Summative Evaluation of the Midwest Wild Weather

1999-2003

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Midwest Wild Weather participating Museums

SciTech Hands On Museum, Aurora, Illinois – Dr. Ronen Mir, Principal Investigator, Ronen@scitech.museum

Discovery Center, Rockford, Illinois – Sarah Wolf, co- Principal Investigator

Ann Arbor Hands-On Museum, Ann Arbor, Michigan

Children's Science and Technology Museum, Terre Haute, Indiana

Grout Museums: Bluedorn Science Imaginarium, Waterloo, Iowa

Koch Science Center and Planetarium, Evansville, Indiana

Lakeview Museum of Arts and Sciences, Peoria, Illinois

Science Center, Carbondale, Illinois

Science Station, Cedar Rapids, Iowa

Advisory Panel Members

Dr. Ann Butcher	Science Coach and Teacher, Nicholson School, Aurora
Dr. Mary Ann Cooper	Associate Professor and Director, Lightning Injury Research, University of Illinois at Chicago
Steve Davis	Director of Exhibits and Outreach, University of Colorado at Boulder
Ron Gird	Satellite and Space Program Leader, National Weather Service, Washington
Margaret McCalla	Research Scientist and Meteorologist National Oceanic and Atmospheric Administration, Washington
Michelle Nichols	Coordinator of Gallery Programs, Adler Planetarium & Astronomy Museum
Phil Schwarz	TV Meteorologist, Channel 7
Dr. Marvin Wesely	Senior Meteorologist, Argonne National Laboratory
Liduvina Vivanco	Bilingual Science Teacher, Joliet High Central Campus

Executive Summary

"Outstanding! I hope it continues."

(5th grade teacher responding to her general experience with the Midwest Wild Weather Project)

After four years of development, implementation, refinement and collaboration, the Midwest Wild Weather Project (MWW) is a tremendous success.

> "Evidence from the data collected on the Midwest Wild Weather Project indicates that …the teachers are very excited about its potential for increasing their students' science literacy and understanding of the scientific process, as well as increasing their knowledge of the weather and exciting them about science in general. Students are very focused, enthusiastic and excited when interacting with the exhibits and universally pleased with their exploration and explainer experiences. MWW is also effectively reaching the intended underserved and underrepresented students across the nine sites are being involved and exposed to the benefits of MWW. The public was involved via weather events at the nine museums and science centers and the collaborative relationship among the consortium members is exemplary and ninety-seven percent (97%) of teachers queried felt it was definitively a good use of tax dollars." (Summation of the four year initiative)

MWW has successfully met or exceeded its objectives on all six of its intended goals. Each of the four formative evaluations of the Midwest Wild Weather Project (1999-2003) was designed to examine different objectives of the project. The first year's evaluation was organized around four primary topics:

1) Administrative structure and implementation,
2) Development of equipment and materials,
3) Training and school programs, and
4) Public dissemination.

Year Two assessed the level and scope of the project's implementation in relationship to its six goals and sought to provide the nine member consortium with a series of recommendations that would enable its members to continue the quality implementation of the MWW Project.

The third year's evaluation examined the impact that the MWW Project had on its fundamental goal of "improving science literacy of students." It sought to assess the changes in student learning that would occur as a result of the hands-on contact and interaction of the students with the MWW exhibits, the use of the teaching and learning materials, and the professional explanations of the project provided by the consortium members. It also assessed the impact of MWW on grade level and gender. The fourth and final formative evaluation of the MWW project was a replication of the evaluation design of Year Three and sought to reaffirm its findings.

This summative evaluation of the Midwest Wild Weather Project is derived primarily from three sources. The first is a synthesis of the four previous

formative evaluations from 1999-2003. The second is a review of the six goals that have defined the MWW project from its inception. (Please refer to Appendix A for a listing of the six goals) And the third is a summative survey of the perceptions of the directors of the MWW project. The survey queried the directors about their perceptions of the project and its ability to achieve its stated goals.

The Summative Evaluation Report is divided into four parts. Part One identifies the three key themes/decisions that enabled MWW to achieve its level of success. Part Two reviews each of the six goals of the MWW project and provides a summary of the key findings of the four previous evaluations as they relate to each goal. Part Two also includes the summary of a survey entitled, "Directors' Summative Evaluation of MWW" which was sent to each of the nine museum directors soliciting their perceptions of the MWW Project. Part Three is the summation of the general perceptions of the directors in relation to MWW. Part Four contains a set of recommendations regarding the entire Midwest Wild Weather Project.

PART ONE

Three Key Decisions

Background

The success of the MWW Project can be attributed to many factors. However, there were three decisions made at the inception of the grant that defined its direction, its impact and its eventual outcomes. The decisions are not listed in rank order, but each made a substantial impact on the eventual success of the project.

New Exhibits

The first of these decisions was to make new exhibits and not refurbish the existing ones from the original Illinois Wild Weather project. The development, distribution, and display of the new exhibits resulted in improvements of design and function from the original models. There was better operation and dependability, and more realistic replication of the specific Wild Weather concepts being observed (e.g., Hot Air Rising, Uneven Heating and the Water Cycle). Given the positive responses of the teachers and the students about the quality of the exhibits, as well as the improved signage and clarity of the presented concepts, the decision to make new exhibits was crucial to the success of MWW.

The new exhibits:

- improved the science literacy of students
- enabled teachers to acquire the science content
- exposed parents and the general public to quality hands-on learning
- provided enhanced practice of the scientific process for teachers and students
- improved the quality of services to underrepresented and underserved populations
- and were the cornerstones for shaping the mentoring and collaborative relationships among the nine sites.

The 11 new traveling exhibits that each museum employed during the duration of MWW included:

1. WIND SPEED
2. MICROBURST
3. WATER CYCLE
4. TORNADO
5. SNOWDRIFTS
6. WEATHER STATION
7. HOT AIR RISING
8. THUNDER DELAY
9. UNEVEN HEATING
10. RADAR TRACKING
11. LIGHTNING

Teacher's Manual Revised

The second decision was the revision and distribution of the Teacher's Manual. The original teacher's manual from the Illinois Wild Weather project was reviewed, revised and updated by the collaborators. There were many changes that were made, key among them were:

- the inclusion of the new science goals for each of the states (Illinois, Indiana, Iowa, and Michigan) which enabled teachers to match the activities in the manual to their individual state goals,
- a new pre-post test was rewritten,
- alternative assessments were developed,
- student activity sheets were revised and
- a Teacher's Manual Activities Matrix was developed.

