CHAPTER 20 — PLANNING FOR CHANGE

Introduction

Implementing the *Mathematics Standards* of the New Jersey State Department of Education's *Core Curriculum Content Standards* will require **consistent, long-term and widespread commitment to systemic change** on the part of districts and school communities.

Changing a district's approach to staff development, staffing, curriculum, and assessment is necessary but insufficient. Involving the representatives of various stakeholders in the community — parents, students, staff, board members, business and industry — is vital, but also insufficient. Restructuring the decision making practices of individual schools and across whole districts is crucial, but not enough. Improving the instructional practices of a few individual teachers, or even a school's entire instructional staff is only a beginning, not an end. Systemic change means changing every aspect of every school in every school system. It is not simply doing a better job at what we have always done; it requires that we redefine the nature of the system and institute whatever practices are deemed necessary to carry out that change.

This task may seem daunting, but it can be done. Recognizing that the teaching and learning of mathematics cannot be accomplished in a vacuum, that mathematics must be connected to other disciplines and to other aspects of the overall school systems holds the potential to make the present reform do what past efforts have failed to do: germinate, take root, flower, and seed again. Before us is an important opportunity we need to seize. Developing and then nurturing a new culture in all facets of the educational community and encouraging continuous self-reflective growth and renewal for all stakeholders is the very nexus of change.

There are several assumptions that have guided the development of this chapter. They are:

- Change is a process, not an event. It takes time and is on-going.

- Change is not linear. Change in one area can affect change in another, often as a catalyst and/or a model.

- Change is accomplished by individuals who react at different rates and in different ways and intensities to new and continuous challenges.

- Although the change process requires an initiator, leadership is provided by a variety of people within an educational community. The process however, cannot be person-dependent or it is bound for failure. There needs to be a respect for the existing organization and a plan to invite the appropriate stakeholders into the process at the onset.

- A culture must be created that values continuous learning, problem solving, reflection, and sharing of knowledge among staff, parents, and students.

A model representing systemic change as occurring along a continuum was designed by Beverly Anderson (1993). This model was adapted and then condensed into the following four stages:

1. **Awareness and exploration**
2. **Transition**
3. **Emergence of a new infrastructure**
4. **Predominance of the new system**

One way in which educators can become involved in systemic change is by employing Anderson's model as a framework to guide and develop an understanding of this complex process. In the four sections that follow, each stage is described. Anecdotal information and resources pertaining to each stage as well as suggestions for implementation are provided for each section. Although each of these stages is presented separately, it is important to keep in mind that change is a recursive process.

Following the discussion of the four stages in the change process, two additional important areas related to change are discussed. The first, professional development, is a primary vehicle for addressing change throughout all of the stages. In this section, the need for professional development is addressed, followed by a discussion of various formats appropriate for professional development activities and of the resources needed to provide these activities. The second section discusses some of the organizational issues that should be addressed by schools undergoing systemic change and provides examples of different types of school organization.

Stage 1 — Awareness and Exploration

Stakeholders become aware that the current system is "out of sync" at the beginning of the change process. As a result of the National Council of Teachers of Mathematics' *Curriculum and Evaluation Standards for School Mathematics,* the National Education Goals for the Year 2000, economic concerns, workforce requirements, and general public discussion, there is widespread recognition that current mathematics curricula and instruction are inadequate for the world of today and tomorrow. Thus there is an opportunity to promote change in the light of existing awareness by building consensus among the various stakeholders of the vision of what mathematics curriculum and instruction should be and what changes are needed to achieve that vision.

Creating a Vision

When any group contemplates organizational change, it is critical to have a collective understanding of what their present circumstances look like (inventory), as well as what they would like them to look like (vision). This comparative process helps name what their strengths, weaknesses, and needs are. The *New Jersey Mathematics Curriculum Framework* provides pertinent information that supports this process. The importance of reaching out to all persons comprising the school and district community cannot be minimized. Teachers, support staff, administrators, students, parents, and other neighborhood members must be involved. The diversity of experience represented by the whole group will make possible a broader vision, thus creating a richer base from which to work. This initiating process takes time and energy; it develops leadership perspective. When carried out with care and attention, it will form a comprehensive, informed basis for decision making and later evaluation. Theodore Sizer noted: "To pretend that serious restructuring can be done without honest confrontation is a cruel illusion" (1991, p. 34).

So how do we get input from stakeholders? Involving as many people as possible, in as many ways as possible, is an important credo for those involved with change. The final section of this chapter describes the roles of various stakeholders (parents, teachers, supervisors, school board members, administrators) in creating a climate for systemic change.

✓	*SUGGESTIONS*

✔ Schedule a variety of times when people can meet to share thoughts and feelings about what they want for their school in the area of mathematics education. These "town meetings" happen when cross sections of population convene to discuss their aspirations for the best possible educational outcomes for all students. A guest facilitator might help organize the discussion. Leaders of the meeting should listen without responding and should encourage deeper thinking. Careful notes should be made, preferably on chart paper so everyone can see what is written. Use the speaker's words rather than your personal understanding or clarification of what you think the speaker said. Perhaps you will want to videotape and then transcribe sections of the meeting. Share the collected information concerning the meetings.

✔ Invite adults and children to describe what their "dream" mathematics classroom would look like and what their role within it would be. Perhaps some will chose to draw their vision. Mount these drawings on school corridor walls creating a collage of visions. Invite additional sketches from all stakeholders in the process (artists' names are not required). Perhaps others might choose to represent their vision through other media. Form is not important. Rather, the collected "vision" becomes a focal point that turns us inward to be reflective and, in doing so, helps to extend our own vision.

✔ Attempt to involve parents through the Parent Teachers Association (PTA) or Organization (PTO). Create multiple opportunities for these important stakeholders to provide input concerning the vision. Brochures published by the New Jersey Mathematics Coalition or the National Council of Teachers of Mathematics[1] (NCTM) can be used to share what's happening in mathematics with parents. At a back-to-school night in one New Jersey school district, parents received a brochure designed by teachers to explain their mathematics program and how parents could become involved. The following vignette illustrates how involving parents might be effective.

Opening Doors: Parents and Teachers

A committee of middle school teachers prepared a presentation for parents which advocated the use of calculators in the classroom. The committee wanted to share an aspect of their vision and receive vital parental support concerning calculator use. The teachers used materials obtained at an institute on the High School Proficiency Test (HSPT). As a group, they had already developed a shared recognition about the power of the calculator as a tool in support of mathematical thinking. Many parents had never thought of calculators being appropriate for the support of problem-solving strategies and everyday mathematics. Through the use of hands-on activities and a subsequent debriefing session, a deeper understanding and a lively discussion between the parents and the teachers about the use of calculators ensued. A groundswell of parental support began and is still flourishing. On that night, a door was opened.

✔ Help to build and extend knowledge by circulating journal and newspaper articles that address the changes and are appropriate for non-educators. Outside sources do help to validate the perception that the vision is appropriate.

✔ A volunteer ad hoc committee, with representation from all sectors involved, should begin to draft a

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[1]For additional information about CBAM, contact the Association for Supervision and Curriculum Development (ASCD), Alexandria, VA 22314.

vision. This draft should be circulated, translated into the languages spoken by the parents when necessary, and reviewed by everyone. The committee should review all comments, make amendments and/or other editorial adjustments, and circulate another draft. This process should continue until everyone finds the document acceptable. A sense of ownership and personal involvement in the process ensures commitment to the efforts necessary to bringing these dreams to reality. The draft, a representation of the learning community's vision, should be finalized and posted with the understanding that it will be reviewed periodically and changed as necessary.

Making an Educational Inventory

The educational inventory should be conducted by as many people as possible. It should include not only the relevant topic areas to be considered but also some sort of scale on which to rate the degree to which the respondent feels the element is functioning. In creating an inventory it is critical to ascertain strengths, weaknesses, and needs. The results of the inventory should be communicated widely.

✓	*SUGGESTIONS*

✔ Generate questions for the inventory from general areas of interest as defined by the school community. These questions can be generated from brainstorming and then condensing the suggestions into a smaller list. Perhaps your community will choose to create clusters of ideas and inquiries on large sheets of paper. Whatever strategy you use to elicit response, it is important to first encourage and honor diverse responses that catalyze discussion, followed by organizing those ideas and inquiries into similar categories.

