The OMSC Teacher Colloquium: An Interpretive Synthesis

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The Ohio Mathematics and Science Coalition (OMSC) is an advocacy group working toward improving and revitalizing mathematics and science education in Ohio. Comprised of individuals from the education, business, and public sectors, OMSC's mission is to facilitate collaboration for continuous and sustainable systemic improvement in these areas of education for all of Ohio's more than 1 million students.

Ohio was among the first states to actively encourage its teachers to seek accreditation from the National Board for Professional Teaching Standards. Hundreds of Ohio teachers are now fully accredited. Others have received Presidential Awards for meritorious teaching. When OMSC asked the North Central Regional Educational Laboratory (NCREL) to help achieve their goals, NCREL turned to Ohio's greatest resource for advice and counsel on how to improve mathematics and science teaching and learning in Ohio—highly skilled and highly motivated Ohio teachers.

On November 11-12, 1999, NCREL and OMSC hosted a two-day colloquium in Columbus bringing together 30 of these master teachers, along with 22 representatives from the business and governmental communities (see Appendix). The group engaged in several focused, interactive processes to explore their ideas about the goals of math and science education, the teaching needed to reach those goals, and the support needed to accomplish that teaching. Specifically, participants were asked to reflect on the following questions:

- What do we want students to know, be able to do, and be like?
- What types of mathematics and science should be taught and learned? How should they be taught?
- How do we find out if students have learned and what they have learned?
- What gaps exist between what we want students to learn and what they are learning?
- What gaps exist between how we think they learn and how they actually learn?
- What strategies are available to close the gaps?

Following the sessions, participants made extremely positive comments. They commended the high level of discussion, the value placed on establishing a consensus vision for mathematics and science teaching, and the processes used to gather information.

However, the colloquium came to be more than an information-gathering session. Many of the participants expressed gratitude that they were given the opportunity to voice their concerns and opinions. There was a general feeling that participation of teachers is often overlooked in most reform efforts. Teachers at the colloquium said they appreciated that OMSC and NCREL solicited their ideas, and they hoped positive steps would be taken as a result of their discussions. Participants suggested that the support shown to the teachers at the colloquium may translate into greater confidence in their abilities and improved performance in their classes—making a difference for their students. Some participant comments following the sessions included:

- "I feel someone has *finally* asked teachers for input and ideas about how to improve student learning. Usually 'higher-ups' dictate what and how to teach. Thank you for treating teachers as valuable and professional contributors to this process."
- "Teacher voices are *very* important in all educational reforms."
- "Hopefully all these wonderful voices will be heard."
- "Teachers are… closest to Ohio's students; therefore, the data gathered here can impact the future of education in our state."
- "Teachers were listened to and therefore energized."

The colloquium also gave participants an opportunity to have their opinions on mathematics and science education reform validated by other professionals. It fostered a feeling of being connected to others with similar visions and similar needs. "We are not alone," said one participant. "[There is] a sense of common vision at this level," commented another, "and a general acceptance of the messy nature of inquiry and real-world problems." For many participants, the discussions inspired new confidence and pride in their peers and their profession. Said another participant, "When I learn, my students learn."

Colloquium Structure and Format

The colloquium was structured to provide maximum opportunity for participants to express their ideas about math and science education. They were encouraged to discuss teaching and learning as it occurs in their own classrooms and in other classrooms around Ohio, and also how their methods and results compare to state and national standards.

Four discussion processes were used to elicit interactive thinking not only about "big ideas," content, and curriculum, but also about the factors inhibiting student learning, improving teacher capacity and instruction, and enhancing the system's capacity to support good teaching and learning. The four processes are described below:

The Outcomes of Schooling: The Affinity Process

Small groups of participants were brought together to discuss the question, What do we want students to know, do, and be like? Each group was asked to design a graphic that represented and illustrated their consensus ideas.

Teaching and Learning in Science and Mathematics: The Carousel Brainstorm

The carousel process was a structured brainstorming session. Small groups of participants responded to several questions posted on charts around the meeting room. Each group spent

three or four minutes brainstorming about each question, rotating around the room until each group had an opportunity to address every question.

