Appendices

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Appendix I - Best Practices in Mathematics and Science

In every mathematics and science classroom, there is a diverse pool of talent and potential. The challenge is to structure the learning environment so that each student has the freedom to use his or her unique strengths to learn, be urged, inspired, and motivated to reach high academic standards. Because all children do not learn in the same way and have varying backgrounds and experiences, flexible and innovative approaches are needed.

Preparing Students for Learning and Prior Knowledge Assessment

Teachers should inquire about students' understandings of concepts before sharing their own understandings about the topic. The technique of "frontloading" to elicit prior knowledge related to real-life experiences and applications can create a direct connection to the content for students.

Strategies: using graphic organizers (Concept Mapping, KWL), showing a video clip or model, demonstration, or using literature.

Developing Active Learners

Students can become active learners by providing opportunities for them to construct their own understanding. These situations should require students to organize, classify, interpret, and draw conclusions about real-life mathematical and scientific problems. Students must communicate their ability to problem-solve through oral, written, and physical demonstrations.

Strategies: open-ended questions, real-life scenarios to solve, and paradoxes

Teaching to Diversity

Teachers, as the facilitators of the learning process, should provide a variety of activities that address knowledge, language, and cultural differences. Activities within the classroom should include a variety of cultures, learning styles, and multiple intelligence. This will help students become aware that there are different ways of knowing and learning.

Strategies: graphic organizers such as concept mapping or KWL, incorporating verbal/linguistic, logical/mathematical, body/kinesthetic, visual/spatial, and musical/rhythmic activities, opportunities to work individually as well as in small and large groups.

Orchestrating Collaborative Discourse

There should be encouragement of student discourse within the classroom through students engaging in dialogue, both with the teacher and especially with one another. Teachers should encourage and accept student autonomy and initiative by allowing students' responses to drive the lessons, shift instructional strategies, and alter the lesson plans. The ways of representing, thinking, discussing, agreeing and disagreeing is central to what students learn about mathematics and science.

Strategies: pose questions and tasks that elicit, engage and challenge thinking; ask students to clarify, critique and justify issues, elaboration during discussions

Varying the Instructional Format

A variety of instructional formats should be used in classrooms to make sense of the content and to construct meanings from new situations. Technology is the tool to be used to develop active learning. Mathematics classrooms should foster the use of the Internet as a tool to provide real time data for student analysis, manipulatives whenever possible to teach concepts while science classrooms should provide the opportunity for inquiry-based instruction. Instead of traditional lecture-type instruction, opportunities should be provided for Internet research, small-group work, individual exploration, peer instruction, and whole-class discussion.

Strategies: use of manipulatives, hands-on activities, and technology-based activities

Using of the Learning Cycle Instructional Model

Teachers need to develop techniques that move their students from concrete to abstract concepts through frequent use of the learning cycle model. First the teacher provides an opportunity for students to generate questions and hypotheses through an open-ended discovery activity. This is followed by the concept introduction lesson(s) provided by the teacher. Finally, students must be provided with opportunities to demonstrate their understanding of the learned concept by transferring it successfully to other situations through solving a scenario, doing a demonstration, or project.

Strategies: pose scenarios to be solved

Integrating Teaching

Multi- and interdisciplinary activities should be included within the classroom that provides connections for students. Students must recognize the various roles mathematics and science play in real life. The connection and application of

mathematics and science will motivate, give meaning to, and reinforce student learning. These activities should involve students in critical thinking, process skills, and product development.

Strategies: give authentic problems to solve, bridging

Questioning for Higher-Order and Critical Thinking Skills

Use effective, open-ended questioning techniques that encourage student inquiry. Encourage students to pose their own questions, evaluate the information presented and make informed decisions about the information. Examples would include “How would you solve a similar situation?” or “What criteria would you use to …?”

Strategies: elaborating, analyzing, hypothesizing, and evaluating

Assessing Student Learning

Assessment should reflect how and what is being taught. It should be embedded at various points in the lesson to guide the instructional planning and pacing. There is a clear alignment between curriculum, instruction, and how students are assessed.

