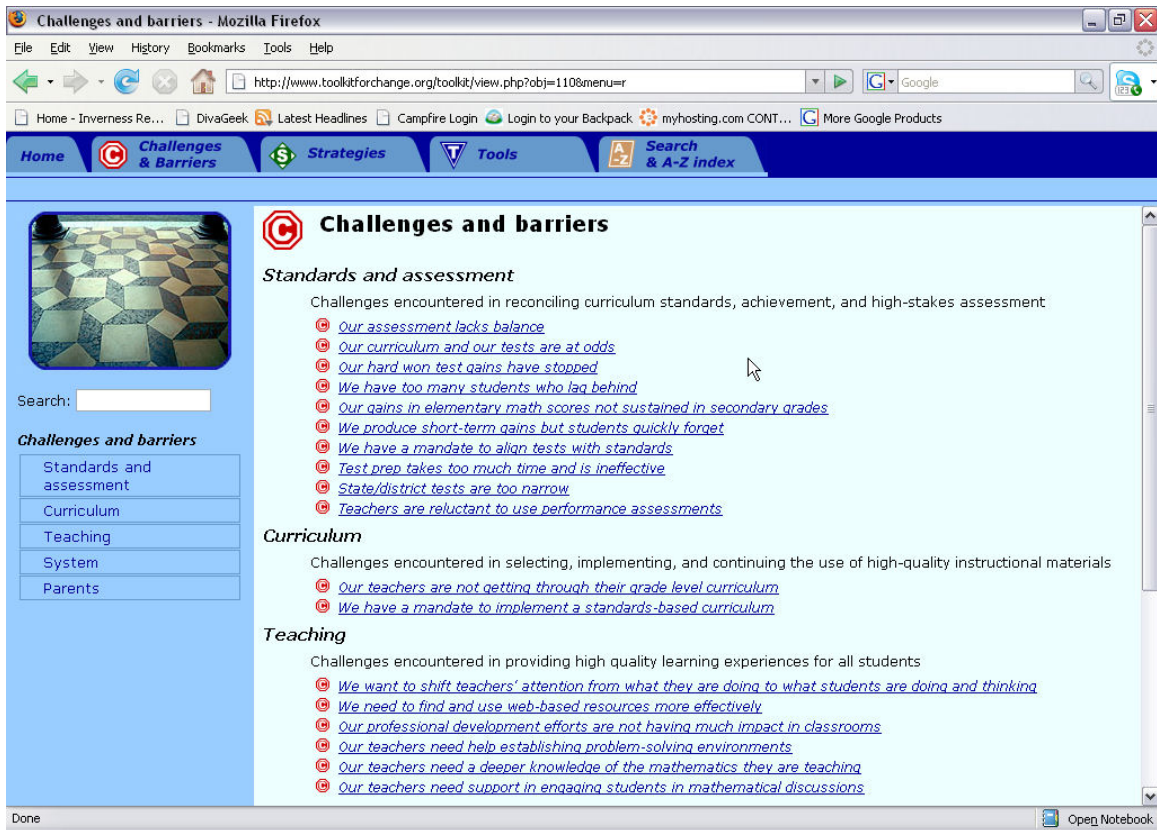
When the user clicks on the link they are shown the full text of the specific Challenge/Barrier title. Below is an example page of a specific Challenge/Barrier. Note that within the text there are certain Strategic Tools linked into this page; these are the Strategic Tools that support the specific Challenges/Barriers.

The screen capture below is an example of a specific Challenge/Barrier page.

Strategic Tools: There are 32 separate pages of Strategic Tools for different ways one might approach resolving the given Challenge or Barrier. Each Strategic Tools title appears as a link.