✔ Help the learning community define the present reality by having small groups generate survey and/or interview questions/statements about each topic area (e.g., mathematics curriculum, instructional techniques, assessment, parent attitudes and involvement, school climate, student attitudes towards mathematics, staff expectations).

✔ Compile and share responses to all questions/statements with the entire school community. The results of any data collection needs to be organized and interpreted. This work is best done in small groups and then shared upon completion with all participants in the process.

Identifying Gaps

Once an inventory of the present school status has been completed, the next step is to identify gaps between what is (the inventory) and what is desired (the vision). Categories need to be clearly identified which all stakeholders agree to be areas of concern and need. In addition, it is also critical to identify those areas that represent strengths. Being able to name what is done well enables the school to build on success.

✓	*SUGGESTIONS*

✔ Compile a list through brainstorming or clustering; then pare it down to a few clearly defined areas that should be addressed first. Keep the number of identified needs relatively small, however. If too many needs are identified, the task of addressing them may seem overwhelming, thus frustrating those involved and dooming the reform effort to failure. It may be decided that some areas will be addressed only at certain grade levels or grade spans initially, with plans to broaden the effort in subsequent years. The following vignette shows the results of one school's discussion.

Identifying Needs: Seeing the Big Picture

Members of one New Jersey school spent half a day reviewing information gathered through a variety of sources. They proceeded to reorganize twenty brainstormed items into five general statements that articulated their needs.

We need:

1. Reading experiences in mathematical contexts.

2. Assessments which don't rely on multiple choice questions or single, exact answers.

3. Flexible daily time commitments to allow for intense mathematical experiences.

4. Opportunities for collaborative, collegial planning.

5. Regular parental involvement in support of children's understanding mathematical concepts.

Exploring Paths

Although it is tempting to settle quickly on an easily available solution, extensive, open-minded exploration is necessary because change is a complex process. The way to attain the vision is rarely by traveling the easiest path.

✔	*SUGGESTIONS*

✔   Arrange for small teams of people to begin to research innovations, practices, and programs pertinent to their topics. This may involve literature searches, conversations among colleagues, or requests to publishers. Each team should circulate key articles or other sources of information they have identified with other stakeholders.

✔   Arrange for visits to classrooms within the school and district to observe other professionals implementing new instructional techniques. Some teachers choose to forge ahead, experimenting with techniques and strategies that others might find threatening. Support and input from peers can encourage and sustain change models as they emerge. In addition, these teachers' experiences serve as a resource for the school and district.

✔   Arrange for visits to exemplary classrooms outside the district to allow for on-site access to quality program implementation. Such visits create opportunities for questioning other teachers or educators as to how their programs evolved, what reactions from others they have experienced, how they perceive children have benefited from the program, what activities are in place to support and sustain the effort, what might be done differently, and what real changes have taken root.

✔   Assign teams to select the most favorable means of addressing needs and to share their recommendations with the larger group. The paths sought should represent a consensus of the involved staff and other stakeholders. If a team learns of serious concerns from other stakeholders relative to its findings, additional input should be sought and a resolution forged. Consensus is a decision-making model, which when applied properly results in a win-win situation for all parties. Unlike majority rule

(when one group is the absolute victor and the other group submits until the next opportunity to block the majority presents itself) or compromise (when both groups relinquish parts of their chosen positions), consensus allows everyone to support, or at least be able to live with, an outcome. Much discussion is required, and everyone's concerns must be addressed. No one may abstain from participation. Each member of the group is required to share his or her understanding in confirmation or challenge and present real issues to which all can respond. These interactions should bring about modifications to which all can subscribe. All decisions need not be made through consensus, but for those decisions where there needs to be long-lasting support, consensus is the preferred way.

✔ Write a plan that articulates the strategies, activities, individual or group responsibilities, timelines, evaluation or assessment methodologies, and monies required. Teams should be aware that this plan represents the best thought of the moment; as the vision is implemented, the plan will continue to be monitored and revised.

✔ Secure the approval of the plan by the school, district, or board of education. Commitment of resources sends a clear message that there is commitment to implementing the plan.

Developing Shared Responsibility

Understanding change in mathematics education is predicated upon developing a common vocabulary and a clear picture of what effective mathematics instruction looks like in the classroom. Developing a sense of shared responsibility in every person involved in the change process is an important and necessary part of the process. By creating opportunities for people to meet and hear about all of the activities that are taking place, everyone comes to understand what the change process looks like. As a result, all become an integral part of the process.

✓	*SUGGESTIONS*

✔ Provide opportunities for leaders to convey information about effective mathematics instruction through modeling, discussion, both informal and formal, and research sharing.

✔ Develop and support an atmosphere of consensus, trust, and care in order to build and extend leadership.

✔ Provide professional development experiences in mathematics, team building, collaboration, and the process of decision-making.

Stage 2 — Transition

As the change process continues, resources are committed and the staff attempts new approaches toward consensus. The explorations of key stakeholders become the basis for decision making, and a willingness to risk change emerges. Success depends on building support for these changes.

Building Support for Change

James Joyce wrote, "A man's errors are the portals of discovery." So it is with the change process. Those involved with change experience the dynamic flux between knowing and coming to know. Along that continuum are doorways that sometimes are stumbled upon and at other times are sought with certainty. The paths to and from such portals can be taxing, exhilarating, calming, and/or frightening. Building support for the changes being created and for the change agents becomes essential. Publicizing the vision through a variety of media is important. However, at the heart of building support for change is understanding the effect the change process has on individuals so that a program of support can be created.
The Concerns-based Adoption Model (CBAM — Hall, Wallace, Dosset, 1973)[2] is an empirically based conceptual framework that describes seven stages individuals pass through as they implement a new innovation. In CBAM, the stages of concern are identified as: awareness, informational, personal, management, consequence, collaboration, and refocusing. The seven stages are defined and suggestions are provided in the chart below.

Teachers will move from a focus on self to a focus on the task at hand and finally to the impact of the changes. It is important to support staff in transition with patience and reassurance while maintaining an awareness of what works well at each stage.

Stages of Concern from the Concerns-Based Adoption Model

Stages of Concern and Definitions	Suggestions
Awareness: Some concern about or involvement with the innovation is indicated.	Share enough information to spark interest but not so much as to overwhelm. People need to know that the results of the change are not known and that it is acceptable, appropriate, and necessary to question.
Informational: A general awareness of the innovation and interest in learning more details about it is indicated. Teachers are interested in substantive aspects of the innovation such as: general characteristics, effects, and requirements for use.	Provide clear, concise and accurate descriptions of the planned change. Communicate with large and small groups orally and in writing. Encourage visitations to other classrooms and schools. Compare and contrast what is presently being done with the proposed innovation. Most of all, be enthusiastic and publicize the enthusiasm of others.

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[2]For additional information, contact the Association for Supervision and Curriculum Development, Alexandria, VA 22314.

Personal: The focus is on teachers' concerns about the demands of the innovation affecting them personally or professionally.

Reinforce and encourage one-to-one exchange. Encourage even small increments of change. Suggest that those at this stage talk to others whose concerns have diminished and who can be supportive.

Management: The focus is on mechanics of using the innovation. Issues related to efficiency, organizing, managing, scheduling, and time demands are critical.

Further clarify the change and address the small "how to" issues. Suggest concrete solutions to the everyday problems. Attend to the here-and-now.

Consequence: The focus is on the impact of the plan on students. The plan should be re-evaluated for relevancy and success in meeting predicted student outcomes. Any needed adjustments should be made.

Provide opportunities for those at this stage to observe students in other settings using the changes successfully.

Collaboration: The focus here is on coordination of efforts in cooperation with other staff regarding the uses of the innovation.

Bring together those at this stage so that they may develop skills and strategies collaboratively; encourage those further along to interact with beginners to foster mentor relationships.

Refocusing: The focus is on the exploration of benefits from further fine-tuning of the plan by means of substitutions, deletions, or new alternatives which may be introduced in order to achieve greater results.

Encourage initiatives to find better ways. Help those at this stage to access resources that can help them refine their ideas and questions. Be ready to accept suggestions that continue the change process.

Vignette — Supporting Change by Encouraging New Voices: The Circular Process

The following vignette shows what the CBAM model looks like in real life.