The revised manual was used by teachers to prepare their students for the arrival of the exhibits to their school. It provided pre and post testing materials for teachers to assess the learning of their students, and the revised worksheets were more directly linked to the concepts incorporated into the exhibits. The linkage to state educational standards provided a framework to integrate the MWW Project into their school and district goals. The value of the teacher's manual was echoed by teachers through the project.

Collaboration and Mentoring

The third decision that was made was to commit to a strong mentoring and collaborative process. The collaboration was the mortar that held the consortium together and made it run as effectively as it did. I have worked in many evaluation efforts over the past 30 years and have rarely seen the level of cooperation, collaboration and sharing that has occurred in the MWW Project. There was a genuine and mutual respect shown to all members of the consortium whether they were “veterans” or newly hired coordinators.

At their first organizational meeting in 1999, the nine museums developed a “Statement of Collaboration” which delineated the fiscal responsibilities, sale of materials, as well as, the publications and presentations relating to the project. They also identified training and meeting schedules, developed an on-going communication via email, fax, phone and mail and established direct observation by new museum staff at established museums to insure the successful implementation the MWW Project. The “Statement of Collaboration” framework outlined by the consortium was necessary, but not sufficient to make the mentoring and the collaboration efforts work as well as they did. The commitment and professionalism of the participants of the nine museums was a significant reason why the MWW project was able to achieve its goals so successfully. Their commitment and professionalism was reflected in the level and degree of sharing.

PART TWO

Summary of the Key Findings of the Six Goals

Of the MWW Project and the Directors' Perceptions

Goal A: Improve Science Literacy of Students

"This is really fun."

(6th grade student responding to her experience with MWW exhibits)

Summary

- The goal of improving science literacy of students was realized

- Exposure to and interaction with the key elements of the MWW Project resulted in significantly increasing the knowledge of students across grade levels albeit at differential rates.

- Students loved the MWW exhibits. Regardless of the age or grade level, there was almost a unanimous positive consensus among the students as to the benefits of the MWW project.

- Male and female students both benefit to the same degree as measured by changes in their learning after they have been exposed to the MWW project.

- In the Year Three evaluation, three grade levels were compared (i.e., 6th, 7th and 8th) with no significant differences found among the learning in the classes. However, Year Four yielded strong differences between the two grade levels (i.e., 5th and 7th) as to the rate of learning after exposure to the MWW project. The seventh graders showed significantly greater levels of knowledge of Wild Weather than did the fifth grade students.

- MWW was shown to be effective in significantly increasing the knowledge of students across grade levels, however, at differential rates.

- Although male and female students at the initial stages of exposure differed in favor of the male students (i.e., during the pre-testing phase prior to exposure to the MWW exhibits), both genders benefited to the same degree statistically in their learning as measured in the posttest data. However, the males did show a strong trend in increased learning gains over the females.

- Data indicated that student learning increased significantly after exposure to the MWW experience and occurred at similar levels between male and females and across grade levels (5^{th}, 6^{th}, and 7^{th}).

Student Learning

During the four years of the study, more than 1,755 students were assessed covering ten grade levels, 26 schools, and 64 classes in all four states. Depending on the year of the evaluation, the format of the assessment varied. The clearest and most definitive statement that can be made about the MWW Project and student learning is that students not only learned but that they truly enjoyed the experience. Students were consistently positive about the MWW experience. Their positive responses focused on the exhibits, the discovery and explainer sessions as well as the activities worksheets. Although none of the exhibits was viewed in a negative light, there was a general consensus, by school and grade level, that the tornado, radar tracking, weather station, thunder delay and microburst were the students' favorites.

Students loved Midwest Wild Weather. Regardless of the age or grade level, there was almost a unanimous positive consensus among the students as to the benefits of the MWW Project. Some of the dominant characteristics indicating student interest included the following observable behaviors:

- Sitting erect and leaning forward
- Eye contact, wide eyed interest
- Head nodding to explainer's comments
- Enthusiastic response to questions and requests for volunteers (e.g., number of hands, enthusiastic waving of hands)
- Sound effects such as “ooh's and ahs”, “wow”, “cool”, “ah ha's”, laughter with their classmates, involvement with demonstrations (e.g., suction cups and air pressure, water in a bottle held over the child’s head, the hot air expansion).

One student assessment undertaken consisted of surveying 38 individual classrooms encompassing 834 students, in 10 grade levels, at 10 different schools and in four states. Please refer to Table #1 for a distribution of the students by grade level and attitude towards MWW. The attitude assessed was based on a five point scale with 5 being the most positive. As can be seen, the overall attitude rating was a 4.86 with no statistical difference among the seven grade levels.

Table # 1

Grade Level	No. of Students	Attitude Towards MWW (5 point scale)
3	84	4.8
4	342	4.9
5	172	4.9
6	102	4.7
7	63	4.8
8	26	4.9
9-12	45	5.0
Total	834	4.86

At each school visited, the 834 students were surveyed in their classes as a whole after they had completed their discovery and explainer sessions. When the students were asked about the most important thing they learned about wild weather, the answers varied both within and across grade level. Although there was a general increase by grade level in the quality and sophistication of the responses by the students, there were several responses in each grade level that were very insightful for that grade level. Some of the concepts and ideas expressed by the students during the class evaluations after they had interacted with the exhibits and had had an explainer session included: the influence of air, water, earth, and the sun on weather, wind speed, evaporation, condensation, lightening to thunder, Doppler radar and tracking.

Although there were many suggestions from students, the number one request was to spend more time with the exhibits. Since it was the first time that almost all the students had experienced MWW, the general conclusion, based on the

exposure time to the exhibits (i.e., explainer and discovery sessions), was that the overall quality of the responses was very good across all grade levels.

The evaluation design for Years Three and Four differed from the design employed in Year Two. The revised design sought to assess more directly the effectiveness of MWW to increase the students' knowledge of wild weather. Over the two years that the Year Three and Year Four assessments were completed, 923 additional students in five grade levels attending 16 different schools in 38 classrooms were assessed.