Strategies: performance tasks, essays, portfolios, video presentations, demonstrations, projects and oral presentations

Promoting Collegiality

Teacher collaboration is essential for effective teaching practices. Teachers should collaborate to establish long-range plans, prioritize curriculum, share best practices, mentor, and model lessons for each other.

Strategies: team, departmental and grade level planning, study groups, peer coaching, and mentoring

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Appendix II - Professional Development

Professional development is a continuous improvement process lasting from the time an individual enters the education profession until retirement. Selecting strategies is dependent upon knowing the primary purpose of the strategy and correlating it to the needs of the teachers involved. Some strategies fulfill some purposes better than others do. For example, strategies such as workshops are more appropriate for building content knowledge and pedagogy, whereas others, such as case studies, focus teachers on examining the practice of teaching and learning. The following are the key purposes for effective professional development:

A. *Developing Awareness:* strategies that focus on developing awareness are usually implemented in the beginning phases of change. These call for introducing teachers to new approaches or content.

B. *Building Knowledge:* strategies that focus on building knowledge provide opportunities for teachers to deepen their understanding of the mathematics and science content and teaching practices.

C. *Translating New Knowledge into Practice:* strategies that help teachers translate new knowledge into practice, engage teachers in drawing on their knowledge base to plan instruction, and improve their teaching.

D. *Practicing Teaching:* strategies that focus on practicing teaching help teachers deepen their understanding through the process of using a new approach, practice or process with their students.

E. *Reflection:* strategies that provide opportunities to reflect on teaching and learning engage teachers in assessing the impact of change on their students. These strategies also encourage teachers to reflect on one another's practice and adapting ideas for their own use.

The following fifteen strategies for professional development fulfill each purpose identified as indicated:

- <u>Immersion</u>

    1. Immersion into Problem Solving allows teachers to engage in the kinds of learning that teachers are expected to practice with their students, such as inquiry-based mathematics and science investigations.
    2. Immersion into the World of Mathematics provides teachers with an opportunity to participate in an intensive experience in the day-to-day work

of a mathematician or scientist who is engaged in research activities often in industry, a laboratory, or museum.

- Curriculum

3. Curriculum Implementation allows teachers to use and refine the use of a particular set of instructional materials in the classroom.
4. Curriculum Replacement Units allow teachers to teach a unit of instruction that addresses one topic in a way that illustrated effective teaching techniques.
5. Curriculum Development and Adaptation gives teachers the opportunity to create new instructional materials and strategies or tailoring existing ones to better meet the learning needs of culturally diverse students.

- Examining Classroom Practice

6. Action Research provides teachers with the opportunity to examine their own teaching and their students' learning by converting the learning environment into a research project in the classroom.
7. Case Discussions give teachers opportunities to study written narratives or videotapes of classroom events and discussing the problems and issues illustrated.
8. Examining Student Work and Assessments allows teachers the opportunity to examine student work so that appropriate instructional strategies and materials can be identified.

- Collaborative Work

9. Study Groups engage teachers in regular collaborative interactions around topics identified by the group, with opportunities to examine new information, reflect on classroom practice, and analyze outcome data.
10. Coaching and Mentoring allows teachers to work one-to-one with another teacher to improve teaching and learning through a variety of activities, including informal classroom observations and feedback, problem solving, and co-planning.
11. Partnerships with Mathematicians and/or Scientists in Business, Industry and Universities give teachers the chance to work collaboratively with practicing mathematicians and scientists with focus on improving teacher content knowledge, instructional materials and access to facilities.
12. Professional Networks link teachers in person or through electronic means with other teachers to explore topics of interest.

- Vehicles and Mechanisms

13. Workshops, Institutes, Courses, Seminars, Conferences, and Professional Organizations use structured opportunities outside the classroom to focus

intensely on topics of interest including mathematics and science content, and learn from others to improve their own practices.

14. Technology for Professional Development provides teachers an opportunity to use various kinds of technology, including telecommunications, video, and CD-ROMs to learn content and pedagogy.

15. Developing Teacher Leaders provides the opportunity for teachers to build upon their skills and deepen understanding of content and pedagogy needed to create worthwhile learning experiences.

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Appendix III - Limited English Proficient Students

Mathematics and science teachers who provide instruction to limited English proficient (LEP) students, must ensure that these students make academic progress while they are in the process of learning English. LEP students have to meet the same goals and objectives as students who are non-LEP. Whenever possible, beginning level LEP students should be provided content instruction in the home language of the students. However, when content instruction is provided in English, it must be made comprehensible through appropriate second language instructional strategies and clear expectations. Modifications for LEP students should include diverse teaching strategies. When assessing acquisition of content knowledge, students should not be penalized for lack of language proficiency. To support teachers of all subject areas in choosing effective strategies when working with LEP students in their classes, the following suggestions are provided. It is important to remember that these strategies should be introduced, extended, and expanded throughout all the levels according to the students' academic and linguistic abilities, and their interests.

At the beginning level, teachers should:

- start by linking lesson topics to students' prior knowledge;
- provide opportunities for students to learn and respond to the usual classroom; directions, for example, "raise your hand," or "put your name in the upper-right-hand corner," and extend those opportunities to commands dealing with mathematics and science concepts;
- use repetition and consistency to monitor comprehension of instructions and gestures;
- use cooperative learning groups where independent students and/or students at more advanced levels of language proficiency can assist beginning students;
- use visual aids and manipulatives, label classroom items; match words with pictures, items, colors, and symbols that contribute to better comprehension of content lesson(s);
- provide opportunities for students to hear and practice the content language of mathematics and science through the context of hands-on and cooperative experiences;
- categorize words, concept and ideas, which provide "hooks" for learning; and
- assign a learning buddy or mentor.

At the intermediate level, teachers should:

- include all strategies outlined for beginning level students;
- encourage students to ask questions to clarify their understanding;
- use concrete materials, hands-on activities, visuals, and real objects to provide multiple access and variety of multisensory approaches to learning;
- show students how to use graphic organizers to identify prior knowledge, prepare study guides, and restructure prior knowledge;
- provide books, articles, and other resources on content topics and teach students how to use them;

- show students how to ask and answer higher-level questions about content;
- teach and have students use technical vocabulary appropriate to the content of mathematics and science; and
- provide explicit instruction on how to use and/or develop diaries, math/science journals, projects, or picture collages.

At the advanced level, teachers should:

- include all strategies outlined for beginning and intermediate level students;
- provide clear examples of finished products when making assignments for book reports, class logs, lab reports, and research assignments related to mathematics and science; and
- check student comprehension by asking students to explain what they have heard or read and where they have seen words, phrases, or situations dealing with mathematics and science.

In general, it is recommended that teachers of LEP students:

- increase their knowledge of second language acquisition and development as it relates to teaching students the academic language of mathematics and science;
- adapt content, teaching techniques, and assessment to students' needs and levels of learning;
- encourage students to ask questions to clarify their understanding;
- involve parents and community members to build understanding through cultural exchanges;
- obtain background information about students' language and culture to ensure better understanding of students; and
- speak clearly and at normal pace with normal stress and intonation.

Appendix IV – Acronyms Used in Bridges to Careers

ACT	American College Testing
CBC	Competency-Based Curriculum
CD-ROM	Compact Disc-Read Only Memory
CRISS	Creating Independence through Student-owned Strategies
ESE	Exceptional Student Education
FCAT	Florida Comprehensive Assessment Test
F.E.A.T.	Future Educators' Advanced Training
FLAME	Florida Action for Minorities in Engineering
FOSS	Full Option Science System
FSU	Florida State University
GLE's	Grade Level Expectations
INSTAR	Investigating Nature through Student and Teacher Active Research
KAPOW	Kids and the Power of Work
KWL	Know-Want to learn-Learned
LEP	Limited English Proficient
M-DCPS	Miami-Dade County Public Schools
MIC	Mathematics In Context
NRT	Norm-Referenced Test
NSF	National Science Foundation
PAC	Partnership with Academic Communities
PACES	Professional Assessment and Comprehensive Evaluation System
SECME	Science, Engineering, Communication, Mathematics Enhancement
SMILE	Science and Mathematics Integrated with Learning Experiences
STC	Science and Technology for Children
TIMSS-R	Third International Mathematics and Science Study-Repeat
T^3	Teachers Teaching with Technology
USI	Urban Systemic Initiative

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Appendix V - Resources

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