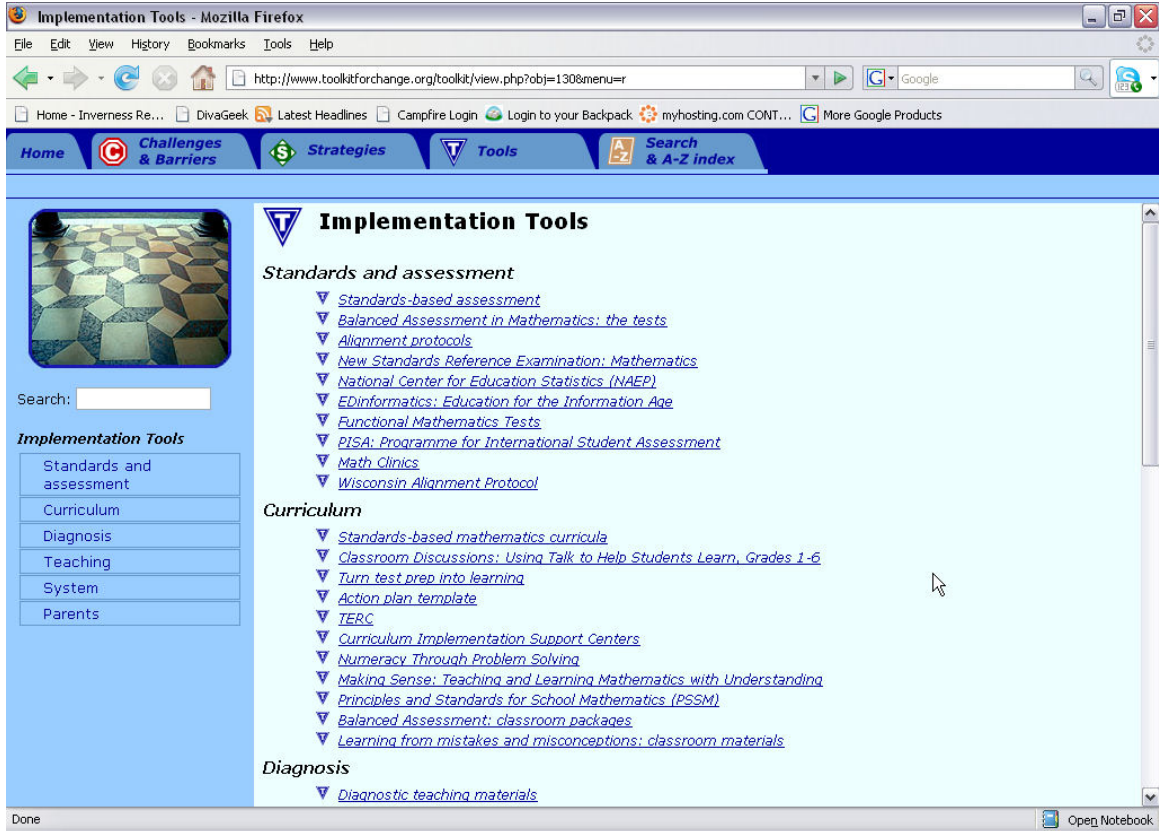*The screen capture below displays the Strategic Tools page.*
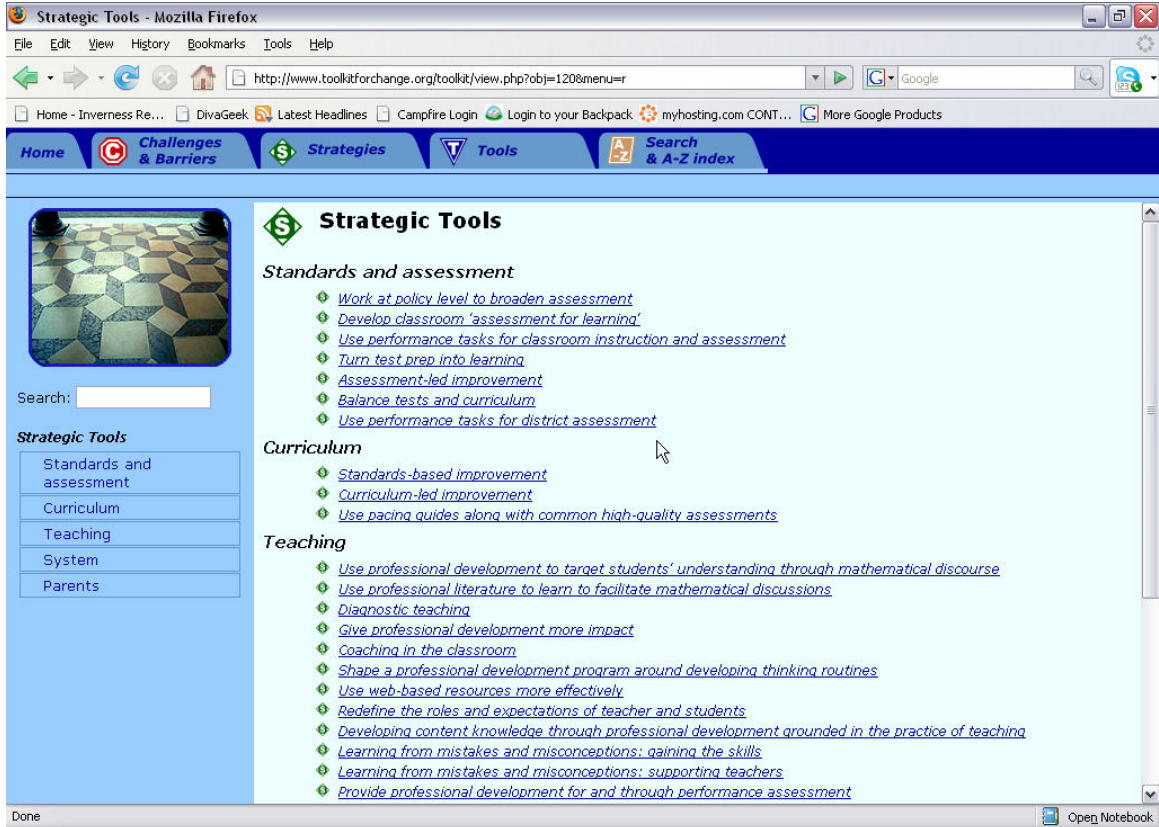
When the user clicks on the link they are shown the full text of the specific Strategic Tools title. Below is an example page of a specific Strategic Tool. Notice that within the text that there are certain Implementation Tools linked into this page. Sometimes Strategic Tools are also back-linked to the Challenges/Barriers that they support.