Data were obtained on the racial demographics and the income levels on most of these students in Year Three and Four. These schools ranged from 1.1 % to 75.2% of their students coming from low-income homes and consisted of a wide cross-section of racial composition. Please refer to Table # 1a for the ethnic composition of the schools.

Table # 1a Ethnic Composition					
	Caucasian	Afro-Am	Asian	Hispanic	Nat. Amer.
Average	62%	32%	1.3%	4%	1%
Number	589	305	12	37	8

Limitations of the Study

Given the "in situ" nature of the research undertaken in Years Three and Four, there were certain limitations in the sample selection process and in the interpreting of the results. Since the studies employed only a pretest and posttest model (see Appendix B for a copy of the pretest and the posttest as found in the Teacher's Manual of the MWW), there were limitations due to history, maturation, testing, instrumentation, regression, and the interaction of those factors. (Please refer to Campbell & Stanley, 1963 and Vierra, Pollock, & Golez, 1998 for a more complete discussion.)

Three questions were posed for this evaluation both years:

- Did the exposure to the MWW project result in an increase in student learning about weather?

- Do males and females differ in their learning after exposure to the MWW project?

- Do varying grade levels learn differentially when exposed to the MWW project?

The most consistent finding in Years Three and Four, as well as tangentially supported in Years One and Two of this evaluation, was that the MWW Project had a strong and positive impact on student learning. The Midwest Wild Weather Project has been shown to increase students' knowledge significantly in the area

of weather. Students exposed to the project have consistently shown a strong and positive increase in their knowledge of weather.

These findings confirm that the exposure to the MWW exhibits (i.e., discovery) and the explainer sessions do increase learning in students. Although the fifth graders in the Year Four study did not show significant gains after exposure to MWW (please refer to the Year Four report for a discussion of this point), they were a clear and unexpected outlier. Excluding that outcome, all other students exposed to MWW consistently demonstrated a strong and positive increase in their knowledge.

The findings on the second question dealing with gender showed that both male and female students benefit from their exposure to and contact with the MWW Project. Their learning of the material after their exposure to the exhibits and the explainer sessions yielded similar levels of understanding and were non significant. From the statistical data, we know that both males and females benefited equally from their involvement with MWW.

The third question in the Year Three evaluation indicated that the MWW had a strong consistent effect on learning growth across grade levels (6^{th} 7^{th} and 8^{th}) without a differential impact on grade levels. Each of the three grades participating in MWW showed parallel gains with no significant discrepancy between the three groups.

However, Year Four's results produced a very significant difference between the knowledge of the content shown by seventh graders compared to fifth graders regarding Midwest Wild Weather. The findings in Year Four, although inconsistent with the previous findings reported in Year Three, may be more predictive of the reality of the MWW project. By the very nature of the subject, the understanding of the complexities of weather should increase by grade level and, as such, the older more experienced students should approach the project with a broader knowledge base and a greater ability to grasp the concepts and theories involved in wild weather.

The conceptual design of the MWW project incorporated a wide-range of skills, activities, levels and knowledge about weather in order to accommodate varying maturity levels of students in grades 4th through 8th. It should be noted that students from grades K through high school have all benefited from the content and quality of the MWW project. These findings appear to be more reflective of the inherent structure of the sound curricular design and framework of the Midwest Wild Weather Project.

When the collective findings of the four years is distilled, the overwhelming conclusion is that The Midwest Wild Weather Project (MWW) is meeting and/or exceeding the primary goal of the grant, which is, improving the science literacy of students.

MWW Perception Survey
Directors' Box

Goal A: Improve Science Literacy of Students
(Scale: 1= Strongly Disagree 5 = Strongly Agree)

MWW was very successful in improving Student's	
Science Literacy	4.3

When queried about the impact of MWW on science literacy, the directors were strongly in agreement that it had a strong influence on students' understanding of science in general and wild weather in particular. It is interesting to note the impressive pre-post test scores that were exhibited by students across grade levels and schools. Throughout the duration of the project and across the many directors who were involved in this endeavor, they took a very direct involvement in the many facets of the MWW project from prototype development to actual implementation in the schools.

Goal B: Assist Teachers in Acquiring

Science Content, Materials, Hands-on Techniques

"Thank you for this great opportunity for our kids!"

(5th grade teacher responding to the MWW exhibits, October 2002)

Summary

- Teachers acquired science content, materials, and hands-on techniques via workshops, teacher's manuals and orientation to and interaction with the exhibits, explainer and discovery sessions.

- One of the most effective ways of reaching teachers was through the Teacher's Manual that accompanied MWW in the schools. The manual provided the teachers with a valuable resource to demonstrate the principles encompassed in the MWW Project, as well as, to extend them into the classroom learning to enrich and embellish the lessons learned from exposure to MWW.

One of the most effective outcomes of the MWW Project was the involvement of teachers in the training and preparation for MWW. To insure that the teachers were prepared to fully benefit from the MWW Project, training was provided throughout the four year duration. The training was the most intense during the first two years and modified according to need and circumstance in the final two years.

Training occurred on three levels. There were systematic teacher workshops available for all participating teachers. Workshops were held at almost every time and location (e.g., on the Fridays before the students have interacted with the exhibits via the discovery and explainer sessions, on the Mondays when the exhibits arrive at the school, at the beginning of the school year, on Saturday mornings, and during the school week after school and in the evenings). The workshops were very well received as seen by the following quote:

> *"The presenters were excellent. It was at the end of a long hard day and we don't get overtime in our district, but at the end of the workshop we were all excited."*
>
> *(4th grade teacher)*

Depending upon the site, the teacher workshops employed a variety of formats. The workshops provided specific training on the exhibits, the use of the teacher's manual, and on the concepts of weather. In addition to formal training for the teachers at the workshops, there was usually an orientation when the exhibits arrived at the schools for all teachers planning to involve their students. Teachers also learned more about the weather concept during the explainer sessions for their students. Although each site determined the agenda for their respective teacher workshops, the following items were recommended, insuring that the key elements of the project were presented to the teachers:

- Reviewing the pre-post testing of the students
- Showing the teachers how to use the manual
- Recommending specific activities

- Emphasizing the involvement of underrepresented, minority and special education students
- Using alternative assessments
- Modifying worksheets for students with disabilities and by grade level (e.g., peer tutoring)

The workshops were well received by the attendees as being very beneficial. There was consensus on several key parts of the workshop. The teachers by almost a unanimous consensus felt:

- They were appropriately informed about the workshop.
- The Teacher's Manual was thoroughly explained.
- The workshop increased their understanding of the exhibit concepts.
- The workshop increased their confidence in teaching the science principles of weather.
- The hands-on activities provided them with useful experience.
- The Coordinator of the workshop was well organized and provided an atmosphere conducive to learning.