Questions used for the carousel brainstorm included:

- What are the big ideas that define K-12 math and science?
- What are the content area categories and understandings necessary in K-12 math and science?
- What factors influence whether or not students learn math and science?
- What can educators do to enhance the learning of math and science?
- What changes in instruction will promote better learning of math and science?
- How can technology positively affect the teaching and learning of math and science?
- How can we increase teacher capacity in math and science?
- How can the "system" within your district support math and science teaching and learning?

The Culture of Science and Mathematics: Read and Reflect

The perception of math and science in the "real world" often differs from that presented in schools. There is a discrepancy between the culture of these disciplines in school and their actual place in society. Participants were asked to read an excerpt from the 1993 book *Mathematical Power: Lessons from a Classroom* by Ruth Parker and Kathy Richardson. The excerpt presented a side-by-side comparison of the perception of mathematics in the classroom and the perception of mathematics as a real-world discipline. The teachers were then asked to make a similar comparison about the perceptions of science.

The Gaps Between Our Reality and Our Ideals: Multiple Interviews

Participants formed nine small groups, each focusing on a particular issue (see below). Within these groups, participants paired off to interview each other one-on-one. In each pair, one participant asked the questions (also below) while the other responded with thoughts and ideas. They then switched roles, giving each participant an opportunity to answer the questions. Next, the participants changed partners and repeated the process until everyone had interviewed everyone else in the small group. Finally, the small groups reassembled, compared notes, and identified meaningful themes and trends.

Each of the small groups focused on one of the following nine issues:

- Mathematics content
- Science content
- Mathematics curriculum and practice
- Science curriculum and practice
- Assessment in mathematics
- Assessment in science

- Technology
- Building teacher capacity
- Organizing the educational system

For each interview, participants asked the following two questions:

- What are the gaps between what *is* and what *should be*?
- What are the gaps between what we want and what experts say we should want?

Additional Sessions

Participants were given a copy of James W. Stigler and James Hiebert's 1999 book *The Teaching Gap: Best Ideas from the World's Teachers for Improving Education in the Classroom.* They were asked to read portions of the book to prepare for a discussion of the reform activities presented by the authors.

The colloquium also provided time for presentations of various reform initiatives, including the National Science Education Standards and Project 2061 Benchmarks for Science Literacy, the new revisions of the National Council of Teachers of Mathematics Standards, findings from the Third International Mathematics and Science Study, and curriculum and assessment materials available from the Ohio Department of Education.

Results of the Colloquium

The following is an attempt to synthesize what was said and what was learned at the colloquium. However, a summary cannot do justice to the strength and vitality of the voices of the teachers who participated. They are teachers with a passion for their work and they speak from a powerful context. Every day in their math and science classrooms, they face the very issues discussed at the colloquium and they know intimately where the problems and pitfalls lie. There is no shortage of opinions among policymakers, administrators, and researchers on what is wrong with teaching and how to improve it, but only after attaining a full understanding of what teachers believe is wrong with teaching, can we make strides to find solutions.

The Outcomes of Schooling

The affinity process asked participants to describe the ideal student, the student they wish all students could be upon leaving their classrooms. Colloquium participants believe students can and should be intellectual risk-takers. Meaningful, productive careers in the modern, ever-changing workplace demand more than just factual knowledge. Students should become not only seekers of information but also managers of information. Problem-solving skills are critical. The ability to manipulate mathematical equations or scientific formulas and definitions is not nearly as useful as the ability to attain a deeper understanding of math and science concepts and to think independently.

Participants said that ideal students are those learners who see concepts rather than "correct" answers to problems. They are able to make connections within their knowledge and apply their understanding to real-life situations. The ideal student is creative and innovative, using his or her imagination to solve problems.

Participants also cited the need for students to be able to work collaboratively. They should be able to communicate effectively, exchange views, discuss different approaches and solutions, and present sound arguments. They should be open to new ideas and accepting of the talents, skills, and needs of others.

Overall, the teachers at the colloquium feel strongly that ideal students possess a social conscience or moral "center." They have confidence in themselves as individuals and have a passion for life and for their work.

Teaching and Learning in Science and Mathematics

During the carousel process, participants generated dozens of suggestions and ideas. They can be categorized into three main themes:

Defining Math and Science Education

Participants believe K-12 mathematics education in Ohio should be more than mastering content. They feel that learning and memorizing specific formulas and definitions is far less important than understanding math as a way of thought or a tool for further learning. Math, as a discipline, should teach problem-solving skills and the processes of thinking both critically and analytically.