The screen capture below is an example of a specific Strategic Tools page.
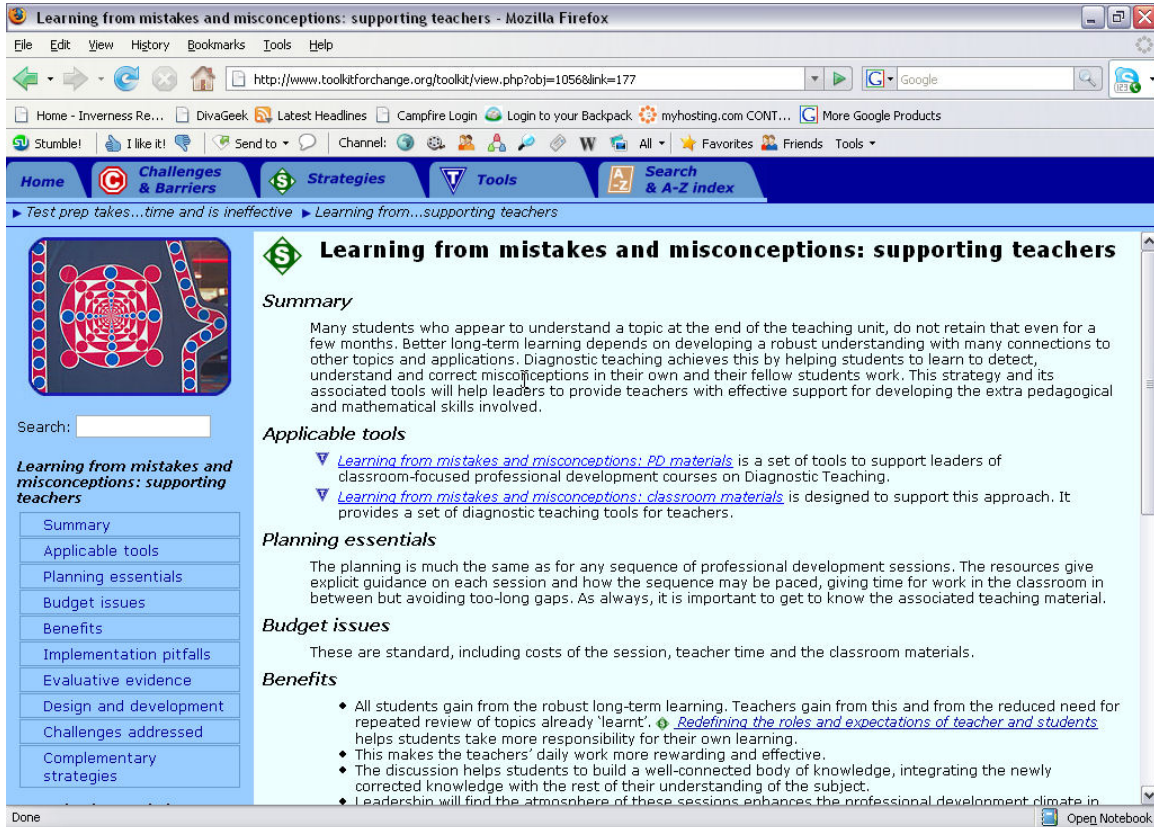
Implementation Tools: There are 53 separate pages of Implementation Tools that potentially address the given combination Challenges/Barriers and Strategic Tools. Each Implementation Tools title appears as a link.