Several of the teachers provided suggestions for improving the workshop. These suggestions included:

- More background on weather
- More suggested resources and books to extend and explain
- Develop materials for the primary grade levels
- More examples of activities
- Longer training sessions

The second type of training that occurred throughout the grant was the ongoing mentoring among the nine sites. The experienced sites (i.e., those that were involved in the original wild weather project in Illinois) have provided active and on-going mentoring to the five new sites.

The third type of training that occurred was the informal liaisons between the sites and the ongoing collaboration to share ideas, jointly solve problems and assist new staff development at the various museums and science centers. The collaborators communicated regularly via email and addressed a wide array of problems and challenges facing the MWW project.

Throughout the four years of the evaluation, there was universal agreement that the hands-on experience was the major strength of the project. The teachers consistently rated the MWW experience either a 6 or a 7 (7 = high) on its ability

to increase student learning and interest in the weather. There was general agreement that the exhibits complemented other areas of the curriculum (e.g., language arts, social studies and math). All of the teachers wanted the exhibits to return the next year and all felt it was an effective use of their "teaching" time, as well, as a good use of taxpayers' dollars. The overall consensus from the sample of teachers interviewed was that Midwest Wild Weather ranged from wonderful to excellent.

Teacher's Manual

The teacher's manual was a very important element in the MWW Project. It contained valuable information for the teacher to assist him/her in bringing wild weather concepts into the classroom. It was extensively revised and incorporated the educational goals for each of the participating states. It also contained activities for the students, background information for the teachers, supplemental materials, instructional suggestions, assessment instruments and discovery sheets to assist the students in their exploration of each of the exhibits. The manual also had a pre-post test for teachers to assist them in assessing what the students learned.

The teacher gave the manual overwhelmingly positive support for its many features. Please refer to Table # 2 for a list of the responses by the teachers

about the manual. The number in parentheses represents the number of teachers who responded to the question.

The only criticism teachers had about the manual was that they wish they had obtained a copy of the manual before the exhibits arrived at their school.

Table # 2

Topic Assessed*		Teacher Rating
Teacher's Manual Overall	*(23)*	4.76
Hands-on activities	(23)	4.67
Background information	(6)	4.67
Guided discovery sheets	(16)	4.80
Supplemental materials	(5)	5.00
Age/Grade appropriate activities	(28)	4.94

The power that the MWW Project exhibited to influence the curriculum and highlight the importance of weather in the participating schools can be seen in the teachers' responses to its overall impact. Ninety-six percent of the teachers surveyed stated that the presence of MWW would increase the school's emphasis on weather that year. Many teachers indicated that it already had.

Exhibits

"These exhibits incorporate so many things - math, science, geography, and language arts - but most of all they keep the kids' interest and they work together in teams and that's great." (5th grade teacher)

The exhibits were very well received by the students and teachers at the schools. The overall rating by the teachers was a 4.89 on a 5-point scale. When the teachers were asked about the exhibits, 100% of them felt that the exhibits were well built, and user friendly. When asked if the information on the signage was valuable, again 100% of the teachers indicated affirmatively.

To insure that the signage clearly communicated the intent of the specific exhibit, an evaluation was completed by staff members at the Science Station in Cedar Rapids. The results yielded several valuable suggestions for improving the signage on the exhibits.

MWW Perception Survey
Directors' Box

Goal B: Assist Teachers in Acquiring Science Content, Materials, Hands-on Techniques
(Scale: 1= Strongly Disagree 5 = Strongly Agree)

MWW was very successful in assisting TEACHERS in	
Acquiring Science Content	4.0
Science Materials	4.5
Hands-on Techniques	4.3

A consistent theme of teachers throughout the entire duration of the MWW Project was the value of the exhibits, especially how they could complement the quality and depth of instruction that the teachers were providing in the classroom.

Goal C: Expose Parents and the General Public to Hands-On Learning

"Cool"
(A young boy describing the MMW experience to his mother)

"This has been one very informative day."
(A member of the public after viewing the MWW exhibits)

Summary

- The general public has had many opportunities to interact with and benefit from the Wild Weather exhibits.

Public Dissemination

As a complement to the efforts in the schools, the nine museums made the MWW exhibits available to the general public throughout the year via Weather Nights or other events. Although the involvement varied over the duration of the project, the exhibits were regularly made available to the public. For example, during the first year of the grant, the exhibits were open to the public at each of the Illinois sites with approximately 30,000 visitors viewing the exhibits over a five month period. These numbers included 2,250 student visitors who were involved in 52 weather demonstrations and 27,750 members of the visiting public.

One caveat that surfaced regarding the public access to the exhibits was the fact "that some of the exhibits would not withstand the usage by 'unsupervised' visitors who may become too 'rambunctious' in their interaction with the exhibits." Therefore some of the exhibits were either not displayed or were put on the museum floor on a limited basis.

MWW Perception Survey
Directors' Box

Goal C: Expose Parents and the General Public to Hands-On Learning
(Scale: 1= Strongly Disagree 5 = Strongly Agree)

MWW was very successful in exposing	
PARENTS to hands-on learning	3.3
The PUBLIC to hands-on learning	3.4

Over the four year period of the grant, the public and parental involvement varied. A director commented that, "Almost no parents followed up with their coupons for visits to the museum. We did numerous Saturday morning weather demos and, although they were always attended, the audiences were small and, again, few if any parents from the schools receiving the program attended." Another director faced space problems and had to limit the time that the exhibits were displayed on the museum floor and correspondingly the public involvement.

Goal D: Provide Practice in Scientific Process Elements of Science Literacy for Teachers and Students

"Absolutely fantastic"
(6th grade teacher describing her experience with Midwest Wild Weather)

Summary

- The Midwest Wild Weather Project made a strong and positive impact with teachers and students in the schools. There were overwhelmingly positive reactions to Midwest Wild Weather (MWW).