At a New Jersey elementary school, the principal and representative teachers from grades K-5 met regularly as the curriculum committee. As a result of reviewing and discussing the *Mathematics Standards* and the *New Jersey Mathematics Curriculum Framework*, this group of educators had been sharing research about how children learn and instructional practices that foster learning. They were excited about what they had discovered and wished to bring about change in the way teachers taught mathematics at their school. They were convinced that past practices needed to change in order to enable all of the students to meet the challenges that the new century would bring. At the same time, they were faced with planning how to best share their enthusiasm and expertise in order to convince other members of the faculty and community to contribute and be part of the change. Having read the *New Jersey Mathematics Curriculum Framework*, they decided to use CBAM as a guide to help them create appropriate activities.

Awareness: Within their respective grade levels, the members of the committee talked informally with colleagues about the *Mathematics Standards* and the *Framework*. They summarized what they had discovered in the literature and sought to discover the levels of understanding commonly shared by the teachers and parents. No push was made to "convert" anyone to their way of thinking. The intent was to

make teachers and parents aware of the existence of the *Mathematics Standards* and the *Framework* and the fact that they promoted alternative methods of instruction.

Informational: Having gotten the attention of many teachers, they held meetings with small groups across grade levels and provided more substantive examples of why children learn and retain more by constructing their own understanding. They showed videos of teachers conducting classes where small cooperative groups were at work with interesting problems and a variety of manipulative materials. They invited peers to observe their classrooms and offered to conduct model lessons. They encouraged questioning and were candid in their responses. Similar activities took place at parent/teacher meetings.

Personal: The curriculum committee actively sought out comments from teachers and parents. They held brainstorming sessions of 8-10 people at a time to get their ideas about the strengths and shortcomings of the mathematics program. At the same time, they conducted a survey of parents, teachers, and students to ascertain their beliefs, feelings, values, and conceptions of mathematics. The committee members analyzed the responses and prepared materials and workshops to address the fear, lack of confidence, and misconceptions that had emerged, while continuing the informational campaign.

Management: As teachers continued to observe and request demonstration lessons, they became more attuned to the day-to-day benefits and challenges of this new mode of instruction. Professional development increased as the need for outside assistance emerged. The principal participated in most of these activities. The participants engaged in heated discussions about different aspects of this approach and learned to share and respect their collective expertise. The curriculum committee invited all staff members to bring their concerns about implementation to the meetings. No one was overlooked.

Consequence: Teachers began to implement change at varying levels with different instructional practices in their classrooms. They used a variety of assessment instruments and strategies to evaluate the impact of these new approaches on their students. They maintained daily logs that reflected not only their activities and strategies but also their feelings about the relative success of their efforts. They were becoming reflective and analytical about themselves and their students' progress.

Collaboration: Teachers began to observe each others' classrooms on a regular basis and to confer about their progress, as well as the progress of their students. Regular planning periods were now built into daily schedules, and teachers often found that they met outside of this provided time as well. A library of activities and resources had been established for teachers in the building. In addition, a special section was created that included materials for parents to use at home. Teachers regularly sent home notices inviting parents to extend activities that were begun but could not be completed in class. A newsletter, initiated by the curriculum committee, had specialty columns addressing research, ideas for parents, cross-curricular explorations, and challenges for students. Teachers and the principal worked to write grants. As a result of their efforts, enriched opportunity for conference attendance, post-graduate work, curriculum writing, and the integration of math and science occurred; the art teacher shared ideas which were included in the math curriculum, as did the music and physical education teachers.

Refocusing: New voices were heard from teachers and parents expressing interest in participating actively as leaders in the curriculum process. The innovative teaching experiences and positive student outcomes caused them to think about the process. As a result, they desired greater input. Now they have taken leadership roles in the change process. The curriculum process has come full circle.

Fostering Communication and Administrative Support

Long-term support of change is crucial to success. Careful planning is needed so that adequate resources, professional development, planning time, and expert help are available. In addition, during this transition stage, it may be necessary to modify or suspend some district policies that might be inconsistent with the desired changes.

✓	*SUGGESTIONS*

✔ *Arrange time so that collaboration among teachers is possible.* Organize the schedules so that some teachers have the same preparation period or find some other common time within the schedule. Organize departmental sharing sessions where various members of the department present what they are doing and lead discussions with their peers. Consider the stages of concern (CBAM) in planning appropriate activities. Logistical problems in scheduling such as those illustrated in the following vignette can be overcome if staff and administrators are committed to making change. (See the section on school organization later in this chapter.)

Scheduling Sharing Sessions

In one high school, departments rotate out-of-classroom duties so that each department has a block of time during parts of the year to meet. Another high school includes staff from other departments in their sharing sessions to promote interdisciplinary work. In another district, the school day was expanded through contract negotiations to provide time for teacher communication about teaching ideas.

✔ *Utilize peer support or coaching, as in the following vignette.* By encouraging a mechanism for teachers to help each other, administrators express respect and support for the practitioner, and thereby help create a climate that values innovation and collaboration.

The Consulting Teacher

One district identified consulting teachers to provide peer support. The consulting teacher (CT) is not an administrator, supervisor, or department head, and has no evaluative responsibilities. The CT teaches a reduced load and uses the gained time to work with colleagues in a non-threatening manner on a variety of professional development topics. The job description defines the responsibilities of the CT as follows: "To work collaboratively with all other consulting teachers and district directors to facilitate the use of varied instructional strategies in subject area classrooms; act as a consultant to department administrators in the areas of budget, curriculum, textbooks, and in final examinations."

✔ *Create opportunities for administrators and supervisors to become knowledgeable about the changes.* This means that they need to attend and actively participate in staff development activities. Changing behaviors is difficult, yet when attempted by administrators will communicate their commitment. For example, an administrator who used to exclusively lecture during staff meetings, now applies what she has learned and uses a variety of other methods to convey and explore information,

ideas, and questions, thereby demonstrating a commitment through action.

✔ *Create opportunities where necessary.* Coach administrators, particularly at the school level, to encourage risk taking and be open to suggestions. Implementation of the *Mathematics Standards* requires empowered professionals. This means that principals need to be ready to share their decision-making responsibility. Specific staff development activities should focus on the changing role of the supervisor and principal, including skills such as consensus building and conflict resolution.

✔ *Organize cross-grade meetings to encourage and support continuous communication between grade levels and schools.*

Providing Appropriate Staff Development

As the transition stage continues, staff development becomes more intensive and focused. At this stage, when changes are being piloted by selected schools, teachers and administrators are the primary groups that should be involved in initiating, planning, and participating in staff development activities. Some mechanism should be developed to communicate information about the activities to non-participating teachers and administrators. (See the section later in this chapter on professional development.)

✓	*SUGGESTIONS*

✔ *Provide a professional growth activity at each departmental and grade level meeting.* The following vignette illustrates this strategy.

Making Connections with the *Standards*

One department chairperson developed a list of examples of connections within mathematics, including:

> fractions .... probability
> functions .... geometric transformations
> multiplication of mixed numbers .... areas of rectangles
> midpoint in coordinate geometry .... averages
> division by zero .... slope

The list became the discussion point in a department meeting, with teachers sharing some examples of what they had already done. The chairperson began by sharing a lesson she had taught. For several subsequent meetings, the first fifteen minutes was devoted to someone sharing a lesson illustrating connections.

✔ *Schedule workshops so that adequate time and support are available for the sessions and for follow-up activities.* Brief after-school or part-day sessions are least effective (Browyer, Ponzio, Lundholm, 1987). Multiday sessions are best to introduce new teaching strategies and curriculum; follow-up sessions can be shorter.

✔ *Encourage participants in staff development activities to keep a log where they write about their experiences.* People write in order to make discoveries (Murray, 1992), and by using this tool they can make new sense and understand more fully what they have experienced. This reflection is as important to the adult learner as it is to the child.

✔ *Provide opportunities to attend out-of-district conferences, seminars, and meetings.* The vignette shows how one district used this strategy. Those who attend should have the responsibility to communicate to the rest of the staff what they have learned.

✔ *Support alternative mentorship opportunities.* Teachers benefit from observing the craft of others in the classroom. Learning to work cooperatively as adults supports similar efforts with children as well as efforts in site-based planning and decision making. Efforts should be made to arrange observations and classroom demonstrations to include parents and administrators whenever possible.