The screen capture below displays the Implementation Tools page.

When the user clicks on the link they are shown the full text of the specific Implementation Tools title. Below is an example page of a specific Implementation Tool. Often Implementation Tools pages will also have a linked in Extended Report which the user may download (see lower left corner of screen capture). Sometimes Implementation Tools pages are also back-linked to the Strategic Tools and Challenges/Barriers that they support.

The screen capture below is an example of a specific Strategic Tools page.

Search/A-Z Index page: Though a Search text box is available on each page of the website, a more complete search function is available on this page that will search not only titles and key words but also all the text in every page of the site. There is also a useful A-Z Index of the entire website's content.

The screen capture below displays the Search and A-Z Index page.

Expert Reviewers' Key Findings that Informed the Toolkit Website

As we have already described, we at Inverness Research Associates convened panels of change agents and expert reviewers to judge both the utility and the value of the Toolkit website. We conducted our reviews at three separate intervals during the development process. The MARS team was sensitive to, and indeed hungry for, feedback from real users in the field. Because the development team's goal was to provide a resource for national leaders of mathematics improvement they wanted this resource—the MARS Toolkit website—to be as complete, up-to-date and useful as it could be for this community.

First and foremost the reviewers shared a keen interest in the *concept* of the Toolkit. All were intrigued that such a resource might offer a single, easily accessible repository for a wide range of tools that could benefit the field of mathematics improvement. And, true to an engineering approach, all three reviews made it clear that more clarification and work were needed on the streamlining of the website's navigation and on the content. It was also clear that progress was made between reviews, and that the "big idea" of a "Toolkit" was welcomed by reviewers as unique and very much needed within the community.

Specifically, some of the key response in terms of navigation and "ease of use" were the following:

- Reviewers reported that initial orientation was key. The home page and the introductory pages did not adequately provide enough of a frame for the Toolkit. They felt that these pages which all users encounter first required more information about the purpose of the website, who exactly the Toolkit team was, and how to best navigate the website as a beginner user.

- As they wandered through the website, orientation still remained an issue. Many reviewers noted a feeling of being 'lost' because they had somehow 'slipped' from a Strategic Tool to an Implementation Tool without knowing it. This actually frustrated many users because then they were not certain of where they were or if they had already gone over the same information.

- The need for clear and simple organization became apparent. In the major category pages of Challenges/Barriers, Strategic Tools and Implementation Tools, the panelists found long list of links very text heavy and hard to skim. Many reviewers also felt that these long lists would benefit by being broken up into logical categories.

In terms of the content and usefulness, our experts reported the following:

- Reviewers had varied opinions on the intended audience(s) for the Toolkit. Many were unsure who the audience was meant to be.

- For many of our experts the language and style of writing used for much of the Toolkit seemed too remote and "ivory-tower" academic. They preferred a more practical style and tone.

- Many reviewers resonated with using Challenges/Barriers to help ground them in their experience, but they connected less to the Strategic Tools that were offered, and tended to move through these pages quickly to advance to Implementation Tools.

- Many of the reviewers noted that they wanted more content, and more depth given to that content. In this sense it was difficult to have a partial or incomplete toolkit, as reviewers noted what was absent as much as what was present.

- Finally, many reviewers wanted more 'evidence' references, i.e., descriptions of who had used a specific Strategic Tool or Implementation Tool and what was their experience of using such a tool. They had a desire to know about the experience of other users in their field.

The Major Revisions That Were Made In Response to Reviews

Though some of the constructive feedback called for enormous amounts of revision work and re-structuring of the website, the MARS team attempted to address nearly all major issues raised by the expert reviewers. Here is a brief summary of the revisions to the Toolkit which appear in the final and current version of the website:

- The MARS team honed and sharpened the stated purpose which now appears prominently on the Home page. They expanded the "Who Are We" page to make authorship/ownership of the website clear.

- They developed a much-needed "Frequently Asked Questions" page.

- They streamlined the links found within each strand, narrowing the links down to a few that made sense instead of offering many varieties. In this area in particular, the reviewers helped the MARS team see that 'less is often more' in terms of website links.

- On each of the main category pages—Challenges/Barriers, Strategic Tools and Implementation Tools—the authors created sub-categories that were used throughout the site to organize the information consistently. These sub-categories made immediate sense to the reviewers who saw the version where they were incorporated.

- The MARS team brought a new level of polish to all the text in the website by re-working the titles, links and content to have a more consistent 'voice'. This improvement in the overall readability enhanced the website substantially.

In summary the MARS Toolkit team accomplished taking their basic concept from a beginning prototype to a live Toolkit website which today offers a substantial amount of information regarding mathematics improvement. The Toolkit was (and still remains) increasingly tailored to the change-agent audience in need of resources, information and tools relevant to the particular niche they fill. Moreover, the team used the feedback they received to engineer ever more successful, carefully crafted versions of the website. One of the expert panelists who was involved in reviews a year apart summed up this accomplishment well:

> *This was a truly helpful experience. I enjoyed the rich variety of information and tools that were given, and found a number of things that I had previously not been aware of and which I now intend to investigate further. This is exactly the kind of support and information that will be helpful to people in the field. The brief summaries were concise and to the point, and then the more complete PDF articles filled in the missing details without getting verbose… In contrast to my very first experience with the website about a year ago, I was impressed with both the specificity of what was given, and the practical nature of the tools suggested. I believe the developers of the website have done an excellent job of creating a clean, easy-to-navigate site that is user-friendly in every way, and addresses some real areas of concern for those of us seeking to bring about change in math education. While there are some areas of concern that I think would be good to address more explicitly, and some holes to fill in terms of strategies and tools, something solid and useful has been created here.*

III. OUR REFLECTIONS ON THE LESSONS LEARNED

The MARS Toolkit was a hugely ambitious project. The team started with nothing but a concept, and, as a group, a large bank of knowledge and experience in the field of mathematics improvement. They have now produced a well-organized web-based tool that offers a proof-of-concept and is still, as of the writing of this report, unique in the field.

Even more importantly, however, the development and engineering process itself gleaned a wealth of valuable lessons learned. We view the development of the Toolkit as an important, first experiment in how to provide support to a national community of mathematics education change agents. Within this view understanding the "journey"—including the issues and barriers encountered along the way, as well as the missteps and wrong turns taken during the course of figuring it all out—is as important as understanding the destination. We at Inverness Research observed and documented how the development of the MARS Toolkit unfolded. We offer in this section of the report our reflections on some of the most important lessons that can be drawn from the development process.

Lessons Learned About The Nature Of The Change-Agent Field

- **There is great variation in the field of mathematics education change agents, especially in terms of the range of their experience and expertise**. At the beginning of the project the MARS team had a sense of targeting the Toolkit for "change

agents." They soon discovered, however, that they could make almost no assumptions about the "typical" change agent. They did not find homogeneity, but rather they encountered a great range of expertise and experience within this community. For example, some of our expert reviewers knew many, even the majority, of the tools referenced in the Toolkit. In contrast other change agents often had only a patchy knowledge of them. Not surprisingly, those who were relatively new to the field of mathematics education improvement tended to be more impressed by the contents of the website, and those with much experience less so. The net result was that targeting an audience was much more challenging than MARS ever expected because the audience varied so greatly.

- **Individual users browsed the Toolkit extensively, instead of adhering to the diagnostic process the website developers used to structure the website.** Initially, as we have described, the Toolkit for Change website was designed to be used in a diagnostic fashion – proceeding from challenge to strategy to tool. However, users tended to use it in a far less structured fashion. They preferred browsing. They looked for things that would catch their interest and attention, often encountering things along the way which they found that were novel, of potential use to them, or that excited them. Even if they came to the website with a specific target in mind, they did not necessarily use the diagnostic Challenges/Barriers and prescriptive Strategic Tools as they were intended, but tended to move through the website in a more random and individual fashion.

  Hence, the issue of how structured or un-structured the web-based Toolkit ought to be remained an open question. Should the website attempt to guide users along some pre-ordained routes, or should it simply facilitate more idiosyncratic usage? On the one hand the website and the organization of content within in it demanded some kind of structure; on the other hand, users seemed to demand multiple pathways through the site and a very open kind of structure.