The teachers' general reactions to their experiences with MWW were very positive. There was a strong consensus that MWW was a value to them as teachers and to their students for learning. Comments ranged from "Absolutely fantastic" and "The kids love it" to the most frequently mentioned reason for the positive comments: "The hands-on experiences were great".

The only concerns expressed by teachers were related to what was the most appropriate grade level for students to receive maximum benefits from the MWW experience. (Table # 3 contains the comments of the teachers regarding MWW) Of those few teachers who expressed a concern about MWW, it was usually tied to their trepidation that the exhibits were considered over their students' heads. They consisted of remarks such as, "Great potential but fourth grade does not

have a weather unit" and "Too high a level for fourth graders" (4th grade teachers at a low-income school).

Table # 3

Teacher Comments on the Overall MWW Experience** (The number in parenthesis "(7)" represents the number of times the comment was made by teachers)	
The "Hands on Experiences" were great. (7) It's very worthwhile. (2) I give it a10 out of 10. Great (6)	I loved it and the kids were excited. (2) It's really good for the students. (2) Excellent! (4) Very good (5)

The teachers were also asked to assess the value of MWW in relation to student learning and interest in science and to them as teachers. As can be seen in Table # 4, there was an overwhelming positive response to the goals of MWW. This nearly universal consensus on the part of the teachers reaffirmed their qualitative remarks about the experience with MWW in general.

Table # 4
Teacher Ratings of MWW

Questions* * The number in parenthesis "(36)" represents the number of TEACHERS responding to that item.	Rating (5point scale; 5 is the highest)
1. Helpful in facilitating student learning (36)	4.72
2. Helpful in facilitating student interest (36)	4.78
3. Value to you as a teacher (36)	4.94
4. Overall value (36)	4.76

Teachers indicated that MWW was a valuable enrichment to their curriculum and an ideal complement to their text and current efforts in the area of science in general and weather in particular.

Another area in which the MWW Project has been very successful is the linkage of the teacher's manual, the student's activities worksheets and 11 MWW exhibits made for the respective state goals for education. Teachers overwhelming saw the MWW exhibits as supporting their state goals for education. The very strong confirmation by the teachers in all four states meant that, by incorporating MWW into their science curriculum, they were fulfilling key aspects of their state goals for education of their students.

Teachers were asked to assess how the MWW activities assisted their students in the scientific process. Teachers were overwhelming supportive of this outcome. Their comments indicated that MWW reached its intended goals. (Please refer to Table # 5 for a sampling of teacher comments.)

Table # 5

Teachers' Comments on MWW and Its Impact on Student Application of the Scientific Process
• These activities and exhibits were very useful in helping my students make observations and predictions. • They learned to estimate. • The students learned how to apply aspects of weather to the real concept not just rote memory. • It lets the students solve the problems themselves. It is not teacher directed.

The impact of the MWW Project can be seen in its potential to influence and enrich other areas of the curriculum. When asked if they had or would integrate the elements and concepts of the MWW project and all of its complementary materials into their curriculum, every teacher (100%) concurred. They identified 11 primary areas of the curriculum where the MWW project could be integrated.

For example, in the area of math, the teachers envisioned the weather exhibits and the teacher workbook as natural complement to graphing, use of tables, making predictions, and estimating to name a few.

In the areas of language arts, writing, and reading, the most frequently mentioned curricular area that the teachers thought had endless possibilities was writing, reading and telling stories about the weather. Art was also identified as an area for drawing weather formations and conditions (e.g., tornados, lightning, dark clouds, and snow drifts). The impact and influence of the MWW Project was sustained throughout the school year in a variety of areas of the curriculum in the participating schools. (Please refer to Table # 6 for a complete listing of the curricular areas.)

Table # 6

Curricular Areas for Integrating MWW	
Language Arts/Writing/Reading (30) Science (2) Earth science Language	Math (17) Social Studies (9) Art Space Studies

Explainer Sessions

"This is the best thing the kids have seen in a long time"
(5th grade teacher regarding an Explainer Session)

One of the best elements of the entire MWW Project was the "Explainer Session". This was the time when a representative from the museum came to the

school and provided a demonstration on the many exciting aspects of weather. Topics included: high and low air pressure, hot air rising, hot air expanding, cold air contracting, weather is AWESome (A = air, W =water, E = earth and S=sun), wind speed, static electricity, weather vocabulary, the water cycle, the Bernoulli effect, uneven heating, cloud formation and how a thunderstorm forms, to name a few.

The teachers gave the Explainer Sessions a 4.97 rating on a five-point scale. One respondent rated the Explainer Session as an 8+ on a scale of 5. Teacher comments ranged from, “This is the best thing the kids have seen in a long time” to “The explainer was great!”

“Science can be fun and interesting.”

(5th grade teacher when asked about the most important thing the students learned)

When teachers were asked to identify the most important thing that they felt their students learned from the MWW experience, there were many strong positive comments that were identified, ranging from an increased understanding of science, high interest in the weather, hands-on experiences, peer tutoring, problem solving and social skills. What was of interest about their responses was the diversity of areas in which the MWW experience impacted their students. The social skills development, the cooperative teamwork, and peer tutoring are examples that affirm the wide-ranging impact of the project to make a difference in the learning and lives of the students.

One teacher noted that behavior problems decreased because of the involvement of one of her "overactive" students as a tutor for younger students. "He became a different child," she remarked with a sigh of relief. She went on to ask in jest, "Can I keep Wild Weather for the rest of the year?" Please see Table # 7 for a listing of the teachers' perceptions of the most important things that their students learned from the MWW experience.

Table # 7

Teachers' Perceptions of the Most Important Things Their Students Learned

- Hands-on activities
- Understanding science and weather
- The students' understand the basic weather concepts and its complexity.
- Weather is complex and there are so many different elements of it.
- The students learned about the weather.
- Increased Interest in Weather
- Peer Tutoring
- Social Skills
- Problem Solving

Given the size and length of the federal grant and the amount of time and resources that were invested in the MWW project teachers were queried about its value as a "good use of taxpayers' dollars". Ninety-seven percent (97%) felt it was definitively a good use of tax dollars.

"Outstanding, I hope it continues."