The value of key mathematical concepts such as algorithms, measurements, models, computation, and algebra lies in their use as tools to solve problems. Understanding how to use these concepts is far more important than committing isolated figures or formulas to memory.

The participants also stressed the importance of understanding the place of mathematics in society and its interrelationship with other disciplines. An emphasis needs to be placed on applying math and connecting mathematical concepts to the solution of real-life problems. Life skills requiring mathematical knowledge need to be taught. Students need to be exposed to math, as it will apply to various career paths, especially those not directly related to math.

For K-12 science education, participants emphasize the need for students to attain an understanding of science by doing science. Discussions focused on the three large areas of content in science and the importance of basics not necessarily present in current Ohio curricula. Importance was given to physical science (motion, energy, matter, etc.), life science (anatomy, habitats, botany, etc.), and earth science (cycles, ecological systems, rocks and minerals, etc.).

Although it is necessary to expose students to as much of this specific content as possible, teachers feel it is even more critical for students to learn about science as a method of exploration and discovery. Through hands-on experimentation, students need to gain an understanding of the scientific method of inquiry. There is no substitute for actually becoming involved in the inquiry process, and it should be stressed as a means to understand science and its value to society.

Improving Classroom Instruction

Participants made significant suggestions for changing the way Ohio's teachers teach in general; but more specifically, they offered ways that they could improve their own instructional practice.

Overall, participants feel that students would benefit from in-depth explorations of fewer topic areas. In science, students need to be given more time to attain a deeper understanding of concepts and make connections to their application, use, and value. To drive instruction, more meaningful questions need to be asked of students. Students need to be shown the relevance of topics through real-world contexts and connections to life experiences.

In mathematics, it was suggested that the most effective lessons are those that are rooted in solving significant real-world problems. They allow enough time to not only solve the problem but to discuss it afterward. Both math and science curricula should focus on investigations of everyday phenomena. Project- and inquiry-based curricula are the most desirable.

Participants believe they can create more opportunities for students to express their ideas by reducing the amount of time devoted to "teacher talk" and focusing on group-centered work. The participants also stress the need for giving students ample opportunities in math and science classes to express themselves in writing, specifically about math and science topics. They feel the ability for students to articulate and explain math and science concepts is currently underdeveloped.

The group discussed the need to build on what students bring to the classroom. Their prior understanding or misconceptions about math and science topics should be addressed and perhaps used as a starting point for teaching. Teachers would benefit by discovering what students already know about a particular topic and by discussing their ideas with them. It is a technique that engages the student from the outset and validates his or her thinking. Teachers need to display a better understanding and interest in students' prior knowledge, and a willingness to explore questions such as, Why do I have to learn this?

Many teachers in the group feel that teachers need to model a passion for science and math and a desire to continuously learn. No teaching technique can be effective if students simply aren't interested in learning. Getting them interested and keeping them interested is much easier if both teacher and student are having fun.

Increasing Teacher Capacity

As the trend in new curriculum development continues to focus on understanding concepts rather than on memorizing facts, teachers are being asked not only to teach differently but also to teach more. Advanced research and technology provide new concepts and data every year. There is simply more information to teach and more to learn; therefore, more is expected of teachers. This situation creates a difficult dilemma as teachers feel they are already being asked to teach too many topics in too little depth. Under these circumstances, participants listed a number of factors they feel would help them improve their performance:

Professional development

- Offer continual professional development during the day, focusing on teacher knowledge and understanding of key ideas and how children learn.
- Establish mentor or "critical friend" programs.
- Immerse educators in the learning process (e.g., Project Discovery).
- Encourage and promote National Board certification.

Preservice training

- Increase the focus of teacher preparation programs to provide new teachers with a repertoire of techniques and a range of strategies for dealing with curriculum, pedagogy, assessment, and school context.
- Improve preparation of new teachers to run their own classrooms with diverse groups of children.
- Coordinate teacher preparation programs with mentoring programs and staff development by colleges, school districts, and unions.

- Teach practical teaching applications and techniques to preservice teachers. Too many college courses are surveys of the field of child development or educational foundations.
- Provide more exposure to rigorous disciplinary courses in the content areas.