- **The landscape of mathematics improvement changed rapidly during the years the MARS Toolkit was developed.** While mathematics education has never been a particularly placid field, the early 2000s saw volatile change such as the reaction to various education initiatives of the 1990s and the rise of "back-to-basics" grass-roots communities who began via parent advocacy groups and school board elections, to dictate or at least influence key aspects of mathematics teaching and learning in the schools. In addition, the impact of "No Child Left Behind," which was signed into law in 2002, was beginning to be felt at the district and school level. Thus, the MARS team garnered tools that stemmed from challenges that existed in a previous landscape. As these were developed the field changed, creating new challenges and issues the tools under development did not always address. It became almost impossible, given the slow and complicated development process, to "keep up with the field." On the other hand, the ever shifting landscape of mathematics education reform, reconfirmed for the MARS developers how important it was to do just that, to keep the Toolkit flexible and responsive to the field.

Lessons Learned About Design Issues and Challenges

- **First and foremost was the challenge of the complexity of the Toolkit endeavor.**
  The task of developing a web-based set of tools and support for mathematics
  education change agents began with much complexity, and grew rapidly into much
  greater complexity than originally anticipated. The task of developing a web-based
  toolkit proved to be much more difficult than originally anticipated, and, as the
  work of the project progressed, the development process uncovered a host of unseen
  issues and challenges.

  There are several factors that made the Toolkit endeavor so challenging. First the
  team attempted to produce something which had never been produced before. They
  tried to support an audience that was ill-defined, and whose needs were not well
  known. In addition they had to work in a medium with which they, as a group, had
  no previous experience. Moreover, the online medium to which they were
  newcomers began to change during the very time they were trying to develop and
  finalize their website. Finally, besides trying to find many useful and rich resources,
  the team also attempted to create material from scratch.

  In essence the MARS Toolkit team somewhat innocently believed they were taking
  on a large, but "do-able" project, to find themselves facing the proverbial many-
  headed Hydra of design challenges for which they did not really have the
  resources—either the people, the budget, or the time—they wished they would have
  had.

- **The challenge of defining the audience for the Toolkit and writing to this
  audience proved to be more difficult than anticipated.** Initially, the MARS team
  planned to divide and organize content based on user-roles, e.g., district math
  supervisor, school administrator, teacher, or parent, etc. It was thought that the user
  would first choose from a list the role that best described him or her, and then the
  content shown to them on the website would change according to this role
  definition. However, it soon became apparent that this model was unfeasible. First,
  there was great variation within specified audiences. Second, it required a very
  substantial commitment in content production and technical organization which far
  out-stripped the original concept, budget and "manpower" for the project. Instead,
  it was decided to narrow the focus of "change agents" to a District Math Coordinator
  and/or Supervisor.

  Nevertheless, even given this definition, the MARS team struggled to write for an
  audience that still had a wide-range of experience and expertise. Some reviewers of
  the Toolkit complained that the text and narratives of the toolkit appeared to be
  directed at multiple or unclear audiences. They said that many of the
  Challenges/Barriers and Strategic Tools pages seemed too vague and not specific
  enough to particular situations; they particularly desired that the material be

organized into grade bands. Though the MARS Toolkit team did manage to add this information to some web pages, it was not implemented through out the Toolkit.

- **The MARS team was challenged to define the overall scope and scale of the Toolkit.** Early on, the team was torn between very different alternatives. The developers struggled to define the Toolkit either as an illustrative prototype, or as a comprehensive, near complete set of tools. Not surprisingly the panel of experts reacted in much the same ways as the common reader of any website. The nature of the Internet, with websites full of large amounts of free information lead all users to naturally expect, and even demand, that any given website should be *the* definitive resource. When this does not happen and when the user does not locate something they expect to find, then the user is disappointed and vocal about it. As a result of the reviewers noting how small the set of tools seemed, it spurred the MARS Toolkit developers to pursue more content, to write more strands and to search out more Implementation Tools. Although they added significantly to the amount of content, it is nevertheless the case today that the final product represents only an illustrative Toolkit and not a comprehensive one. In hindsight, given the constraints of budget and time, it might have been more useful to have a clear initial goal of creating a Toolkit website that would be illuminative of what a "toolkit" might look like and what it might achieve.

- **Both finding and inventing content for the Toolkit website was difficult and time-consuming.** When the MARS Toolkit project began, it was inspired by tools already known to the team. Since members of the team are highly respected leaders within the mathematics improvement community, they were aware of good work and ideas others had done, as well as work that they had produced themselves. This initial set of tools, ideas, strategies served as a rich beginning, but nevertheless only a beginning.

  The MARS team knew they must find or create more content. Content is a critical part of any website. It is what attracts and keeps users engaged. Ironically, much like paper publications, no matter how attractive the visual design of the website is, it is ultimately the quality and quantity of content that makes for a compelling website. The team soon learned that it was difficult to import existing tools, as there were proprietary issues attached, as well as the need to extensively reformat them. Similarly, it was time consuming and challenging to create new tools. The MARS team found that it took very long amounts of time to track down, research and then write up a given strand thoroughly, much less submit it through their iterative editing process and then publish it to the website.

- **Issues of authority and selection were raised during the content development process. Thus another lesson learned involved the criteria for selecting tools, and the assignment of authority for their selection.** As we have mentioned, during the development phase of the Toolkit project the nature of the Internet underwent a metamorphosis. A growing phenomenon took place from 2004 onward in the Internet culture, known as "open source," which refers to the growth of a second generation of websites, those which are marked by having dynamic, shared content

and moving away from more static types of websites. For example, anyone can review and rate books at Amazon.com, or edit the open source encyclopedia, Wikipedia.org. As the "open source" model becomes more and more prevalent on the World Wide Web and users are exposed to it, a different sense of who is the "author" and who has "authority" to provide content also shifts and develops.

In contrast, however, the MARS team began with and later adhered to a more traditional approach. As authorities of long-standing in their respective areas of expertise they saw themselves as providing a pool of exemplary ideas residing in the Toolkit that would be useful to the field. Given their goal, the MARS team was inclined therefore to design a more controlled and less interactive model—though still hoping that users would contribute ideas, experience and resources. The tension between the two differing perspectives on expertise and authority made the content selection and design process even more thorny for the team than it already was.

- **Still another challenge revolving around the selection, presentation and writing of tools involved questions of tone and stance.** The MARS team faced the question of what editorial stance to take toward the tools—advocating some and not others or attempting to remain objective and neutral. Since the inspiration for the Toolkit was the team's knowledge pool of excellent tools, they began the project with a sense of advocacy. However, this stance opened the website to criticisms of being "ideological" or "political" in their choice and presentation of tools. As a result, in the first full version of the website, the MARS team did not make their advocacy stance clear, and the lack of its articulation bothered reviewers. Reviewers were then not sure why certain tools they were aware of were not found in the Toolkit. Was it because the authors did not know of these tools? Or was it because they disapproved of them? They wondered if the authors had an "agenda," but when they read the introduction pages of the website, they could discern none.

  Similarly, there was a tension between simplicity of content and tone, and wanting the Toolkit to provide an educative function, especially in the realm of the Strategic Tools, where the MARS team hoped to enlighten users as to how they might pursue more general improvement strategies (e.g., pursuing a curriculum or professional development led reform). They worried that people would use tools without understanding the broader context in which those tools would be successful.

  They wondered if they should just list all the tools with little to no comment, but that would then mean backing out of the richer more strategic descriptions they had done in the early phase of development. In addition the task to simply list "all" the tools was much harder than it initially appeared. These kinds of problems were made more complex by the mixed response of the reviewers. Some clearly wanted a large, comprehensive list, but still with the depth and breadth of strategic context the MARS team had provided certain tools. Other reviewers wanted nearly the opposite: a few, good, strong tools recommended by smart, experienced authors. Needless to say these questions of tone and stance were unavoidably mixed with issues of the political landscape of mathematics improvement, wherein the questions of advocacy *and* neutrality were likely to cause difficulty with at least some readers.

- **Keeping the website maintained with up-to-date content was a challenging job.**
  Any website faces the major challenge of keeping its content current and interesting.
  Much like its ancestor, the periodical, website authors need to constantly seek fresh
  sources and new information and parlay this into polished writing with useful links
  to related material. The MARS Toolkit for Change suffered in the reviewers' eyes by
  not being up-to-date with the current developments in mathematics improvement.
  Not only were some items "out of date", but other newer tools were seen to be
  absent. Repeat reviewers wanted to see what was new, and expected the site to be
  constantly offering new materials. But "keeping current" was particularly difficult
  because, as we discussed previously, this landscape had changed dramatically in a
  very short time during the early 2000s.

  There were also issues of how changes were decided upon and prepared for the
  Toolkit. The lack of a clear process sometimes resulted in a slow pace for making
  changes to the website. Due to the team's careful and iterative editing process, as
  well as the cyclical nature of the team's schedule of working on the Toolkit, changes
  were not always posted to the website in a timely manner, underscoring the
  challenge of keeping current.

- **The hoped for interaction between the Toolkit and the users proved difficult to
  achieve.** Though it had been hoped for the Toolkit to become a "node" within a
  mathematics improvement community, this largely did not occur. Nor was it
  specifically engineered. True interactivity would have required a wide readership
  with incentives and interest in responding to the content present in the Toolkit. It
  would have also required well designed mechanisms for interaction. Though the
  Toolkit did have a page titled "Comments and Contributions" (within the
  Home/Introduction section) where users were invited to email their comments or
  ideas for additional tools, it was rarely used.

  This design issue, like others we have just described, had its roots in one of the most
  fundamental design quandaries the MARS developers faced, namely settling on the
  scope, scale and functions of the Toolkit. If indeed the Toolkit was intended only as
  an illustrative example or prototype of a set of web-based tools, then interaction with
  users might not have been an intended result. On the other hand if the development
  of a full-fledged, participatory Toolkit was the goal, then greater interaction would
  have been a stronger element of the design effort.

IV. INVERNESS RESEARCH ASSOCIATES' SUMMARY THOUGHTS

In this final section of our report we situate the MARS Toolkit effort within the larger context of the mathematics education improvement landscape. This wider perspective enables us to see more clearly the benefits of the Toolkit and its development to the field it is intended to support.

When we look broadly and in retrospect at the Toolkit project we see the following:

1) It is very useful to identify, define and target the mathematics education improvement community. There is an important group of people working on the improvement of mathematics education that wants and needs support. All of our reviewers applauded the idea of a supportive website and a set of supportive tools developed specifically for this sector of the mathematics education field.

2) The engineering process the MARS development team used worked well. The iterative "design-feedback-redesign" cycle was particularly effective for the very difficult and complex challenge the team set itself to meet. Over the five years of its lifespan the project made good progress moving from concept to prototype to successive versions, with each step providing major improvements along the way.

3) In our opinion the MARS Toolkit for Change Agents was an experiment and not a full-blown development project. It was unrealistic to think that this project could develop a comprehensive set of tools that were well indexed and kept up to date. Most likely it would have been more profitable to think of the MARS Toolkit as a design research experiment from the start, but, ironically, part of the process of development was figuring out what the product was to be.

4) Individuals did use the website and found it to have some value. But it was clear to us that the same individuals would not continue to use the website as a resource in a repeated and ongoing fashion. This would only occur if a) there frequent and continuous updating and adding of new items, and/or b) there were greater opportunities for dialogue and discussion around the challenges, strategies and tools embedded in the design of the Toolkit website.

5) In the majority, those that used the Toolkit did so as individuals looking for resources that would enhance their independent work, and did so in a manner that was informal and unstructured. And even though much of the resources and information on the website is about strategic change for communities, the Toolkit remained a source for individuals and not communities.

6) Finally, the toolkit concept might well be modified and extended to include the idea of creating a virtual learning community. Rather than being seen simply as a stand-alone set of tools, the vision could be expanded. A community website, full of dialogue

and interaction, might well be greatly enhanced by the presence of "tools." The conjunction of the two ideas could be symbiotic. The use of the Toolkit by a community of mathematics education improvement agents could greatly enhance the usage as well as the updating of the tools in the toolkit; and the presence of tools could enrich and focus the interactions and dialogue that takes place on a the community website.

In summary, the MARS Toolkit served as an important step in developing and supporting what we call the improvement community that, in turn, supports mathematics education betterment. It was also an important step in conceptualizing the idea of "tools" for the change agents that work in the improvement community. Clearly the Internet is the logical place for such tools to be located, but it is also clear that designing a comprehensive web-based toolkit is a very ambitious, if worthy, task. We also think that the interaction of Challenges, Strategic Tools and Implementation Tools is a good concept, but one that requires interactive and dynamic treatment, not a static exposition. There is no doubt that the MARS Toolkit has value for individuals as a stand-alone resource. But we also believe that the Toolkit might have even more value when used as a node in a community, creating a resource-rich forum, as much as a repository of tools. Hence, we believe that the Toolkit produced by this project is an important prototype. It reaffirms the importance of the mathematics education improvement community and the potential of web-based tools in support of that community.