(4th Grade Teacher responding to the question of what's the best thing about MWW)

When asked what was the BEST aspect of the Wild Weather project, the most frequent response was the hands-on nature of the learning experience followed by the excellent contribution of the Explainer Sessions and the quality of the explainers. Please refer to Table # 8 for a listing of "Best Aspects of MWW as Identified by the Teachers." The number in parentheses represents the frequency which the item was mentioned.

Table # 8
Best Aspects of MWW

• Hands-on (15) • Explainer session made it all connect for the kids. (4) • The explainer was great. (4) • The exhibits increased the students' interest in the weather. (2) • Excellent way to correlate what they learn to the "real world." • The exhibits allow students to see and interact with exhibits and concepts. • Weather is something we experience all the time. • Students working collaboratively in small groups/teams. (11) • Peer tutoring • Students learn to draw conclusions • Problem solving.	• Students were highly motivated and excited. (2) • Direct observation of the weather is important. • It truly stimulated the kids to think and to try things on their own. • Very user friendly, it was easy for the kids to use. • I'm really glad it came to our school. • The presenters and planners were so well organized. • I loved Millie the molecule. • The person in charge made the whole program work smoothly. • Explainer session was great! • The kids worked together in groups. • It's like bringing a museum to the kids.

Improving Midwest Wild Weather

"Nothing"

(The responses of 19 teachers to the question how can we improve MWW)

The teachers' response to the second question yielded several suggestions on how to improve the MWW for Year Three. While the majority of the teachers who were questioned (19) felt that it did not need any improvement, several recommended more time with the exhibits. The third most frequently mentioned area for improvement came from four teachers who noted that there should be more orientation and training of the teachers prior to the exhibits coming to the school. Other suggestions focused on the teacher workshops, the schedule, the teacher's manual, and the explainer sessions. All of the teachers presented their suggestions in a positive, constructive way, indicating a genuine appreciation of the exhibits in particular and the Midwest Wild Weather project in general.

MWW Perception Survey
Directors' Box

Goal D: Provide Practice in Scientific Process Elements of Science Literacy for Teachers and Students;
(Scale: 1= Strongly Disagree 5 = Strongly Agree)

MWW was very successful in providing TEACHERS with	
Practice in the scientific process	3.5
Increased science literacy	3.8
MWW was very successful in providing STUDENTS with	
Practice in the scientific process	4.5
Increased science literacy	4.3

The directors felt strongly that both the teachers and the students benefited from the MWW project. They felt that the students benefited more than the teachers, but that the impact was consistently positive and beneficial to all involved. A distinction was made between the teachers involved, with the newer teachers benefiting the most from their exposure to MWW than the more experienced teachers who were already familiar with Midwest Wild Weather.

Goal E: Serve Underrepresented and Underserved Populations

"Everyone loved it, even those kids with no interest in anything."

(High School Special Education Teacher 2001)

Summary

- A Spanish version of the student work sheets was developed.
- A Braille version of the signage on the exhibits was completed and sent to each of the schools for use with students with visual impairments.
- Students with special needs were included in the Wild Weather activities.

Underrepresented and Undeserved Populations

One of the goals of the MWW Project was to "serve underrepresented and underserved populations by providing them with rich experiences in science." As part of the assessment, teachers were asked if they had students from minority groups, low-income families and/or students with special needs in their classes and if they were involved in the MWW opportunities. Depending on the specific demographics of the particular district, the number of students from minority groups varied by school; the number of low income and special education students was very constant. The special education numbers (i.e., 89% of the teachers had students with special needs in their classes) indicated a strong commitment on the part of the schools to insure that all of their students were include in the "mainstream" of the educational experiences of the other non-

disabled students. The overall percentage of “included” special education students along with the comments from teachers indicating awareness of and genuine sensitivity to the needs of students in special education clearly confirms that the goal of serving these students via the MWW grant was being realized.

Likewise the number of students from low-income families and in low-income areas had been a focus of the consortium of museums. Ninety–four percent (94%) of the teachers had students in their classes with these backgrounds and they were actively involved in all of the grant activities. Teachers indicated that the exhibits were an excellent opportunity for these students to experience hands-on, interactive, high quality exhibits, which merged the weather concept with a physical reality that the children could actually see. As a fifth grade teacher from a low-income school remarked, “This experience is very positive. It’s the only hands on experience some kids ever get.” (Please see Table # 9 for the percentage of teachers with students from each of the three groups identified by the goal of the grant.) The number of low income, special needs, and minority students and their active involvement in the MWW confirmed the level of commitment of the museum collaborators to insure that this goal of the MWW was realized.

Table # 9

Percentage of Teachers with Students from each Group		
Minorities	Underserved/Low Income	Special Education
64%	94%	89%

In addition to the direct involvement of the students in the individual classes, the consortium of museums continued to work to insure that the exhibits and the experiences would be accessible to all students. A Spanish language version of the worksheet was developed. The signage on each of the exhibits was translated into Braille for use for the blind and visually impaired students. Warnings were also provided to insure that the bright flashing lights and loud thunder sounds on some of the exhibits would not trigger an adverse reaction in students prone to epilepsy. There was a sincere and consistent concern and commitment on the part of the museums to insure that all students benefited from the MWW experience.

MWW Perception Survey
Directors' Box

Goal E: Serve Underrepresented and Underserved Populations
(Scale: 1= Strongly Disagree 5 = Strongly Agree)

MWW was very successful in serving STUDENTS	
Underrepresented (with disabilities)	4.0
Underserved (Culturally and ethnically diverse students)	4.8

One of the goals of the MWW Project was to bring science education and science literacy to students who were either underserved and/or underrepresented. This was a priority for the directors and their respective museums. One of the museums actually targeted an urban city school system for the implementation of the MWW Project. As the director noted, "At our site we served the entire urban city district, so we had a disproportionately high number of underserved and underrepresented." The director went on to state that as far as he knew, the students with disabilities were included in all activities of the regular classroom and students were routinely involved in many other museum programs. Of

special note were the efforts of the museums to reach out to other school populations such as home schooled families and youths. One director specifically mentioned the reaction of the home schoolers to the MWW project. He stated,

> "We offered MWW programming for home-schoolers at our museum. We received extremely positive feedback from students and parents (home school parents can be very critical) on how much they liked the program and how much science they learned. Similar responses were observed at participating schools."