Support

- Narrow and redefine the curriculum.
- Allow more time for collegial, collaborative discussion among peers.
- Allow more flexible scheduling or alter and adapt school schedules (e.g., 10 weeks on and 2 weeks off).
- Provide additional funding and equipment.
- Increase involvement of business and industry.
- Make sure administrators "walk the talk."

The Culture of Math and Science

Participants' ideas about the culture of school versus real-world science and mathematics are informative about problems in science and math curricula and instruction. Almost unanimously, the teachers bemoaned the ways in which school learning is textbook driven rather than driven by the examination of meaningful tasks or real problems. They cited the following concerns:

- Because teachers are not trained scientists or mathematicians, they lack professional perspective and technique.
- The teaching of science lacks the level of inquiry found in real-world research and development.
- School learning is far too often fact based or directed at finding the "right answer" rather than focused on teaching problem-solving skills.
- The structure and organization of the school day does not always promote inquiry learning or provide adequate time for reflection.

The Gaps Between Our Reality and Our Ideals

The one-on-one interview process elicited discussions about the gaps not only between what participants *want* students to learn and what they are learning but also between what is expected of teachers and what they are currently able to achieve. Four areas emerged as primary concerns:

1. ***Assessment*—**In general, teachers feel there is no clear definition of what assessment is or should be.
   - Grades from tests do not fully reflect students' understanding and skills.
   - There is no balance between traditional and nontraditional assessments or between formative and summative assessments.
   - Time is rarely available for interpreting and reflecting on the results of assessments.

2. ***Teacher Capacity—***Public expectations of teachers are rapidly increasing, while the system of teacher preparation, development, and support is stagnant and resistant to change.
    - Collaboration among teachers, administrators, university professors, legislators, business leaders, and parents is spotty.
    - Accountability and follow-up are weak.
    - There is inadequate time for professional development, reflection, and interaction with colleagues in school.
    - Professional development needs to be funded adequately.
    - Mentors are desperately needed for beginning teachers.
    - Teachers often do not respect their own profession.
    - Teachers, generally speaking, do not know how to affect an individual's commitment to change.

3. ***System Organization—***The overriding focus of school administrators and board members is on raising student test scores rather than on improving of teaching and learning.
    - The Ohio Department of Education (ODE) curriculum models, along with the Proficiency Tests, drive schools and teachers to teach a curriculum that is "a mile wide and an inch deep."
    - The ODE model emphasizes process at the expense of content.
    - Teacher preparation programs do not support the 9-12 licensure plan of ODE.
    - Most teachers assume they're doing a good job, when in fact many aren't.
    - Professional development is not sustained or long term, nor is it focused on what teachers really need.
    - Professional development does not model good teaching.
    - Parents don't understand what really goes on in schools and classrooms.

4. ***Technology—***There is not enough teacher training, application, and reflection on the best classroom use of available technology.
    - There is a lack of understanding and application of technology, possibilities, and integration methods for student learning.
    - There is not enough time to use technology effectively.
    - Equipment is poorly maintained and hardware/software updates are too slow or nonexistent.
    - There is little collaboration among teachers concerning computer and technology use.
    - There is a severe shortage of funding or possibly just a lack of commitment on the district level.
    - There is undue competition and fear among teachers.

Where Do We Go From Here?

Several of the discussions over the two-day period led to the question of how to begin to address some of the problems that are apparent in Ohio's math and science system. More is asked of teachers and they are all too often left to devise their own strategies to respond to demands and challenges. Colloquium participants seemed aware of their own shortcomings. As one participant said, "I know I need more education, training, and collaboration to help me improve my teaching practices."

Below are the themes that emerged from the ideas and suggestions of this particular group.

Collaboration Among Teachers

- **Participate in ongoing, relevant professional development opportunities**

  Improving schools begins with improving the practice of teaching. Offering opportunities like this colloquium is valuable but should be expanded to include a more representative sampling of Ohio teachers. Although collaboration among the highest-achieving teachers is useful, it does nothing to benefit those teachers who need it the most. The participating teachers have a great desire to give more to their profession but have rarely been asked to do so.

- **Participate in cross-district collaboration and networking**

  Information should be shared with other teachers in other districts. New program development, teaching techniques, or other valuable ideas should be disseminated across Ohio to make truly meaningful changes in policy, testing, administration, and ultimately student performance. A greater emphasis needs to be placed on establishing more equity in inservice training and on changing the current perceptions of sharp differences between urban, suburban, and rural schools. Neither classroom walls nor district boundaries should inhibit the flow of improvement across the state. The best teacher of a teacher is another good teacher. More time and resources need to be devoted to getting them together.

Collaboration Between Teachers and Decision Makers

- **Organize task forces**

  Forming small task forces of teachers, administrators, school board members, and parents to communicate directly with the Ohio Department of Education, the Governor, and local legislators to monitor and align goals would increase communication between those making policy and those abiding by policy.

- **Unify teacher groups and administrators**

  This group of teachers is eager for change and is not lacking for ideas and suggestions. However, the prevailing attitude among teachers is that change has little support from administration decision makers. The commitment of teachers to improving schooling needs to be matched by a commitment from administrators. Steps toward alleviating dissension and conflict (us vs. them) can be taken by bringing administrators and teachers

together in collaborative settings. (Colloquium sponsors believe both sides are equally committed, but working separately to build solutions. Communication needs to be improved.) Relations and communication with the public also need to be improved to enhance the image of schools and schooling.

Consistency and Uniformity on National, State, and Local Levels

- **Establish uniform national standards**

  The state-to-state differences in required performance standards and curriculum need to be eliminated. Curriculum, assessment, and instruction need to be aligned more effectively, with a focus on teaching fewer but "bigger" ideas.

- **Offer focused university-level training**

  Assistance should be given to colleges and universities in establishing teacher-training programs that more consistently produce quality math and science teachers by modeling quality teaching. Participants also expressed a need for teacher education programs to produce more math and science specialists.

What's Holding Us Back?

Though the ideas presented here and others discussed at the colloquium generated genuine excitement and enthusiasm from participants, they cite a list of obstacles that stand in the way of meaningful improvement in their classrooms. These see include the following:

- All too often there is a lack of funding for the most essential math and science programs. Labs and equipment are frequently in disrepair or are inadequate. Texts and other materials are frequently outdated or obsolete.
- The prevailing culture of schooling promotes a lack of continuity. There is no clear effective process for change or improvement.
- Curricula are typically too broad, fragmented, repetitive, and poorly articulated.
- Inadequate time is allotted for planning and instructional reflection.
- Leadership fails to provide a unified, ambitious vision for change and improvement in instructional practice.
- New teachers are poorly trained and ill-prepared.
- Support from home and the community is inadequate.
- Political "red tape" inhibits substantial progress or improvement and discourages reform efforts.
- Testing and grade reporting encourage competition rather than individual success.
- A clear disregard for equity in math and science exists.
- Communication among teachers and between teachers and administration officials is poor.
- Teachers perceive themselves as isolated and underused.

After the Colloquium ...Now What?

These sessions, held over two days with a relatively small number of teachers, were clearly only a beginning. It would have been impossible to thoroughly address all the difficult issues that confront Ohio's math and science teachers. Many of the topics discussed at the colloquium need further thought, discussion, and action. Time constraints prevented the discussion of equally challenging topics such as special needs students, global educational practice and goals, specific teaching techniques, and equity concerns.

However, the discussions and ideas that took place were an invaluable first step in changing the way the participants think about education, the role they play, and how to improve. In a post-colloquium review of the days' events, three dominating, illuminating concepts emerge.

First, Ohio's schools, regardless of size, location, or budget, experience similar problems. Across the board, the concerns cited above are true in rural, suburban, and urban schools. No district is immune from the challenges and obstacles facing the education of Ohio's children. Change, reform, and innovation should extend across all district boundaries and benefit all schools and students.

Second, the key to changing math and science education is *collaboration.* As one participant wrote, "The need for a cooperative venture in education—from teachers to administrators to the state—is paramount." It is a theme that permeates the relationships among teachers within the same school, districts, and subject areas. It extends to teachers across Ohio, as well as administrators, policymakers, business leaders, community members, and parents. No group alone will affect meaningful change in math and science education without cooperation, input, and collaboration from all others.

The third factor that rises from the discussions is one of enormous, untapped potential. The teachers who participated in the colloquium are excited about their profession and the possibilities for the education of their students. They are enthusiastic in their desire to improve, participate in reform, and change the way math and science are taught in Ohio. Obvious to all who participated in the colloquium is the energy these teachers bring to their students, their schools, and their communities. That's the good news.

These same teachers convey an unsettling sense of isolation in their missions. Many feel alone, not only standing in front of their classrooms but also in their desire to do what needs to be done for the student. They feel little meaningful support from their administrations or communities. They feel at times ignored and discounted, even though they serve closest to the students themselves.[1] The colloquium seemed to recharge this group of teachers and inspire an eagerness to return to their schools and share lessons from the colloquium. They were lessons not from colloquium leaders or organizers, but from each other.

In their book *The Teaching Gap*, Stigler and Hiebert suggest one way to develop better-quality teachers is to respond to the needs not of the system but of the teachers themselves. The colloquium has shown quite vividly that not only do teachers agree, but they are ready and willing, in fact excited, to improve their own performance. With the right support and leadership, there is now an opportunity to harness that enthusiasm and provide more opportunities for teachers to create synergistic approaches to teaching. Transferring the energy, desire, and enthusiasm of these teachers and others like them into the implementation of fresh approaches to teaching is the key to the success of math and science education reform.

In Ohio, this colloquium was one small step. According to the teachers who participated, it was a step in the right direction. There is no better authority to make that judgment.

References

Parker, R., & Richardson, K. (1993). *Mathematical Power: Lessons from a classroom.* Portsmouth, NH: Heinemann.

Stigler, J. W., & Hiebert, J. (1999). *The teaching gap: Best ideas from the world's teachers for improving education in the classroom.* New York: The Free Press.

Endnotes

1. Carolyn Kelley, a researcher at the Wisconsin Center for Education Research at the University of Wisconsin-Madison, and colleagues are nearing completion of a series of case studies of National Board-certified teachers. Their findings echo the voices of the teachers attending the Ohio Colloquium: Board-certified teachers are viewed locally as among the best; however, the effects of Board-certification rarely reached outside the certified teachers' own classrooms. Board-certified teachers feel responsible to share their skills and knowledge with others but see limited opportunity to do so. See "Study sheds new light on board certifications" in *WCER Highlights, 11,* 4) Winter 1999-2000), pp. 4-5.

Appendix

Colloquium Participants

Teachers

Name	City/Town
Joyce Ackley	Chillicothe
Michele Andrews-Sabol	Lima
Tammi Bender	Mentor
Marlene Bolea	Canton
John Brovarone	Ravenna
Cheryl Burkhardt	Avon Lake
Ann Carlson	Westerville
Bernie Clemens	Cincinnati
Gerald Conover	Minster
Ann Marie Elliott	Cincinnati
Kathleen Gephart	Blanchester
Jackie Greene	Mantua
Linda Hallenbeck	Ohio Governor's Office, Teacher-in-Residence
Anne Holbrook	NASA, Teacher-in-Residence
Charlene Kobida	Cincinnati
Fen Lewis	Strongsville
Colleen Longville	Akron
Mark Lorson	Hilliard
Lynne Marlowe	Columbus
Mary Olson	Akron
Linda Petz	North Canton
Steven Proehl	Latham
Ed Quickert	Columbus
Dennis Ray	Chillicothe
Stephen Reinke	Cincinnati
John Rowe	Cincinnati
Maire Sammon	Rocky River
Peggie Shaw	Circleville
Al Summers	St. Henry
Elissa Young	Barbeton

Appendix cont'd

Other Participants

Name	City/Town
Michael Battista	Kent State University
Nancy Berkas	NCREL
Michael Billirakis	Ohio Education Association
Theron Blakeslee	NCREL
Bob Brazzle	NCREL
Anne Burglunder	NCREL
Edwina Campbell	Ohio University
Kathy Carpenter	Ohio Department of Education
Libby Cupp	Regional Professional Development Center
Carol Damian	Ohio State University
Rowena Douglas	Ohio Department of Education
Marcia K. Fetters	University of Toledo
Richard Goetz	OMSC
Janet Herrelko	University of Dayton
Peter Hewson	University of Wisconsin-Madison
Shannon Lochtefeld	Ohio Legislative Office of Education Oversight
Mary Ann Larson	NCREL
Anne Mikesell	Ohio Department of Education
Nancy Sattler	Terra Community College
William Steenken	OMSC
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OMSC NCREL

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