Developing Support Groups

One district encouraged teachers to sign up in pairs for workshops. They completed homework assignments together, provided each other cognitive coaching, observed each other's lessons, and videotaped their lessons for collaborative review. This laid the groundwork for continued professional peer support in a non-threatening and honest environment. Ideas could be shared while both developed and enhanced their teaching strategies and classroom environments.

Stage 3 — Emergence of the New Infrastructure

By the time a school and district have reached this stage in its change cycle, many critical issues have already been addressed. Stakeholders are aware of strengths and weaknesses; a vision has been forged and a set of shared values has emerged; priorities have been set and solution strategies have been pilot-tested. However, it is still important to remember that change takes time and that it progresses at an uneven level of development for the participants. Keys to bridging the next step in this process are found in the ability of people to decide upon the structures necessary to reach their goals; an environment that nurtures a willingness to acquire new skills and that provides needed resources; and the courage to shed those behaviors and beliefs that are inconsistent with the changes being introduced. Collaboration, respect for the contributions of all stakeholders in the educational community, commitment, and an atmosphere that allows shared risk-taking must all exist.

At this stage, stakeholders will no longer be asking *What Mathematics Standards?* Instead, they will be discussing how they have used the standards in their lessons, and sharing the ways in which they have invited children to solve *real* problems about *real* issues. Enthusiastic conversation about children's discoveries and understanding of mathematics concepts will be the talk in the staff room. Mathematics will be perceived more as an integral part of all subject areas and all teachers will expand their own understandings through collaboration and team teaching. The question then is how do we support and extend these efforts?

✓	*SUGGESTIONS*

✔ *Provide multiple opportunities for intensive staff development.* Instructional change in schools ultimately rests with classroom teachers. New mathematics programs should be enhanced by comprehensive, ongoing professional development. This education should be hands-on, experience-based, and conducted in cooperative groups. It should be supported by on-site coaching, available on a daily basis. Its focus should be both on content and pedagogy. Teachers should form study groups where discussions range from collaborative lesson planning and delivery of instruction to reflective inquiry of the learning and teaching processes. Through a commitment to action research, these study groups would serve to continuously inform the learning community.

✔ *Support alternative approaches to instruction.* Just as the traditional role of the teacher working alone, isolated in a classroom, must be challenged, so too must the traditional role of the student. We need to reconsider the model of the student working alone and competitively. Information and understanding are the collective responsibility and property of all who come to school to learn. We need to understand and employ a variety of approaches to help all students build a conceptual understanding of mathematics. We need to develop and extend our instructional repertoire to include: cooperative groups, student-centered classrooms, interdisciplinary studies, use of appropriate manipulative materials, ongoing opportunities for written and oral communication, challenging problems to be solved over extended periods of time, and encouragement of student questions. Additionally, teachers should, on occasion, work in pairs in the classroom, thus enriching the background brought to students and modeling the collaboration which is so critical to most learning situations.

✔ *Establish mentorships.* In addition to sharing strategies, knowledge and experience, a mentoring relationship among professional staff encourages heightened self-esteem and increased personal expectations. Formal, positive, collaborative peer support systems help to create meaningful and enduring professional growth. Although informal relationships evolve, because they are self-selective the benefits are limited. A more encompassing, well-designed network for both new and tenured teachers results in additional support for staff development and new instructional approaches. What does mentorship look like? It can be as simple as teachers visiting other teachers' classrooms, sharing their professional observations, and collaborating on ways to improve, extend, and enrich the art and craft of their teaching. Moreover, this collaborative spirit induces self-reflection and evaluation, as well as adaptation. The result: Better outcomes for students!

✔ *Encourage and organize visits from others outside the school or district.* Having established and embarked upon a well thought-out path, it is important to share your model with others who are just starting or who not yet involved in the change process. Think of how visits helped (or might have helped) you when first starting. Moreover, perspectives from those not involved in your innovation can be helpful in making evaluations of your progress.

✔ *Continue to learn with the community.* There is a continuous need to inform and engender support from the community outside of the school building. Parents in particular should be informed and involved in the changes that are taking place. They can and should provide encouragement to their children. Also, those who are implementing change need to continue to learn from parents. They can be resources and sounding boards regarding the progress, attitudes, values, and needs of their children.

✔ *Continue to communicate.* Providing updates of activities and reporting successful and less successful efforts allows participants in the change process to learn and to revise their plans in an iterative manner. It is essential to understand that no procedure is fail-safe; it can be expected that errors will occur. But progress and improvement will also be taking place. Communicating in an ongoing fashion and through various media is essential. When interested stakeholders feel left out of the "information pipeline," misconceptions and negative feelings about the change may develop. Public relations need to be attended to throughout all four stages of change.

✔ *Reduce stress.* Stress, anxiety, and strain are some of the by-products of innovation. In seeking to establish and understand our roles in the change process, stress is a natural outgrowth of the process. As we relinquish long held practices and beliefs, our credibility, trust, and professionalism may feel challenged, resulting in stress. Another source of stress is prolonged misunderstanding. Building a common vocabulary, assuring everyone's active participation, involving all in the decision-making process through committee representation and/or review helps to reduce the possibility of misunderstanding. Stress blocks the ability to think creatively, act positively, and behave rationally,

which in turn inhibits change.

✔ *Seek regular responses.* Periodically secure information that answers a few important questions. Students, staff, and parents should all be asked from time to time *How are we doing?*

✔ *Use ongoing assessment practices.* Through the use of traditional (tests, quizzes) and non-traditional (performance, authentic, anecdotal records, logs) assessments a picture of how the change has affected outcomes for students can be discerned. Consider asking children about their performance and how responsible they feel for their success or failure. Through anecdotal records and student and teacher logs, additional information can be added to refine the picture. The more ways you invest in seeing what effect the change has had on students' learning the better the analysis and revision you will be able to do.

Stage 4 — Predominance of the New System

After the district has made the commitment to a new way of operating, the next step is to solidify ownership of the change among all stakeholders: the parents, the school board, the teachers, other staff, and when appropriate, the students. Ownership implies more than acceptance and compliance. Rather, ownership is the result of each person making the new system his or her own.

In the last stage of the model, change becomes institutionalized. The system is predominant. Because continuous learning and change have become integral parts of the school and district culture, rethinking, innovation, and willingness to take risks are second nature to the staff.

Many of the same strategies that have been used at other stages are appropriate here. Particularly important are efforts that encourage the staff to reexamine parts of the system in light of the changes that have been made. In particular, the new system needs to match the vision. This happens naturally since perspectives have changed; incongruous elements of the system are immediately obvious. What strategies can we use to help staff reexamine parts of the system and to continue shaping reality to match the vision?

✔	*SUGGESTIONS*

✔ *Reexamine staff supervision.* In small groups, the staff should examine the processes and procedures for staff supervision to ensure consonance with changes. It is easy to slip back into old behaviors if support mechanisms are not maintained. For example, if cooperative learning has become the norm, the supervision process should focus on strengthening teacher skills in collaboration and group processes.

✔ *Reexamine assessment practices.* The assessment changes which began earlier should now be led by the teachers, as in the following vignette. Students and parents should also be actively involved.

Reversals

At a grade-level meeting in one school, teachers agreed to use reversals of traditional problems each day as a way of better assessing student understanding. The following are some examples generated by the teachers:

- Instead of asking *What is the probability of a four when one die is tossed?*, students were asked to describe an event for which the probability would be 1/6.
- Instead of simplifying 22/33, students were asked to write four fractions that simplify to 2/3.
- Instead of asking for the average of three numbers, students were asked to write four sets of numbers, three in each set, with a given average.

✔ *Reexamine incentive systems.* A system of incentives should be designed to reward desired behaviors and change without penalizing undesired behaviors.

✔ *Reexamine staff development.* Teachers should meet to design staff development activities they need. The principal should provide less direction and more support to teacher initiatives.

✔ *Reexamine ways to rekindle enthusiasm.* In order to maintain, nurture, and extend the change, ways of sharing and recognizing success need to continue and be varied. Activities like the contest described below can be used to spark enthusiasm.

Staff Problem Solving Contest

In one K-8 district, the staff was given a challenging problem to solve and then asked to explain their solution. Teachers worked in teams to discuss the problem and how they would present their solution. Each member of a team that presented their solution received a prize.

✔ *Reexamine board of education involvement.* Members of the board of education should meet regularly with staff to analyze and improve components of the system. They should visit schools to see innovations in action. Their involvement should result in budget decisions that reflect new understanding.

✔ *Reexamine facilities.* Changes in facilities through renovation and construction should occur in concert with needs that emerge during the change process.

✔ *Reexamine hiring criteria for professional employment.* Criteria for hiring administrators and staff should be redesigned in light of the new system. Content specialists should be involved in hiring new teachers. New staff members need to be acculturated by existing staff members using a teacher- designed process.

Personnel Choices

In one district, the interview questions asked of candidates changed in light of the *Mathematics Standards*. Now candidates are asked questions like:

- What are some connections between mathematics topics that you might emphasize in your classroom?

- How is mathematical knowledge assessed?

- In your classroom, would a student be more like a sponge or a construction worker? Illustrate your answer.

- How would students participate in your class? Orally? In writing? In groups?

- As a teacher, do you consider yourself more of a dispenser of knowledge or a facilitator? Explain.

The expectation is that by this last stage the staff has reached a state of mind that provides self-generated and mutually supported change:

> "We now understand that the only way we can ensure our own growth is by helping others to grow; the only way to maximize our own potential is by helping others to improve little by little, day by day" (Bonstingl, 1992, p. 5).

Professional Development

In the preceding sections of this chapter, a process for systemic change has been illustrated, focusing on improving mathematics teaching and learning. It is evident from this discussion that, in order for mathematics learning to improve, mathematics teaching must change. These changes require substantial investments of time, energy, and support. Professional development, affecting the beliefs, attitudes, knowledge, and practices of teachers in the school, is central to achieving this change. In order for the vision described in this *Framework* to become a reality, it is critical that professional development activities focus on mathematics specifically. Generic staff development does not provide the understanding of content, of instructional techniques, and of critical issues in mathematics education that is needed by classroom teachers.

Throughout the earlier sections of this chapter, many professional development activities have been illustrated. In this section, after examining the characteristics of effective professional development programs, some of the different formats for professional development activities will be analyzed. This section will conclude with discussions of resource issues and responsibilities related to professional development.

Characteristics of Effective Professional Development Programs

Without carefully planned professional development programs, it is unlikely that the vision described in this *Framework* can be implemented. For example, integrated approaches to teaching mathematics require planning, curriculum development, design of appropriate assessment activities, ongoing planning, and revision during implementation; in addition, staff members need to have a knowledge base of the subject areas to be integrated with mathematics. Each of these activities involves professional development for the participants in them.

How can we ensure that this professional development is effective? Ten key principles have been identified from the research as being critical for the success of professional development programs in mathematics (Clarke, 1994).

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✓	*SUGGESTIONS*

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✔ *Address issues of concern and interest, largely (but not exclusively) identified by the teachers themselves, and involve a degree of choice for participants.* Teachers are more likely to respond positively to staff development if they are involved in determining its format and content. They should also have the opportunity to select among a variety of alternatives, since not all teachers have the same needs and interests.

✔ *Involve groups of teachers rather than individuals from a number of schools and enlist the support of the school and district administration, students, parents, and the broader school community.* When individual teachers are the only ones involved in a staff development activity, the likelihood that activity will have any real impact on the classroom is slight. Teams or groups of teachers can provide each other with the ongoing support needed to implement change in the classroom. The support and encouragement of the administration, students, and parents are vital for implementing and maintaining the innovations learned through professional development activities.

✔ *Recognize and address the many impediments to the professional growth of teachers, which exist at the individual, school, and district levels.* Unless professional development activities take into account and specifically address some of the barriers to change, they are unlikely to have any lasting effect. Some of the more important areas to consider include providing for administrative support, funding, and follow-up; taking into consideration site-specific differences among schools; ensuring that student assessment and teacher evaluation are consistent with the proposed changes; ensuring a common vision among all constituencies; and assuring that teachers see the proposed changes as practical and feasible. In addition, it is important that the activities emphasize and encourage professional growth rather than focus on correcting deficits. Professional development activities must also reflect the philosophy of teaching and learning that will be used in the classroom.

✔ *Use teachers as participants in classroom activities or show students in real situations to model desired classroom approaches.* Teachers prefer and learn more from active, hands-on sessions than from lecture-type presentations. Such sessions allow teachers to construct their own meanings for instructional approaches, incorporating them into their own view of teaching. Activities that show real students in real classrooms demonstrate the feasibility and effectiveness of an innovation.

✔ *Solicit teachers' conscious commitment to participate actively in the sessions and to undertake required readings and classroom tasks, appropriately adapted for their own classroom.* Two types of commitment are necessary: commitment to active participation and to the philosophy and approaches underlying the professional development activities. Teachers who are unwilling to make the commitments necessary for a particular professional development activity are not yet ready for that activity and are unlikely to benefit from it; they would be better served by a different activity, perhaps one more appropriate for an earlier stage of concern.

✔ *Recognize that changes in teachers' beliefs about teaching and learning are derived largely from classroom practice.* It is most likely that changes in instructional practice will take place only after teachers are able to validate these changes by observing them in practice in classrooms. It is thus critical that professional development provide for trying out new approaches and then discussing the results.

✔ *Allow time for planning, reflection, and feedback.* Teachers need to have opportunities to report successes and failures, to share their own experiences as they try out new approaches, and to discuss problems and solutions regarding individual students and new teaching approaches.

✔ *Enable participating teachers to gain a substantial degree of ownership by involving them in decision-making and by respecting their roles as true partners in the change process.* Having frequent meetings, allowing for individual choice, providing appropriate assistance from consultants, and establishing an ongoing program for professional development in mathematics are some of the ways in which ownership can be enhanced.

✔ *Recognize that change is a gradual, difficult, and often painful process, and provide opportunities for ongoing support from colleagues and critical friends.* Ongoing support is vital for systemic change. Some support is affective, such as recognition of changes in mathematics instruction as one of the school goals or encouragement from parents that they concur with the goals of the mathematics program. Other support is cognitive, such as help in working with cooperative groups or attending a workshop given by a consultant on discrete mathematics or fractal geometry.

✔ *Encourage participants to set further goals for their own professional growth.* Professional development should be regarded as a continuous process in which teachers constantly reflect on their own teaching and seek to improve it.

In planning for ongoing professional development, each of the preceding principles should be considered. Addressing every one of these areas increases the likelihood that professional development activities will result in the desired outcomes.

Types of Professional Development Activities

In the previous sections of this chapter, many different types of professional development activities have already been mentioned. These can be categorized in several different ways: individual, with a partner, or as part of a group; at the school, in the district, or outside the district; scheduled or not; with a presenter or with a facilitator. Each type of professional development activity has advantages and disadvantages and may or may not be appropriate for a given individual at a given stage in the change process.

One general type of professional development activity is the *inservice session.* These are scheduled times at which a group of teachers meet with a presenter to learn about a specific topic or approach. This may be a one-time workshop (relatively ineffective except to build awareness), a series of hands-on workshops focusing on a specific grade level (especially appropriate for those beginning to use an innovation), a conference (effective for novice and experienced users of an innovation), or a course (especially appropriate for those integrating an innovation into their everyday practices).

Similar to the *inservice session* is the *work group* or *discussion group.* These also are meetings held at scheduled times, perhaps with a facilitator. Some examples of these types of sessions include a town meeting held to discuss the school's vision of what a mathematics program should look like (Stage 1: Awareness), discussions of school needs (also Stage 1), groups that meet to discuss articles that they have read (Stage 1) or visits made to other schools (Stage 1 or 3), committees charged with developing a school vision (Stage 1), grade-level or department meetings at which instructional approaches are discussed
(Stage 2: Transition), and informal study groups such as the one described in the following vignette.

Starting a Study Group

In an elementary school, six K-3 teachers have met for the last school year on Wednesdays from 3:30 to 5:00 p.m. The teachers meet to discuss new trends in early education research, whole language, New Jersey's *Mathematics Standards*, and initiatives to create opportunities for their students to "do" mathematics and science.

"I found that making the change was a bit intimidating. I wasn't sure that the kids would learn," said Mr. Halloran. "So Carla and I decided to work together." After a bit of time, the two teachers were joined by two more of their colleagues, who later invited two additional teachers.

"It really helped to have Larry working with me. This year we were able to create thematic units of study that blended science and mathematics," reported Mrs. Garcia. "The students are really excited about learning how to investigate their world."

Some *work groups* take place outside the school or district. Some good examples of this are curriculum consortia such as the one in Cumberland County, math alliances which involve K-12 teachers and university or college faculty, committees of the New Jersey Mathematics Coalition or of the Association of Mathematics Teachers of New Jersey, or groups planning for special activities, such as Math, Science, and Technology Month. Still another type of *work group* is the professional development network being established by the New Jersey Statewide Systemic Initiative (NJ SSI).

Still another type of professional development activity provides individualized support for teachers as they implement new instructional approaches. Peer coaching and mentoring usually involve pairs or small groups of teachers working together in order to improve and/or refine their skills, understandings, and performance. Specifically, in peer coaching, teachers work with a colleague, whom they have selected, to achieve specific instructional goals through a process of regular observations and feedback. In a mentoring relationship, the teachers do not choose one another. Rather, a more experienced teacher is teamed with a lesser experienced teacher for the purpose of providing, improving, and/or refining specific instructional techniques and/or specific content. (See the earlier vignette about the consulting teacher.) In order for peer coaching and mentoring to succeed, teachers should receive training in the use of peer coaching and mentoring models, and time during the school day should be allotted for conferences and in-class observation of one another. The amount of time required for the initial seminar is from one to three days. Further, in order for mentoring to succeed, the roles of mentor and student need to be clearly developed, understood, and accepted.

Mentoring and Teacher Portfolios

To introduce the concept of portfolio assessment, a supervisor initiated the idea of an unofficial teacher portfolio. The teacher portfolio generated a positive attitude towards portfolio assessment and provided an opportunity for sharing instructional creativity. Three teachers were each asked individually to prepare a portfolio by selecting three examples of assessments they had used with students in the past quarter. They were encouraged to select assessments that typified life in their classrooms. They each wrote a paragraph describing each assessment and then explaining why they had selected it. The supervisor met with each of the teachers individually to give them feedback on their portfolio and then suggested that they might find it helpful to meet together to discuss their assessment strategies. The supervisor also sent a memo to other math teachers highlighting outstanding assessment examples. Some of the types of assessments that the teachers included were:

> Making up functions which exemplified properties learned
> Lab summary sheets that drew together concepts learned in various labs
> Creation of a test and answer key on a given topic
> Designing a physical model to illustrate the wrapping function in trig
> Lots of "explain how you would find ..." questions
> Student journals

Resources Needed for Professional Development

Many types of resources are needed to support professional development. Some of these are not difficult to provide, such as encouraging teachers to try new approaches or providing them with support to ease the stress often engendered by change. Others, such as providing a time and place for teachers to meet collaboratively or providing computers for teachers to use, require reallocating or expanding resources.

Providing time for reform is probably one of the most critical issues facing school districts. The desire to revise the mathematics program may be present, yet without adequate time for planning, staff development, and implementation, the impetus to actually make the reforms may not be generated. When districts are examining the use of time in order to advance reform of the mathematics program, they need to decide:

- Which staff members should work together

- How often key participants should be away from their classrooms

- The duration of additional time demands for staff members

Researchers Susanna Purnell and Paul Hill (*Finding Time for Reform*, 1990) studied schools and businesses which had successfully implemented reform and identified six strategies used to provide time for reform. "An integral part of any attempt to restructure school is the need to create time for the school staff to help design, endorse, and enact reform." How can we organize time in order to make reform a reality? The six strategies Purnell and Hill found present in successful efforts at reform are:

✓	*SUGGESTIONS*

✔ *Refocus the purpose of existing time commitments.* For example, faculty and department meetings and district-wide staff development days can be used to support reform efforts. Thus, part or all of regularly-scheduled faculty meetings might be devoted to planning for an integrated mathematics and

science program.

✔ *Increase the amount of time available.* Common strategies that have been used include issuing supplemental contracts, providing stipends for additional time spent in professional development activities, and increasing the number of contract days for faculty.

✔ *Promote volunteer time.* Some schools have increased teacher participation in reform efforts by providing incentives for teachers to volunteer their own time. This may be done by providing services such as child care after school or on Saturdays. It may also be done by providing for credits on the salary scale on the basis of time spent in professional development activities.

✔ *Promote more efficient time use.* Time can often be reallocated by conducting more effective meetings and using telecommunication and computer technology to better manage communications and time. For example, procedural matters can often be handled better in writing than in a meeting.

✔ *Reschedule the school day.* Adjustments can be made in the master schedule or hours can be banked towards early dismissal or late arrival of students. This time can be used for professional development and can be built into the school's weekly and monthly schedule.

✔ *Provide time outside the classroom during the school day.* The most frequently cited time-creation strategies include the use of substitutes, cooperative arrangements with universities in which faculty and students take over classrooms, the use of outside resources (e.g., outside speakers, parent volunteers), and the use of school personnel (e.g., school administrators serving as substitutes, combining classes for joint presentations). Some schools provide double planning time for mathematics and science faculty involved in developing interdisciplinary courses, others relieve staff of "duty" assignments, and still others schedule concurrent planning periods for faculty involved jointly in curriculum efforts. Some schools designate a "team" leader, who is provided with assigned time for coordinating plans among members of the team. Still others build a "conference" period into the day that can be used for teacher planning, student-teacher conferences, or parent-teacher conferences. The following vignette shows how release time was used to provide for ongoing staff development.

Managing Time in Order to Promote Collaborative Exchanges

At one county vocational school system, the basic skills teachers of mathematics from four high schools met monthly for a half-day throughout the entire school year as a product team. The purposes of the product team meetings were for the teachers and their supervisor to work collaboratively to develop appropriate instructional practices; to reorganize and revise the course content; to investigate new software, manipulatives, and teaching practices; and to share innovations, products, and information learned through workshops or professional reading to ensure a quality mathematics program. Since all of the basic skills teachers were teamed with secondary mathematics teachers, the basic skills teachers were able to leave their schools for one-half day per month without disrupting instruction. In turn, since each team of teachers had a common planning time and a team planning period built into their work schedules, they were easily able to share their insights and new learning with their partner throughout the school year. Further, teams of teachers participated together in staff development opportunities outside of the school district. During the two years the teachers met in product teams, major shifts in the course content, instructional practices, and pedagogy occurred.

In addition to the previous strategies for increasing the amount of time available for work on reform efforts,

Purnell and Hill discovered that the following strategies were also employed in order to reduce barriers to time:

| ✓ | *SUGGESTIONS* |

✔ Waive policies and contract provisions that limit time.

✔ Minimize administrative requirements associated with reform.

✔ Refrain from introducing programs that compete for time; trying to change everything at once generally leads to chaos.

✔ Incorporate non-classroom time for teachers as a routine part of the school day and calendar.

✔ Provide or enlist adequate resources for reform. Write grants to fund summer staff development activities, set up an education foundation that provides mini grants for teachers to integrate technology into their classrooms, work with the Parent Teacher Association (PTA) or Organization (PTO) to raise funds for calculators or computers, or solicit corporate contributions for equipment and materials. (One school had a fund-raising night at the local fast food restaurant, with a certain percentage of the gross sales donated to the school.)

School Organization

If genuine reform is to take place, there need to be changes in how schools are organized (Canady, 1988). Schools must be organized in such a way that they facilitate rather than inhibit collaborative work among faculty and students, active learning of mathematics, integration of mathematics with other subject areas, and use of technology in the mathematics classroom. Specifically, issues concerning time, staffing, and space need to be revisited, analyzed, and evaluated.

Time

The National Education Commission on Time and Learning in its report, *Prisoners of Time*, states that learning is a prisoner of time (1994, p. 7). In summarizing data regarding time use in American schools, they reported that the typical secondary school:

- opens and closes its doors at fixed times in the morning and early afternoon

- is in session for nine months

- offers a six period day with approximately 5.6 hours of classroom time

- provides students with 51 minute instructional periods

- is in session for 180 days per year

- bases a graduation requirement on seat time

Further, the Commission wrote that four false premises support how schools are organized (1994, 8). These false premises are as follows:

- All students arrive at school ready to learn in the same way.

- Academic time can be used for non-academic purposes with no effect on learning.

- Because yesterday's calendar was good enough, it is good enough now.

- It is reasonable to expect world-class academic performance from students within the current time constraints.

In *Prisoners of Time*, the Commission reported that America may be ready to accept a change of plan for its schools. More than 52 percent of Americans favor students spending more time in school, with a plurality favoring an increase in the number of school days, but only 33 percent favoring a longer school day. At the elementary, middle, and secondary levels, we need to analyze how we organize time in light of our plans for mathematics program reform.

Some of the issues regarding time that should be addressed include whether periods are to be flexible (determined by the teachers) or rigid (following an unchanging bell schedule), whether students attend the same classes all year or only part of it, whether students attend the same classes daily, and how much time is needed by students for mathematics learning.

Flexibility

With cross-curricular integration as an important component of effective mathematics programs, it is important for teachers to be able to reorganize time during the school day in order to address specific content needs. This is most easily accomplished in the self-contained elementary school classroom, as can be seen in the following vignette.

Science, Mathematics, Reading, and Writing in a First Grade Classroom

In my first-grade class each fall, the students and I investigate leaves. This is always a favorite unit for students. They learn about science, reading, writing, and mathematics during this unit. For example, after collecting and identifying their chosen leaf, the students do leaf rubbings in their notebook and then work with their partner, taking turns telling what is similar and different about each of their leaves. Students' responses as to similarities or differences between the leaves are recorded using a Venn diagram. Children note size and the absence or presence of certain shapes. I use the students' responses to introduce the terms *pinnate* and *palmate*. Next, using a two-column chart marked at the top with characteristics of a pinnate or palmate pattern, the children place their leaf in the appropriate column. The children then record in their notebooks their understanding of the chart through pictures and, in some cases, text. Concepts of similar/different and more/less are examined by the students. This unit culminates with the children hearing stories and reciting poems about the fall, about leaf collecting, and about ways to investigate our world. Because I organize instruction using large blocks of time, I can shift and reorganize time according to instructional needs. This strategy helps me to deliver the best possible instruction to my children.

Classrooms in which math is integrated with other subjects are also beneficial in the middle school. Some middle schools accomplish this by assigning teams of 100-125 students to a designated group of teachers. In

this situation, teachers from two or more disciplines (e.g., mathematics, science, social studies, and English) meet regularly to coordinate instruction for a particular group of students. In the meetings, the teachers plan to capitalize on what is being presented in one another's classes. Monitoring student progress, designing assessment projects, and discussing discipline concerns are all a part of the dialogue. By providing for a flexibly scheduled day, teachers can rearrange and allot different amounts of time based on specific content and student needs. For example, teachers might combine science and mathematics instruction time twice a week in order to address the needs of a specific project. An example of a collaborative effort involving 7th grade mathematics and language arts teachers is provided in the vignette below:

Geometry and Reading: Perfect Together

One of the concerns I had with my seventh-graders was finding out what they already knew about geometry. I could see by the expressions on their faces that they were confused by many of the terms I was using and the by the physical shapes I was showing them. Since I work in an instructional team with a language arts teacher, I decided to ask Ms. Carl for some suggestions. She told me about two techniques and volunteered to teach them to my students.

I began the next class by using the first technique, K-W-L (know, want to know, learned). I asked the students to briefly write in their notebooks everything they knew about geometry and everything they wanted to know. The students shared their responses while I recorded them on the overhead. My students' responses showed me that they knew much more than I had suspected. However, my hunch that they had difficulty connecting terms with the actual objects was also confirmed. During the next few classes, we worked primarily with solid geometric shapes, geoboards, and several computer programs (e.g., *Geometer's Sketchpad*) in an effort to solidify (no pun intended) their understanding.

Ms. Carl then taught a vocabulary lesson using a semantic feature analysis chart. The students had used this technique before in reading class but were surprised to see how well it worked with geometry. The students and Ms. Carl listed the names of polygons and then they listed a few features such as plane figure, straight sides, and all sides have equal lengths. The students then made a chart like the one below, labeling each column as sometimes (S), always (A), or never (N).

Shape	Plane figure?	Straight sides?	Four sides?	4 right angles?	Closed figure?	Sides equal?
Triangle	A	A	N	N	A	S
Rectangle	A	A	A	A	A	S
Quadrilateral	A	A	A	S	A	S
Square	A	A	A	A	A	A
Parallelogram	A	A	A	S	A	S

Later we added additional features: 2 pairs of opposite sides have equal length, 2 pairs of opposite sides are parallel, 3 sides and 3 vertices, and more. On the next day, the students reviewed the items that they wanted to know (W) and marked an L next to those they now had learned.

Another technique sometimes used in the middle school involves scheduling intact groups. A group of students moves to classes throughout the school day as a unit. Students are kept together for instruction in from two to five different disciplines per day. Large blocks of time are provided to teachers and they are asked to schedule appropriate amounts of time for instruction in areas assigned to them. Common planning time is provided, and activities are usually coordinated by a unit leader.

A majority of secondary schools in the United States uses a *traditional scheduling* model based upon ability grouping, subject matter, and grade-level divisions (Wrangell, 1990). This mass-production model should be studied carefully, because, all too frequently, students' needs become secondary to the efficacy of the model, rather than the model being adjusted to meet the needs of students. The flexibility that is desirable at the lower grade levels is often more difficult to arrange at the high school level, but it is equally desirable.

One way of providing flexibility is to keep the structure of the traditional schedule but offer class periods at varying times during the week. For example, although a seven-period schedule is in existence, only six periods might meet each day, thereby allowing each class to meet for a double period over a seven-day cycle. This model also allows for a daily rearrangement of periods during the school day and for organizing the school year in cycles. A similar schedule in which each period is lengthen but one class is skipped each day allows for slightly longer class periods for all subjects.

Variations in choice of time patterns for class periods, instructional practices, and number of students in group settings are also served by a *modular schedule*. In this type of situation, the day is divided into twenty-minute modules, and students are scheduled into classes that may have differing lengths. For example, in one school, students at the lower achievement levels were assigned to mathematics classes that were 60 minutes long (three modules), while higher-achieving students had mathematics classes that were only 40 minutes long (two modules). The number of modules that a course meets can vary from day to day or can remain stable.

A *vertical* or *flexible scheduling* technique, generally used with individualized pacing, also provides flexibility. In this model, courses are designed around themes. Regardless of age, students schedule themselves for their courses from a master schedule and negotiate long-term contracts for each term. The amount of time spent on a particular course may vary from student to student or from course to course.

Frequency and Duration

Other scheduling considerations also arise in connection with improving the mathematics program. How much time should students spend on mathematics? How frequently should classes meet? Should the class meet all year? Walter Borg, in a review of research about time and school learning, found that of the three areas typically measured by standardized tests (reading, language arts, and math), "... mathematics is the most strongly influenced by potential quantity of schooling." (1980, p. 49). Rosenshine (1980) reports that second-graders spend an average of 35 minutes a day on math and fifth-graders spend an average of 45 minutes a day on math. This finding was based on actual observations of classes and including time spent doing math-related activities in other subjects. New Jersey's students typically spend about 45 minutes a day on math in the secondary grades; students in other parts of the country (e.g., Texas and Oklahoma) spend about 55 minutes a day on mathematics.

✓	*SUGGESTIONS*

✔ Increase the amount of time elementary school students spend on mathematics to a minimum of five hours a week (*Agenda for Action*, NCTM, 1980, 20).

✔ Increase the amount of time middle grades students spend in mathematics classes to a minimum of seven hours a week (*Agenda for Action*, NCTM, 1980, 20).

✔ Require high school students to take mathematics each year they are in school and increase the amount of time spent each week in mathematics classes.

✔ Consider different possibilities for scheduling mathematics classes. For example, some schools now use *block scheduling* in which students take four 85-minute classes each day in the fall and then take four different classes in the spring. One difficulty with this kind of schedule is that students are not studying mathematics for an extended period. A variation of this which provides for greater continuity is one where students take four 85-minute classes one day and four different ones the following day. Another variation is to have two 15-week sessions in the fall and spring during which students follow typical schedules, and have a six-week winter schedule in which alternative schedules are used.

Staffing

The major issue with respect to the staffing of mathematics classes is whether classes should be taught by a generalist or a specialist. In most elementary schools, mathematics is taught by the general elementary teacher in a self-contained class. Supplementary instruction may be provided by a basic skills teacher or a gifted and talented teacher. In most high schools, mathematics is taught by a specialist who teaches mathematics all day to different groups of students of varying achievement levels. Other organizations are also possible. In selecting an organization appropriate for a particular situation, it is important to consider both the needs of the students and the talents and interests of the faculty.

Many elementary schools prefer self-contained classes, especially for the primary grades. It is generally felt that younger students respond better to the more consistent environment provided by a single teacher. In some elementary schools, however, older students may be taught by two or more teachers. In one model, teachers are paired so that one teacher teaches mathematics and science to two different classes, while the other teaches language arts and social studies. This model allows the teachers to develop a specialty area and to integrate content reasonably well while working with a relatively limited number of students.

Another possible model for elementary school organization relies upon a mathematics specialist who teaches only mathematics to students in five different classes. In this case, students spend about half the day with a homeroom teacher who teaches reading, language arts, health, and social studies to two different classes. The students spend the remainder of the day in "specials," including both math and science. Such a model provides for greater expertise in mathematics by the teacher while maintaining a stable base for the students.

One concern at the elementary level is the common practice of pulling out students for special instruction or support service. This practice may result in a loss of instructional time for students, thus frustrating them. An alternative is to provide in-class support for these students. The two teachers (classroom teacher and teacher providing supplemental instruction) work with two groups of children within an instructional area at the same time. While one group is receiving instruction, the second group relocates to another area within the classroom to receive supplemental or special instruction. This in-class delivery of supplemental instruction is favored by such federal programs as the Basic Skills Instructional Program and is also effective for gifted students. It offers schools flexibility in staff assignments and fosters teacher creativity in choice of instructional design. Care must be taken, however, to ensure that the teachers are equal partners in the

planning and the implementing of instruction and assessment.

Research findings have suggested that educators should carefully consider the physical, emotional, and social needs of twelve to fourteen year-olds when designing how time will be utilized at the middle school level. While departmentalization may produce more high-quality instruction in a particular content area, positive student-teacher relationships may suffer. Similarly, self-contained classrooms at this level generate positive student-teacher relationships but often the quality of instruction is lessened (Hollifield, 1988).

Our Roles In Improving Mathematics Education

I'm a Teacher. What are my roles in implementing change?

- I am the direct link to children in the classroom. If changes do not happen in the classroom, the community loses faith in the ability of the educational system to reflect the real world. My success as a professional educator impacts the future opinions of my students and reflects my own capacity to learn and grow along with my students.

- Parents expect me to develop the skills and focus the creativity of their children, making them productive learners. They want me to enhance the natural curiosity of their children in fields such as mathematics and science. Parents will support a school system that delivers on its promises.

- I have a professional responsibility to work with my colleagues in mathematics, including those who are elementary generalists, to make mathematics an exciting and productive experience for the children we teach. I need to find ways to cross disciplinary lines.

I'm a Supervisor. What are my roles in implementing change?

- As a leader in mathematics, I am convinced that mathematics reform is needed. I am accountable for my understanding, interpreting, and implementing the recommended changes. I am an advocate for improvements in mathematics education. I will take an active role in mathematics reform because students need a world class education in mathematics.

- The only thing constant in progress is change. A person's attitude can accelerate or block the change process. I need strategies for working effectively with people.

- My role as a leader involves communicating, and often convincing teachers, administrators, parents, policy makers, the community at large, and students of the need for change. I need techniques in order to be effective.

I'm an Elementary School Principal. What are my roles in implementing change?

- I am more than a manager. I am the instructional leader with the responsibility of helping teachers understand the "why" and "how" of mathematics reform. I have an important role to play in the creation of staff development that helps my teachers keep abreast of change and responsive to new knowledge of how children learn.

- I am the first person whom parents and the community hold accountable for providing a current education that looks to the future. I am the educational link between the school, the parents, and the community.

- The first exposure to structured learning occurs in my school. In mathematics, I need to be sure this experience builds on young children's natural curiosity and love of puzzles, games, and riddles that encourage mathematical thinking.

- My school's mathematics program has to be productive and exciting so children will see mathematics as more than just arithmetic and far more than boring drill. They need challenging opportunities that will keep them enthusiastic and prepare them for the next level of learning.

I'm a Secondary School Principal. What are my roles in implementing change?

- My school is the last step in student transition to work or higher education. The community and the administration hold me responsible for providing students the means by which either choice will open challenging opportunities.

- I am the instructional leader in my school to whom teachers look for guidance and direction. I set the tone for progress or I become a barrier for creative change by my teachers.

- I need to work with my teachers to plan staff development that helps them understand the "why" and "how" of change in mathematics education. The changes in mathematics education can be a blueprint for the educational change that will be occurring in other disciplines as additional standards are implemented.

I'm a Superintendent. What are my roles in implementing change?

- The school board and the community hold me accountable to provide an educational program that does not lag behind the progress made in this field as more schools implement the *Mathematical Standards* adopted by the New Jersey State Board of Education. My school board needs to be prepared, and I must assist them to be responsive to community expectations.

- Principals and teachers look to me for guidance and support of their educational needs. I need to provide professional growth opportunities and resources that keep them abreast of the changes in mathematics education.

- I need to assist my school board with current information about mathematics reform to guide their review of needed policy changes.

- I need to ensure my board's ability to respond to questions which compare our district's mathematics programs and achievements with those in similar districts.

I'm a School Board Member. What are my roles in implementing change?

- My community holds me accountable for the success or failure of the school program. Taxpayers support the schools and expect the school board to provide students with an education which prepares them for the future workforce and gives them the ability to apply what they learn to solving real work problems.

- I help set the policies that direct the actions of the superintendent. In mathematics education, this direction must assist the timely improvement of our curriculum.

- I am the communication link between the school system and the larger community. I have the obligation to explain the need for changes that are coming in our schools and the specifics of the steps that our board is taking to ensure that the reform is successful. I can build supporters of our school system by showing other adults who do not have children in the schools the advantages of this reform effort, and why mathematics, with a curriculum framework now in place, is the logical starting point.

I'm a Parent. What are my roles in implementing change?

- A parent is a child's first teacher and role model. Children believe what they see and hear at home. If they hear that mathematics is too hard or not important to their future, they will carry that myth with them to school, impairing their chances of success.

- All parents want their children to succeed in life. As parents, we need to show our children early on that school mathematics is not only necessary for survival, but that it is the door to most careers they will later choose. The right skills and the right choices will open the doors to opportunities in the world outside of school.

- Children have a natural curiosity. Helping them find answers to the constant question "why" is a natural bridge into mathematics and science learning. Early exposure at home to simple puzzles and games helps us build the bridge from learning at home to success at school.

- Throughout their school experience, children need support and encouragement. We need to stay involved in the mathematics options that are available to our children, enabling them to keep moving ahead rather than relegating them to lower level jobs.

Who can help me?

- Teachers addressing changes in their own classrooms will welcome the opportunity to give information and guidance to parents and colleagues.

- The National Council of Teachers of Mathematics offers many publications. Write to NCTM, 1906 Association Drive, Reston, VA 22901.

- The Association of Mathematics Teachers of New Jersey provides many conferences. Write c/o Nancy Schultz, 20 Aberdeen Avenue, Wayne, NJ 07470

- The Web Site is http://dimacs.rutgers.edu/nj_math_coalition/framework.html/ for on-line resources related to the *Mathematics Standards.*

- The mathematics specialist(s) at the New Jersey State Department of Education can provide information about initiatives at the state level, including the statewide assessments. See the Department's home page at http://www.state.nj.us/education/.

- The New Jersey Mathematics Coalition, at 908/445-2894 for assistance in obtaining workshop leaders. The home page of the Coalition, http://dimacs.rutgers.edu/nj_math_coalition/, contains the Parents' Guide to the Mathematics Standards, the Coalition newsletter, and other timely information.

Summary

In order to achieve the world-class mathematics classroom that students need and deserve, and in order to realize our vision, systemic changes must take place. After recognizing, and then developing an awareness of other possibilities through exploration, we move to a transition period where we make commitments to try new teaching and learning approaches. We begin to see what needs to be re-envisioned and rearticulated. We begin to examine professional development and school organization in light of our goals. We institutionalize the things that we have introduced.

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Software

Geometer's Sketchpad. Key Curriculum Press.

On-Line Resources

http://dimacs.rutgers.edu/nj_math_coalition/framework.html/
    The *Framework* will be available at this site during Spring 1997. In time, we hope to post additional resources relating to this standard, such as grade-specific activities submitted by New Jersey teachers, and to provide a forum to discuss the *Mathematics Standards.*