The responses of the directors parallel the experiences of the MWW grant and its efforts to reach out to the underserved and underrepresented populations.

Goal F: Foster Mentoring Relationships between SPARC and Five New Sites.

Summary

- The mentoring process was very effective at all levels.
- The professionalism of the collaborating museums and science centers was exemplary.
- The mentoring process was established early in the MWW experience with museums in Illinois working closely with the five new sites in Iowa, Michigan, and Indiana.

Mentoring and Collaboration

The mentoring process, which was established in the first year of the grant, continued to function extremely well in the MWW Project. The established museums in Illinois worked closely with the five new sites in Iowa, Michigan, and Indiana.

The overall “chemistry” within the mentoring process was outstanding. The commitment among the participants along with the mutual respect that they each demonstrated to one another gave the process the high level of integrity that it had for its overall success.

One of the strengths of the consortium was the truly collaborative nature and sharing among the nine participants. Although it was reflected in many ways, it was the mentoring that the collaborative process was particularly strong. Of particular interest was the network of support that surfaced among the coordinators. Using email, phone and onsite visits with their mentors, the new staff was quickly "brought up to speed." Some examples that highlight the benefits of the mentoring relationships include:

- Marketing and advertising materials and strategies
- Book and scheduling techniques
- Developing teacher workshops
- Set-up and delivery approaches with the schools
- Removing the exhibits from the schools
- Explainers Sessions
- Discovery Sessions
- Setting up and running Family Weather Events
- Types of schools to visit
- Effective use of the teacher cadre
- Dealing with school complaints
- Increasing attendance at public weather events
- Protecting the exhibits in transit
- Utilizing the teacher's manual effectively

Nothing seemed to be viewed as proprietary among the coordinators. Literally, anyone could call any other member of the consortium and receive friendly and meaningful help. If one of them had a successful strategy or technique, it was readily shared with the others. The volume of email addressing and responding to problems and needs attested to the collaborative nature of the participants. The coordinators also utilized the expertise of the advisory panel to clarify a question about how the Coriolis Force affected the rotation of tornadoes in the Northern and Southern Hemispheres. The advisory panel provided the information and the entire consortium benefited.

During the second year of the grant, the collaborators held two meetings. These meetings had multiple agendas. In addition to two very informative presentations on the role of electricity by Robert Kampf entitled, "Nuts and Bolts of Lightning" and "Watt is Electricity, the Million Volt Electric Show", the conference also included sessions on collaboration, an overview of the specific exhibits, opportunities for collaboration, "sharing and mentoring", fiscal issues, an evaluation report, mentor roles and training, a review of the teacher's manuals and marketing strategies for the MWW Project.

The second meeting was held in August 2000 in Milwaukee, Wisconsin. Although the agenda included the discussions on the budget, exhibit covers, and timelines, the primary activity was to visit the exhibit manufacturer, E^{+} facilities, examine the actual exhibits and provide feedback to the production staff of the firm. There

were also breakout sessions for the directors and coordinators. The director's agenda consisted of discussions of collaboration, involvement in the ASTC, cost sharing and future meeting dates. The coordinators discussed scheduling, the teacher's manual, networking, and evaluating the Midwest Wild Weather Project.

At both of the meetings, opportunities were provided for mentoring to occur, as well as, additional training for the new staff. These important meetings solidified the relationships among the collaborating museums.

MWW Perception Survey
Directors' Box

Goal F: Foster Mentoring Relationships between SPARC and Five New Sites
(Scale: 1= Strongly Disagree 5 = Strongly Agree)

Mentoring Experiences	
MWW was very successful in fostering Mentoring experiences among the four original centers in Illinois and the five new sites in Iowa, Indiana, and Michigan	4.5

Please rate your relationship with the other MWW members in the following areas as they relate to the MWW project (Scale: 1= very poor….5 = very positive)

MWW Relationships	
Level of Communication	4.8
Level of Supportive	4.0
Degree of Collaboration	3.7
Degree of Cooperation	4.3

When asked to provide specific examples of how the collaboration worked, the directors pointed out that MWW led to the partners to work on projects unrelated to MWW. There were consistently high levels of cooperation on the project and a genuine willingness to share and mentor each other. With rare exceptions, this

was especially true of new directors as they were hired. One of the charter MWW members aptly described it by saying:

> "Each time a new educator came on board, they would travel to the other museums and observe. They did a lot of communicating and supporting each other."

What worked well in the collaborative process?

There were many aspects of the collaborative process that worked very well. From the willingness of the members to divide up the work and to share information to the very successful face to face meetings, the collaborative process enabled the project to consistently achieve its many goals so well.

> As one director stated, "The openness and sharing of information among all museums was remarkable. The positive feedback and support were very helpful in the process. The collaboration meetings were great – fun, informative and productive, and visiting other museums was a learning experience."

What, if anything, could have been improved in the collaborative process?

Even as successful as the collaborative process was, when asked if anything could have been done to improve the collaborative process, there was general consensus that the collaboration was one of the real strengths of the project. However, given the nine diversely located sites, the responses from other partners could have been more timely in the reporting process to NSF. Another director felt that there were other opportunities that could have been realized if all of the directors had participated fully.

Given the fact that MWW was a multiyear, complex and detailed process, I feel that one of the directors captured the sentiment of the other museums in the following quote,

> "Overall, I think it was a great success and thought that the lead museum SciTech did an excellent job in leading it."

PART THREE

Directors' Perception of the MWW Project

Midwest Wild Weather

Directors' Summative Evaluation Form

A survey entitled, "Directors' Summative Evaluation of MWW" was sent to each of the nine museum directors, soliciting their perceptions of the MWW Project as it related to the six goals of the grant, as well as, their general perceptions and recommendations for improving the grant. The Directors were informed that their responses would remain confidential and be merged with the other directors and incorporated into the final report. Their responses on each of the goals are incorporated in Part Two of this report. Their general comments and suggestions are included here in Part Three.

Four of the nine directors responded. They had an average of 16.5 years of experience as directors, ranging from 27 years to less than one year. When asked to rate their involvement in the MWW Project, it was rated very high.

MWW Perception Survey
Directors' Box

General Remarks

In the opinion of the directors, the major strengths of MWW consisted of:

1. The exposure to science as an enjoyable activity for students
2. The opportunity to serve students outside their core audience

3. The outstanding and innovative set of traveling exhibits
4. The extremely productive meetings
5. The innovative aspects of the STEM content, interactive exhibits and educational programs developed
6. The overall impact that nine small museums were able to make in terms of numbers reached and the results achieved.
7. The rapid and cost effective way of designing, developing, evaluating and producing 100 exhibits within the first year.
8. The high levels of collaboration

<u>If you had MWW to do all over again, what would you do differently?</u>

When asked what, if anything, they would do differently, the directors identified several areas for possible revision.

1. The many benefits of the MWW Project could be further enriched with more time for follow-up with teachers and students before and after the explainer sessions.
2. The explainer sessions should be presented in different formats, e.g., some could be run more like a class activity or a field trip.
3. Given the key role that the lead museum played, additional funds should have been provided to cover the staff time devoted to the project, e.g., exhibit development and grant coordination.
4. Of the many positive benefits of working with a collaborative e.g., sharing and communication and mutual problem solving, the process is more time

consuming than a single museum implementing a project such as MWW. Therefore, more time for prototyping and exhibit development needs to be integrated into the grant's budget and time frame.

5. The reproduction of the teacher's manual should have been copied in sufficient numbers so that all teachers involved in the MWW project would have had a copy prior the exhibits coming to their school.

PART FOUR

Recommendations and Concluding Remarks

Recommendations to the Granting Agency

"Wow! This is really great!"

(5th grade student interacting with the tornado exhibit)

The following recommendations have been generated from the review of the evaluations of the past four years of the MWW Project, as well as, the feedback from teachers, science museum directors and staff, the parents and the public and, most importantly, the students. The recommendations are submitted to the agency in the spirit in which the Midwest Wild Weather Project was administered and delivered to thousands of students, teachers, and parents, in schools throughout the Midwest … with great optimism and enthusiasm.

1. Continue to replicate projects that inspire wonder and awe in children.

2. Use the model developed by the MWW collaboration for similar networked NSF funded projects, so that the NSF can get ISE learning to rural and smaller communities.

3. Extend similar networked projects to more than 3 years. Three years only provides a time frame to finally refine the implementation of the grant to the point that it is beginning to achieve all of the goals. Two additional years would have enabled MWW to set a high standard for a national model.
4. Provide additional dollars for the "scalability" of the project to additional sites.

5. Provide larger budgets to similar networked projects.

6. Provide funding to facilitate more meetings of the participating museums. The organizational meetings that were held provided invaluable opportunities for the sharing and collaboration. Each was like a science museum mini-conference

7. Increase the start-up timelines for prototyping

8. Although the evaluations completed to date were designed to answer the question, it is of interest to see how much of the learning gains from MWW can be attributed to the explainer session, the discovery session, the student worksheets and workgroups as well as the teacher's influence. This research question should be explored in the future.

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Concluding Remarks

The Midwest Wild Weather was a phenomenal success in so many areas. It achieved its goals and has truly made a difference in the education and learning of students.

As I ponder the past seven years of my involvement in the Wild Weather initiative (four with MWW and the three years prior years with the Illinois version of Wild Weather), I am struck by the powerful and consistent themes that have flowed through this wonderful adventure to make a difference in the lives and learning of students and teachers. I have witnessed students time and time again who were so overwhelmingly excited about their interaction with the exhibits that they were lost in a world of exploration and wonder. I heard teachers repeatedly praising its impact on the student learning in science, how excited their students were and the quality of the exhibits, the materials, and the concepts overall.

The degree of confirmation by the teachers and the strong testimony of the students reaffirmed for me that the Midwest Wild Weather Project is one of the finest projects I have had the privilege to work with during my 30 years of evaluation in education. The efforts of so many professionals are truly complementing the education of children in our schools…A job well done!

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Appendix A

The Midwest Wild Weather Project has six primary goals. They range from improving science literacy for students and assisting teachers in acquiring science content, and teaching material to involving underrepresented and underserved students in the exciting world of science.

Goals of the Midwest Wild Weather Project

A) Improve Science Literacy of Students

B) Assist Teachers in Acquiring Science Content, Materials, Hands-on Techniques

C) Expose Parents and the General Public to Hands-On Learning

D) Provide Practice in Scientific Process Elements of Science Literacy for Teachers and Students

E) Serve Underrepresented and Underserved Populations

F) Foster Mentoring Relationships between SPARC and Five New Sites

Appendix B
Teacher's Handbook

Pretest-Posttest Used By Teachers

To Assess Changes In Student Learning.

Midwest Wild Weather Pre- and Post-Test

Name
_____Date_____

1) The shape of a tornado is called a(n):
A. cumulus B. vortex C. vertigo D. inversion
2) Cold Air:
A. rises B. falls C. holds more water than warm air D. causes rainbows
3) Water vapor is a:
A. gas B. solid C. liquid D. A, B, & C
4) The five types of precipitation are rain, freezing rain, snow, sleet and:
A. wind B. lightning C. tornado D. hail
5) Tornados will most likely occur in the:
A. Fall and Winter B. mostly in the Fall C. Spring and Summer
D. Winter and Spring
6) Lightning is a discharge of:
A. static electricity B. AC (alternating current) C. DC (direct current) D. excess outside
7) A tornado warning means:
A. a tornado has been sighted B. a tornado could form
C. there will not be a tornado D. excess heat
8) The water of the ocean:
A. heats faster than the land B. cools faster than the land C. cools and heats more slowly than land D. heats and cools at the same rate as the land
9) The change of water from liquid to gas to liquid in the atmosphere is:
A. the heat cycle B. the water cycle C. sublimation. D. dew point
10) Doppler radar tells:
A. the speed rain is moving B. the direction rain is moving
C. the temperature D. A & B
11) As the speed of air increases, the pressure it exerts:
A. also increases B. does not change C. decreases
D. at first increases, then decreases
12) Compared to measurement in degrees Celsius, temperature above zero measured in Fahrenheit:
A. has a higher numerical value B. has lower numerical value
C. is the same D. is not related
13) Weather results from a complex interaction of:
A. air and water B. air, water, and sun C. air, water, earth, and sun
D. sun and water
14) The change of water from a gas to a liquid happens as:
A. the water vapor cools B. the water vapor warms
C. the water vapor expands D. the water vapor falls
15) Define “weather”: