

DIMACS Center
Rutgers University

DIMACS Connect Institute (DCI)

Final Report

August 2004

The concept behind the DIMACS Connect Institute (DCI) is that research and education should work hand-in-hand. Collaborations between researchers and educators are formed by understanding each other's work and needs. To this end, the institute was designed around separate programs that are focused on each group's interests, along with plenary sessions and evening lectures aimed at meshing the two groups with the planned outcome of stimulating discussion and problem-solving.

This grant funded the four years of the DCI program: DCI '00, DCI '01, DCI '02, DCI '03. Separate grants funded the researcher workshops associated with DCI and the education program was also funded through support of the AT&T Foundation and DIMACS' funds obtained from its university and corporate partners. We continued the support of teachers in a Summer 2004 follow-up program, the Bio-Math Connect Institute (BMCI), using DIMACS funds.

Ia. Participants from the programs (by year and program)

DCI '00

Education Program:

Participants:

Okey Alozie, Bushwick High School, New York, NY
Kindra Cerfoglio, Edward C. Reed High School, Sparks, NV
Kaho Chan, Edward C. Reed High School, Sparks, NV
Julia Davis, Academy of Mount Saint Ursula, New York, NY
John Dollhopf, The Hill School, Pottstown, PA
Sharon Edelkind, Hillcrest High School, Jamaica, NY
John Francisco, Rutgers University, Graduate School of Education, New Brunswick, NJ
Joanie Funderburk, Grandview High School, Aurora, CO
Joyce Gates, Central Catholic Jr./Sr. High School, Lafayette, IN
Erich Gott, Eaglecrest High School, Aurora, CO
Lisa Gravitz, White Plains High School, White Plains, NY
Christine Healy, Bethpage High School, Bethpage, NY
Dan Ilaria, Rutgers University, Graduate School of Education, New Brunswick, NJ
Dan Langbauer, Sitka High School, Sitka, AK
Lorraine Lurie, High School of Telecommunications Arts and Sciences, Brooklyn, NY
Charles Mullins, Arkansas School for Math & Science (ASMS)
Janice Ricks, Marple Newtown Senior High School, Newtown Square, PA
Laurie Rubel, Collegiate School, New York, NY
Janina Rzeszutek, Hackensack High School, Hackensack, NJ
Christianah Sadiku, West Philadelphia High School, Philadelphia, PA
Jennifer Schwartz, Depew High School, Depew, NY
Cherie Umstead, High School of Legal Studies, Brooklyn, NY
Nicole Vaiana, Curtis High School, Staten Island, NY
Brian Van Gorden, Port Allegany High School, Port Allegany, PA
Dawn Vega, The Charter School of Wilmington, Wilmington, DE
Steven Wezniak, San Marcos High School, San Marcos, CA

Organizers:

Linda Lesniak (Program Director), Drew University
Fred S. Roberts (Director of DIMACS, Principal Investigator), DIMACS, Rutgers University
Joseph Rosenstein (Associate Director of Education), DIMACS, Rutgers University
Barry Tesman (Education Program Director), Dickinson College

Lead Teachers:

L. Charles (Chuck) Biehl, The Charter School of Wilmington, Wilmington, Delaware
Bro. Patrick Carney, The Montclair Kimberley Academy, Montclair, New Jersey
Mihaela Nicolescu, Salk School of Science, New York, New York

Mentors:

Heather Gavlas, Grand Valley State College
John Gimbel, University of Alaska at Fairbanks
Peter Slater, University of Alabama at Huntsville

Research Program, Week 1 (Graph Partitions, July 10 - 14, 2000):

Participants:

Lars Dovling Andersen, Aalborg University
Darryn Edward Bryant, University of Queensland
Mary Courtney, Pace University
Michael Daven, Mount Saint Mary College
Jeffrey H. Dinitz, University of Vermont
Saad El-Zanati, Illinois State University, saad@math.ilstu.edu
David Fisher, University of Colorado at Denver
Chin-Mei Kau Fu, Tamkang University
Sheel Ganatra, The Charter School of Wilmington, Delaware
Michael L. Gargano, Pace University
Heather Gavlas, Grand Valley State University
John Gimbel, University of Alaska at Fairbanks
Terry Griggs, The Open University
Alan Hartman, IBM Research Laboratory, Haifa, Israel
Irih Ben-Arroyo Hartman, Open University and Haifa University
Dean Hoffman, Auburn University
Mel Janowitz, Rutgers University
Alexander Kelmans, University of Puerto Rico
Brenda J. Latka, Lafayette College
Curt Lindner, Auburn University
Geoffrey L. McKenna, George Washington University
Louis V. Quintas, Pace University
Michael Edwin Raines, Western Michigan University
K. Brooks Reid, California State University, San Marcos
Alexander Rosa, McMaster University
Cem Saraydar, Rutgers University
Benjamin Sudakov, Princeton University
Evan Bruce Wantland, Western Montana College of the University of Montana

Organizers:

Chris Rodger (Chair), Auburn University
Linda Lesniak (Program Director), Drew University
Fred S. Roberts (Principal Investigator), DIMACS, Rutgers University

Research Program, Week 2 (Distance and Centrality Concepts in Graphs, July 17 - 21, 2000):

Participants:

Jean R.S. Blair, United States Military Academy
Adam Buchsbaum, AT&T Labs - Research
Fred Buckley, Baruch College - CUNY
Peter Dankelmann, University of Natal at Durban

Jean Dunbar, Converse College
David Erwin, Western Michigan University
David Fisher, University of Colorado at Denver
Michael L. Gargano, Pace University
John Gimbel, University of Alaska at Fairbanks
Alan Goldman, Johns Hopkins University
Weizhen Gu, South West Texas State University
Sudipto Guha, Stanford University
Teresa Haynes, East Tennessee State University
Stephen Hedetniemi, Clemson University
Michael Henning, University of Natal at Pietermaritzburg
Genie Jackson, East Tennessee State University
Mel Janowitz, Rutgers University
Garry Johns, Saginaw Valley State University
Alexander Kelmans, University of Puerto Rico
Sulamita Klein, University of Paris
Buck McMorris, Illinois Institute of Technology
Martyn Mulder, Erasmus University of Rotterdam
Christine Nickel, Johns Hopkins University
Ortrud Oellermann, University of Winnipeg
James B. Phillips, University of Alabama - Huntsville
Kenneth Proffitt, East Tennessee State University
Justo Puerto, Universidad de Sevilla
Louis Quintas, Pace University
Vishal Raj, Rutgers University
Cem Saraydar, Rutgers University
K. Brooks Reid, California State University, San Marcos
Zhizhang Shen, Plymouth State College
Henda Swart, University of Natal
Arie Tamir, Tel Aviv University
Steven Winters, University of Wisconsin at Oshkosh

Organizers:

Peter Slater (Chair), University of Alabama - Huntsville,
Linda Lesniak (Program Director), Drew University
Fred S. Roberts (Principal Investigator), DIMACS, Rutgers University

DCI `01

Education Program:

Participants:

John Bates, The Peddie School, Hightstown, NJ
Alla Bogomolnaya, Orange High School, Cleveland, OH
David Brouillard, Ponoganset High School, Glocester, RI
Leon Edwards, Granby High School, Norfolk, VA
Dolores Endicott, Upper Township Middle School, Petersburg, NJ
Kathy Erickson, Monument Mountain Regional High School, Great Barrington, MA
Richard Giantisco, Delaware Valley Regional High School, Frenchtown, NJ
Michael Paul Goldenberg, Washtenaw Technical Middle College, Ann Arbor, MI
Jerry Jared, The Blue Ridge School, St. George, VA
Jason Lewis, Holmdel High School, Holmdel, NJ

Ron Murdoch, Thetford Academy, Thetford, VT
Gisele Nassif, Baruch College Campus High School, New York, NY
Carol Oehlbeck, Greece Arcadia High School, Rochester, NY
Augusto Ortiz, Elizabeth High School, Halsey House, Elizabeth, NJ
Roberto Suarez, Barringer High School, Newark, NJ
Ronald Varnum, Greensboro Day School, Greensboro, NC

Organizers:

Linda Lesniak (Program Director), Drew University
Fred S. Roberts (Director of DIMACS, Principal Investigator), DIMACS, Rutgers University
Joseph Rosenstein (Associate Director of Education), DIMACS, Rutgers University
Barry Tesman (Education Program Director), Dickinson College

Lead Teachers:

L. Charles (Chuck) Biehl, The Charter School of Wilmington, Wilmington, Delaware
Bro. Patrick Carney, The Montclair Kimberley Academy, Montclair, New Jersey
Mihaela Nicolescu, Salk School of Science, New York, New York

Mentors:

Nancy Eaton, University of Rhode Island
Dean Hoffman, Auburn University
Evan Wantland, Western Montana College of the University of Montana

Research Program, Week 1 (Intersection Graphs, Tolerance Graphs, July 9 - 13, 2001):

Participants:

Michael Ackerman, Murray State University
Mihir Bhanot, DIMACS REU Program
Kenneth Bogart, Dartmouth College
David Brown, University of Colorado at Denver
Zhongyuan Che, Wesleyan University
Jason DeVinney, Johns Hopkins University
Nancy Eaton, University of Rhode Island
Micheal Gargano, Pace University
Marty Golumbic, Haifa University
Mohamed Haouari, Ecole Polytechnique de Tunisie
Stephen Hartke, Rutgers University
Garth Isaak, Lehigh University
Robert Jamison, Clemson University
Suh-Ryung Kim, Kyung Hee University
Sandra Kingan, Penn State University
Joshua D. Laison, Dartmouth College
Renu Laskar, Clemson University
Marc Lipman, Oakland University
Marina Lipshteyn, Bar-Ilan University
Jozsef Mala, Budapest University of Economic Sciences & Public Administration
Terry McKee, Wright State University
Geoffrey McKenna, George Washington University
T. S. Michael, United States Naval Academy
Henry Martyn Mulder, Erasmus Universiteit
Maura Murray, Salem State College

Kathryn Nyman, Cornell University
Fred S. Roberts, Rutgers University
Zhizhang Shen, Plymouth State College
Li Sheng, Drexel University
Randy Shull, Wellesley College
Ann Trenk, Cornell University
Evan Wantland, Western Montana College of the University of Montana
Peisen Zhang, Columbia University

Organizers:

Fred McMorris (Chair), Illinois Institute of Technology
Linda Lesniak (Program Director, Co-Principal Investigator), Drew University
Fred S. Roberts (Director, Principal Investigator), DIMACS, Rutgers University

Research Program, Week 2 (Tournaments, July 16 - 20, 2001):

Participants:

Jorgen Bang-Jensen, Odense University
Erol Barbut, University of Idaho
Mihir Bhanot, DIMACS REU Program
Zhongyuan Che, Wesleyan University
Micheal Gargano, Pace University
Z. Gregory Gutin, University of London
Dean Hoffman, Auburn University
Olivier Hudry, Ecole Nationale Supérieure des Telecommunications
Seog-Jin Kim, University of Illinois at Urbana-Champaign
S.J. Kirkland, University of Regina
Larry Langley, The University of the Pacific
Brenda Latka, Lafayette College
Gary MacGillivray, University of Victoria
Jozsef Mala, Budapest University of Economics
Sarah Merz, The University of the Pacific
T.S. Michael, United States Naval Academy
Kittikorn Nakprasit, University of Illinois at Urbana-Champaign
Darren A. Narayan, Rochester Institute of Technology
Mike Pelsmajer, University of Illinois at Urbana-Champaign
K. Brooks Reid, California State University, San Marcos
Peter Slater, University of Alabama in Huntsville
Meike Tewes, T-Nova Technologiezentrum
Stephan Thomasse, Université Claude Bernard
Alan Tucker, State University of New York at Stony Brook
Anders Yeo, University of Aarhus

Organizers:

Garth Isaak (Chair), Lehigh University
Linda Lesniak (Program Director, Co-Principal Investigator), Drew University
Fred S. Roberts (Director, Principal Investigator), DIMACS, Rutgers University

DCI `02

Education Program:

Participants:

Yusuf Abdi, Rutgers Graduate School of Education, New Brunswick, NJ
Sandra Bornstein, Poly Prep Country Day School, Brooklyn, NY
Karen Brown, High Technology High School, Lincroft, NJ
Kristina Dixon, Port Allegany High School, Port Allegany, PA
Dorothy Donovan, Poly Prep Country Day School, Brooklyn, NY
Alexis Doyle, Bishop Ford Central Catholic High School, Brooklyn, NY
Ellen DuBoff, Byram Hills High School, Armonk, NY
Patrick Flynn, Turner High School, Kansas City, KS
Catherine Franklin, Fayette County High School, Fayetteville, GA
Robert Fraser, Pittsford Mendon High School, Pittsford, NY
Kear Halstater, Cresskill Junior/Senior High School, Cresskill, NJ
David Hyman, Livingston High School, Livingston, NJ
Ingrid Kretschmann, New Providence Middle School, New Providence, NJ
James Kupetz, Jr., Seton Catholic High School, Pittston, PA
Beth Lazerick, St. Andrews School, Boca Raton, FL
Joseph Lucchetta, Columbia High School, Maplewood, NJ
Persheen Maxwell, The International High School at LGCC, Long Island City, NY
Roberto Reyes, Columbia High School, Maplewood, NJ
Bruce Spak, Frankford High School, Philadelphia, PA
Christine Spatola, White Plains High School, White Plains, NY
Janelle Stufft, Kennedy Catholic High School, Hermitage, PA
Tara Templeton-Harell, Dobyns-Bennett High School, Kingsport, TN

Organizers:

Linda Lesniak (Program Director), Drew University
Fred S. Roberts (Director of DIMACS, Principal Investigator), DIMACS, Rutgers University
Joseph Rosenstein (Associate Director of Education), DIMACS, Rutgers University
Barry Tesman (Education Program Director), Dickinson College

Lead Teachers:

L. Charles (Chuck) Biehl, The Charter School of Wilmington, Wilmington, Delaware
Bro. Patrick Carney, The Montclair Kimberley Academy, Montclair, New Jersey
Mihaela Nicolescu, Collegiate School, New York, New York

DCI '02 Mentors:

John Gimbel, University of Alaska at Fairbanks
Dean Hoffman, Auburn University
Peter Slater, University of Alabama at Hunstville

Research Program, (Labelings and Numberings of Graphs, July 14 - 19, 2002):

Participants:

James Abello, DIMACS, Rutgers University (formerly with AT&T Labs)
David W. Atkins, East Tennessee State University
Suman Balasubramanian, Clemson University
Krystyna T. Balinska, Technical University of Poznan
Gary Bloom, City College of New York (CUNY)
Ljiljana Brankovic, The University of Newcastle
Robert C. Brigham, University of Central Florida
Tamara Burton, Rochester Institute of Technology
Han Hyuk Cho, Seoul National University
Linda Eroh, University of Wisconsin Oshkosh

David Erwin, Trinity College
Michael Gargano, Pace University
Stephen Hartke, Rutgers University
Bert Hartnell, St. Mary's University
Johannes H. Hattingh, Georgia State University
Jamie Howard, East Tennessee State University
Robert E. Jamison, Clemson University
Min Jung Kim, Seoul National University
Suh-Ryung Kim, Kyung Hee University
Renu Laskar, Clemson University
Alexander Lee, Lynbrook High School
Sin-Min Lee, San Jose State University
Ian Levitt, Polytechnic University
Daphne Liu, California State University at Los Angeles
James A. MacDougall, The University of Newcastle
Dan McQuillan, Norwich University
Eric Mendelsohn, University of Toronto
Darren A. Narayan, Rochester Institute of Technology
Ji Yeon Park, Kyung Hee University
Nick Phillips, Southern Illinois University
Louis V. Quintas, Pace University
Fred S. Roberts, DIMACS, Rutgers University
Alexander Rosa, McMaster University
Peter Slater, University of Alabama in Huntsville
Barry Tesman, Dickinson College
Bin Tian, Rutgers University
Denise S. Troxell, Babson College
John Villalpando, Clemson University
Walter D. Wallis, Southern Illinois University
Liming Wang, Rutgers University
Xuding Zhu, National Sun Yat-sen University

Organizers:

Peter Slater (Chair), University of Alabama in Huntsville
Linda Lesniak (Program Director, Co-Principal Investigator), Drew University
Fred S. Roberts (Director, Principal Investigator), DIMACS, Rutgers University

DCI '03

Education Program:

Participants:

Victoria Barrameda, Lake Worth High School, Lakeworth, FL
Jason Bershatsky, Mercersburg Academy, Mercersburg, PA
Ramona Besleaga, Spiru Haret High School, Romania
Amy M. Bray, Rush-Henrietta Ninth Grade Academy, Henrietta, NY
Nicolae Breazu, Spiru Haret High School, Romania
Joel Bundt, M.O.C.-Floyd Community Schools, Orange City, IA
Fred G. Campillo, Stephen F. Austin High School, Austin, TX
Erin Cerchio, William Dickinson High School
Nicole A. Davis, Grayson High School, Loganville, GA
Nancy Dorff-Pennea, Suncoast Community High School, Riviera Beach, FL

Mogos Carmen Elena, Alexandru Ian Cuza High School, Romania
Melvin Fox, Mercyhurst Preparatory High School, Erie, PA
Sister Elizabeth Graham, Christ the King Regional High School, Middle Village, NY
Michael Greene, Archbishop Mitty High School, San Jose, CA
Brenda Hartmann, Mountain Lakes High School, Mountain Lakes, NJ
Janet Indermuehle, Central High School, Springfield, MO
Catalina Anca Isofache, Alexandru Ian Cuza High School, Romania
Halle Kananack, School of the Future, New York, NY
Thomas Kehinde, Norman Thomas High School, New York, NY
Jeffrey Lesser, Schreiber High School, Port Washington, NY
Marta Magiera, John Hope College Preparatory High School, Chicago, IL
Misty Maib, Metairie Park Country Day School, Metairie, LA
Laurene McKenna, Fort Ann Central School, Fort Ann, NY
David Donald Mellor, North Smithfield High School, North Smithfield, RI
Sonja Lynne Mitchell, New Haven, CT
Lois Rashkin, Bayshore High School, Bradenton, FL
Heather Robinson, Grayson High School, Loganville, GA
Russell Rogers, II, Wallkinn Valley Regional High School, Hamburg, NJ
Segal Rosenfeld-Kirsch, Fair Lawn, NJ
Kenneth Smith, Hudson County Schools of Technology, North Bergen, NJ
Melissa Spencer, Creekside High School, Murray, UT
Willie Taylor, McGill-Toolen Catholic, Mobile, AL
Godfred Tong, District 23, Brooklyn, Brooklyn, NY
Jessica VanDriesen, Wadleigh Secondary School, New York, NY
Ben Weins, M.O.C.-Floyd Community Schools, Orange City, IA

Organizers:

Linda Lesniak (Program Director), Drew University
Fred S. Roberts (Director of DIMACS, Principal Investigator), DIMACS, Rutgers University
Joseph Rosenstein (Associate Director of Education), DIMACS, Rutgers University
Barry Tesman (Education Program Director), Dickinson College

Lead Teachers:

L. Charles (Chuck) Biehl, The Charter School of Wilmington, Wilmington, Delaware
Bro. Patrick Carney, The Montclair Kimberley Academy, Montclair, New Jersey
Mihaela Nicolescu, Collegiate School, New York, New York

DCI '03 Mentors:

Kim Factor, Marquette University
John Gimbel, University of Alaska at Fairbanks
Evan Wantland, Warren Wilson College

Research Program, (Combinatorial Design Theory, July 13-18, 2003):

Participants:

Frank Bennett, Mount Saint Vincent University
Vladimir Boginski, University of Florida
Tiberius Bonates, RUTCOR, Rutgers University
Marco Buratti, Universita di Perugia
Peter Danziger, Ryerson University
Megan Dewar, Carleton University
Jeff Dinitz, University of Vermont

Peter Dukes, Arizona State University
Tony Evans, Wright State University
Kim Factor, Marquette University
Franya Franek, McMaster University
Mike Gargano, Pace University
Heather Gavlas, Illinois State University
John Gimbel, University of Alaska at Fairbanks
Lucia Gionfriddo, Università degli Studi di Catania
Dean Hoffman, Auburn University
Jonathan Jedwab, University of Richmond
Alexander Kelmans, University of Puerto Rico
Sandra Kingan, Penn State University, Harrisburg
Esther Lamken, Caltech
Curt Lindner, Auburn University
Alan C.H. Ling, University of Vermont
Sasha Logan, Auburn University
Karen Meagher, University of Ottawa
Lorenzo Milazzo, Università di Catania
Lucia Moura, University of Ottawa
Fred S. Roberts, DIMACS, Rutgers University
Alexander Rosa, McMaster University
Kiley Smith, Wake Forest University and AT&T Labs
Brett Stevens, Carleton University
Leo Storme, Ghent University
Barry Tesman, Dickinson College
Walter Wallis, Southern Illinois University
Evan Wantland, Warren Wilson College
Bridget Webb, The Open University
Igor Zverovich, RUTCOR, Rutgers University

Organizers:

Robert Jamison (Co-Chair), Clemson University
Eric Mendelsohn (Co-Chair), University of Toronto
Linda Lesniak (Program Director, Co-Principal Investigator), Drew University
Fred S. Roberts (Director, Principal Investigator), DIMACS, Rutgers University

Pilot BNCI Program 2004

Education Program:

Participants:

Richard Adkisson, Oakcrest High School, Mays Landing, NJ
Ramona Besleaga, Spiru Haret High School, Romania
Amy M. Bray, Rush-Henrietta Ninth Grade Academy, Henrietta, NY
Fred G. Campillo, Stephen F. Austin High School, Austin, TX
Mogos Carmen Elena, Alexandru Ian Cuza High School, Romania
Dolores Endicott, Upper Township Middle School, Petersburg, NJ
Kathy Erickson, Monument Mountain Regional High School, Great Barrington, MA
Thomas Fleetwood, The Charter School of Wilmington, Wilmington, DE
Patrick Flynn, Turner High School, Kansas City, KS
Cathy Franklin, Jordan High School, Columbus, GA
Lou Giglio, Riverdell Regional High School, Oradell, NJ

Kear Halstater, Cresskill High School, Cresskill, NJ
David Hyman, Livingston High School, Livingston, NJ
Catalina Anca Isofache, Alexandru Ian Cuza High School, Romania
Jerry Jared, The Blue Ridge School, St. George, VA
Elena Kaczorowski, Fox Lane High School, Bedford, NY
Halle Kananack, School of the Future, New York, NY
James Kupetz, Seton Catholic High School, Pittston, PA
Marta Magiera, John Hope College Preparatory High School, Chicago, IL
Misty Maib, Metairie Park Country Day School, Metairie, LA
Charles Mullins, Arkansas School for Math, Sciences and Arts
Ronald Murdoch, Hartford High School, White River Junction, VT
Keara Pompliano-Gallagher, South Amboy Middle/High School
Segal Rosenfeld-Kirsch, Harel High School, Jerusalem, Israel
Turi Elizabeth Swan, Seymour Community High School, Seymour, WI
Brian VanGorden, Port Allegany High School, Port Allegany, PA
Callie Roth Welstead, M.L. King High School, Riverside, CA
Linda Wohlever, Hathaway Brown School, Shaker Heights, OH

Organizers:

Fred S. Roberts (Director of DIMACS, Principal Organizer), DIMACS, Rutgers University
Midge Cozzens (Co-Organizer), Colorado Institute of Technology
Shelly Leibowitz (Principal Coordinator), Wheaton College
Joseph Rosenstein (Associate Director of Education), DIMACS, Rutgers University
Robert Hochberg (Principal Lecturer), East Carolina University

Lead Teachers:

L. Charles (Chuck) Biehl, The Charter School of Wilmington, Wilmington, Delaware
Patrick (Pat) Carney, The Montclair Kimberley Academy, Montclair, New Jersey
Kathleen Gabric, Hinsdale Central High School, Hinsdale, Illinois

Research Experience Leaders:

Laurie Heyer, Davidson College
Elizabeth "Z" Sweedyk, Harvey Mudd College

Research Experience Consultant:

Steve Billups, University of Colorado

Guest Lecturers:

Midge Cozzens, Colorado Institute of Technology
Laurie Heyer, Davidson College
Elizabeth "Z" Sweedyk, Harvey Mudd College
Teresa Przytycka, NIH
Fred S. Roberts, DIMACS, Rutgers University
Bill Sofer, Rutgers University

Module Writing:

Shelly Leibowitz, Wheaton College

Math Education Expertise:

Joe Rosenstein, Rutgers University

Jerry Goldin, Rutgers University

Val DeBellis, The Shodor Education Foundation, Inc.

Ib. Participating Organizations

Rutgers, The State University of New Jersey, Princeton University, AT&T Labs – Research, Bell Labs, Telcordia Technologies (formerly Bellcore), the NEC Laboratories America, Avaya Labs, IBM Research, HP Labs, Microsoft Research.

Each provided speakers and organizers. Rutgers hosted the programs. The AT&T Foundation also provided partial support for DCI.

II. Project Activities

DIMACS Connect Institute (DCI)

DCI was the successor program to the DIMACS Research and Education Institute (DREI). One of the main goals of DCI has been that the research program corresponds similarly to the topics of study in the education program. The teachers were encouraged to ask the researchers for help with their homework problems. The researchers were encouraged to discuss with the teachers matters of pedagogy. Both types of discussions occurred during the day at breakfast, lunch and breaks, and continued in the evening at the hotel at dinner and after dinner. The “research scavenger hunts” were another vehicle for integration. These were intended, among other things, to introduce teachers to the activity of mathematical research, using books and journals in the library, MathSciNet on the computer, and research participants as resources, and to introduce participants to each other. The scavenger hunts were extremely successful, generating positive feedback from both teachers and researchers. Teachers used the researchers as resources. The teachers had to do a presentation towards the end of the research week to both the research participants and their fellow teachers.

The main difference between DREI and DCI was that the teachers participating in DCI engaged in a “real research experience” on an extended topic in graph theory. The teachers worked in groups to produce a Technical Report on their work. They had to do a presentation towards the end of the program explaining their research.

Another difference between DREI and DCI was that the teachers had the opportunity to return the following summer. The teachers participating in the second summer engaged in a more advanced research experience on an extended topic in graph theory and also served as guides to the new teachers. The teachers again worked in groups to produce a Technical Report on their work. They had to do a presentation towards the end of the program explaining their research to both their cohort group and the new cohort group.

Another main difference between DREI and DCI was the emphasis on bringing research experiences back into the classroom. The culmination of this part of the program was an annual high school student research conference held each spring at Rutgers University beginning in April 2001.

DCI 2000

DCI '00 was held at the DIMACS Center on the Rutgers University campus (July 10 - August 4, 2000). The overall theme was Graph Theory and Its Applications to the Problems of Society; the Research Program topics were Graph Partitions, and Distance and Centrality Concepts in Graphs. There were approximately an overall total of 100 people registered for this program. Program attendees included 26 high school teachers; 28 resident researchers for week one; 35 resident researchers for week two. (The research program totals included undergraduate students, faculty and researchers who attended one or more days of the program.)

Linda Lesniak (Drew University) was both overall program director and director of the research program. Barry Tesman (Dickinson College) was the education program director. L. Charles Biehl (teacher, The Charter School of Wilmington), Mihaela Nicolescu (teacher, Salk School of Science), and Bro. Patrick Carney (teacher, The Montclair Kimberley Academy) were the lead teachers for the education program. The lead teachers assisted Tesman in running homework sessions, teacher implementation sessions and overall program planning, and assisted the mentors with the research projects. Mentors for the research portion of the program were Heather Gavlas (Grand Valley State College), John Gimbel (University of Alaska at Fairbanks) and Peter Slater (University of Alabama – Huntsville).

There were two aspects of the education program: the first two weeks consisted of a series of lectures given by Barry Tesman. During the second two weeks, the teachers engaged in research projects under the guidance of the mentors and lead teachers. A successful part of the education program consisted of teacher presentations based upon a topic introduced by a research program participant. Also, a library of books and materials was set up for the teachers and researchers to use as reference materials and for developing professional plans and presentations. As in previous years, All Institute speakers spent time with the teachers after their presentations to answer questions, etc.

Eighteen of the teachers returned with their students in April 2001 for the High School Student Research Conference, at which the students (30 in all) presented research work on a topic based upon the classroom lecture materials/plenary sessions that were given to the entire Education group during the previous summer. This was a tremendously successful and very exciting conference. See the section on Project Training/Development for some discussion of this part of the program.

The DCI '00 program continued in Summer 2001 with 18 teachers returning for a second summer in the period of July 23, 2001 - August 3, 2001 (three of these teachers returned for a third summer in 2002). These two weeks followed closely the format of the last two weeks of the previous summer's program. However, the research topics were more in-depth, emphasizing the skills they learned during the first summer. The returning teachers also acted as "guides" for the new cohort teachers on the DCI 2001 program. Research mentors for this part of the program were Heather Gavlas (Grand Valley State College), John Gimbel (University of Alaska at Fairbanks), Peter Slater (University of Alabama – Huntsville), Nancy Eaton (University of Rhode Island), Dean Hoffman (Auburn University), and Evan Wantland (Western Montana College of the University of Montana).

A library of books and materials was set up for the teachers and researchers to use as reference materials and for developing professional plans and presentations. Plenary speakers spent time with the teachers after their presentations to answer questions, etc.

The lead teachers' took on new responsibilities with the change in format of the DCI program.. They participated in program and schedule planning from the very first meeting. Lead teachers were able to do "implementation" sessions for the teachers each week during the four-week period. The participants' reaction to these implementations was undeniably enthusiastic with a desire to have seen more. The lead teachers ran a plenary session for teachers and researchers in which each of them presented a mini

implementation lesson. They also participated in one pedagogy plenary session. They also assisted the Mentors of the Research portion of the program in guiding the teachers in their research projects.

The research program consisted of two week-long research conferences. The topic of week one was Graph Partitions, chaired by Christopher Rodger (Auburn University), and the topic of week two was Distance and Centrality Concepts in Graphs, chaired by Peter Slater (University of Alabama – Huntsville). High quality formal research presentations were given throughout the conference and we noted a high level of research activity (work sessions, small group sessions, presentations) taking place.

DCI 2001

DCI '01 was held at the DIMACS Center on the Rutgers University campus (July 9 - August 3, 2001). The overall theme was Graph Theory and Its Applications to Problems of Society; the Research Program topics were Intersection Graphs, Tolerance Graphs and Tournaments. There were approximately an overall total of 90 people registered for this program. Program attendees included 16 high school teachers; 35 resident researchers for week one; 25 resident researchers for week two. (The research program totals included undergraduate students, faculty and researchers who attended one or more days of the program.)

Linda Lesniak (Drew University) was both overall program director and director of the research program. Barry Tesman (Dickinson College) was the education program director. L. Charles Biehl (teacher, The Charter School of Wilmington), Mihaela Nicolescu (teacher, Salk School of Science), and Bro. Patrick Carney (teacher, The Montclair Kimberley Academy) were the lead teachers for the education program. The lead teachers assisted Tesman in running homework sessions, teacher implementation sessions and overall program planning, and assisted the mentors with the research projects. Mentors for the research portion of the program were Nancy Eaton (University of Rhode Island), Dean Hoffman (Auburn University), and Evan Wantland (Western Montana College of the University of Montana).

There were two aspects of the education program: the first two weeks consisted of a series of lectures given by Barry Tesman. During the second two weeks, the teachers engaged in research projects under the guidance of the mentors and lead teachers. A successful part of the education program consisted of teacher presentations on a topic based upon a topic introduced by a research program participant. Also, a library of books and materials was set up for the teachers and researchers to use as reference materials and for developing professional plans and presentations. As in previous years, All Institute speakers spent time with the teachers after their presentations to answer questions, etc.

Nine of the teachers from the 2001 Education Program and six teachers from the 2000 Education Program returned with their students in May 2002 for the High School Student Research Conference, at which the students (39 in all) presented research work on a topic based upon the classroom lecture materials/plenary sessions that were given to the entire Education group during the previous summer.

The DCI '01 program continued in Summer 2002 with 10 teachers returning for a second summer in the period of July 22, 2002 - August 2, 2002. These two weeks followed closely the format of the last two weeks of the previous summer's program. However, the research topics were more in-depth, emphasizing the skills they learned during the first summer. The returning teachers also acted as "guides" for the new cohort teachers on the DCI 2002 program. Research mentors for this part of the program were Nancy Eaton (University of Rhode Island), Evan Wantland (Pacific University), John Gimbel (University of Alaska at Fairbanks), Dean Hoffman (Auburn University), and Peter Slater (University of Alabama at Huntsville).

A library of books and materials was set up for the teachers and researchers to use as reference materials and for developing professional plans and presentations. Plenary speakers spent time with the teachers after their presentations to answer questions, etc.

The lead teachers participated in program and schedule planning from the very first meeting. Lead teachers were able to do “implementation” sessions for the teachers each week during the four-week period. The participants' reaction to these implementations was undeniably enthusiastic with a desire to have seen more. The lead teachers ran a plenary session for teachers and researchers in which each of them presented a mini implementation lesson. They also participated in one pedagogy plenary session. They also assisted the Mentors of the Research portion of the program in guiding the teachers in their research projects.

The research program consisted of two week-long research conferences. The topic of week one was Intersection Graphs, Tolerance Graphs, chaired by Fred McMorris (Illinois Institute of Technology), and the topic of week two was Tournaments, chaired by Garth Isaak, (Lehigh University). As with DCI '00, high quality formal research presentations were given throughout the conference and we noted a high level of research activity (work sessions, small group sessions, presentations) taking place.

DCI 2002

DCI '02 was held at the DIMACS Center on the Rutgers University campus (July 14 - August 2, 2002). The program was reduced to a total of three weeks and included only one research program week. However, the total number of program hours was not much less than in DCI 2001 since we started on Sunday evening and went to late on Friday afternoon. The change was made to try to make DCI attractive to more teachers by having one less week (a suggestion which was made on many evaluations).

The overall theme was Graph Theory and Its Applications; the Research Program topic was Labelings and Numberings of Graphs. There were approximately an overall total of 65 people registered for this program. Program attendees included 22 high school teachers and 41 resident researchers. (The research program totals included undergraduate students, faculty and researchers who attended one or more days of the program.)

Linda Lesniak (Drew University) was both overall program director and director of the research program. Barry Tesman (Dickinson College) was the education program director. L. Charles Biehl (teacher, The Charter School of Wilmington), Mihaela Nicolescu (teacher, Collegiate School), and Bro. Patrick Carney (teacher, The Montclair Kimberley Academy) were the lead teachers for the education program. The lead teachers assisted Tesman in running homework sessions, teacher implementation sessions and overall program planning, and assisted the mentors with the research projects. Mentors for the research portion of the program were John Gimbel (University of Alaska at Fairbanks), Dean Hoffman (Auburn University), and Peter Slater (University of Alabama – Huntsville).

There were two aspects of the education program: the first week and a half consisted of a series of lectures given by Barry Tesman. During the second week and a half, the teachers engaged in research projects under the guidance of the mentors and lead teachers. A successful part of the education program consisted of teacher presentations on a topic based upon a topic introduced by a research program participant. Also, a library of books and materials was set up for the teachers and researchers to use as reference materials and for developing professional plans and presentations. As in previous years, All Institute speakers spent time with the teachers after their presentations to answer questions, etc.

Eight of the teachers from the 2002 Education Program, one of the teachers from the 2001 Education Program, one teacher from the 2000 Education Program and five visiting teachers returned with their students in May 2003 for the High School Student Research Conference, at which the students (78 in all) presented research work on a topic based upon the classroom lecture materials/plenary sessions that were given to the entire Education group during the previous summer.

The DCI '02 program continued in Summer 2003 with the teachers returning for a second summer in the period of July 20, 2003 - August 1, 2003. These two weeks followed closely the format of the research portion of the previous summer's program. However, the research topics were more in-depth, emphasizing the skills they learned during the first summer. The returning teachers also acted as "guides" for the new cohort teachers on the DCI 2003 program.

A library of books and materials was set up for the teachers and researchers to use as reference materials and for developing professional plans and presentations. Plenary speakers spent time with the teachers after their presentations to answer questions, etc.

The lead teachers participated in program and schedule planning from the very first meeting. Lead teachers were able to do "implementation" sessions for the teachers each week during the three-week period. The participants' reaction to these implementations was undeniably enthusiastic with a desire to have seen more. The lead teachers ran a plenary session for teachers and researchers in which each of them presented a mini implementation lesson. They also participated in one pedagogy plenary session. They also assisted the Mentors of the Research portion of the program in guiding the teachers in their research projects.

The research program consisted of a weeklong research conference. The topic was Labelings and Numberings of Graphs, chaired by Peter Slater (University of Alabama in Huntsville). As with the previous summers, high quality formal research presentations were given throughout the conference and we noted a high level of research activity (work sessions, small group sessions, presentations) taking place.

DCI 2003

DCI '03 was held at the DIMACS Center on the Rutgers University campus (July 13 - August 1, 2003). The program was a total of three weeks and included one research program week. We started on Sunday evening and went to late on Friday afternoon. We first experimented with a three week program in DCI '02 in response to suggestions from the high school teachers. We learned that a three week program makes DCI attractive to more teachers than a four week program.

The overall theme was Graph Theory and Its Applications; the Research Program topic was Combinatorial Design Theory. There were approximately an overall total of 75 people registered for this program. Program attendees included 35 high school teachers and 38 resident researchers. (The research program totals included undergraduate students, faculty and researchers who attended one or more days of the program.)

Linda Lesniak (Drew University) was both overall program director and director of the research program. Barry Tesman (Dickinson College) was the education program director. L. Charles Biehl (teacher, The Charter School of Wilmington), Mihaela Nicolescu (teacher, Collegiate School), and Bro. Patrick Carney (teacher, The Montclair Kimberley Academy) were the lead teachers for the education program. The lead teachers assisted Tesman in running homework sessions, teacher implementation sessions and overall program planning, and assisted the mentors with the research projects. Mentors for the research portion of

the program were John Gimbel (University of Alaska at Fairbanks), Kim Factor (Marquette University), and Evan Wantland (Warren Wilson College).

There were two aspects of the education program: the first week and a half consisted of a series of lectures given by Barry Tesman. During the second week and a half, the teachers engaged in research projects under the guidance of the mentors and lead teachers. A successful part of the education program consisted of teacher presentations on a topic based upon a topic introduced by a research program participant. Also, a library of books and materials was set up for the teachers and researchers to use as reference materials and for developing professional plans and presentations. As in previous years, All Institute speakers spent time with the teachers after their presentations to answer questions, etc.

Two of the teachers from the 2003 Education Program, two of the teachers from the 2002 Education Program, and one visiting teacher returned with their students in May 2004 for the High School Student Research Conference, at which the students (21 in all) presented research work on a topic based upon the classroom lecture materials/plenary sessions that were given to the entire Education group during the previous summer.

The DCI '03 program continued in Summer 2004 with the teachers returning for a second summer in the period of July 18, 2003 – July 30, 2003. These two weeks followed a similar model to that of the past DCI programs but the topic was the interface between mathematics and biology. This program is discussed in detail under DCI 2004.

A library of books and materials was set up for the teachers and researchers to use as reference materials and for developing professional plans and presentations. Plenary speakers spent time with the teachers after their presentations to answer questions, etc.

The lead teachers participated in program and schedule planning from the very first meeting. Lead teachers were able to do “implementation” sessions for the teachers each week during the three-week period. The participants' reaction to these implementations was undeniably enthusiastic with a desire to have seen more. The lead teachers ran a plenary session for teachers and researchers in which each of them presented a mini implementation lesson. They also participated in one pedagogy plenary session. They also assisted the Mentors of the Research portion of the program in guiding the teachers in their research projects.

The research program consisted of a week-long research conference. The topic was Combinatorial Design Theory, chaired by Robert Jamison (Clemson University) and Eric Mendelsohn, (University of Toronto). As before, high quality formal research presentations were given throughout the conference and we noted a high level of research activity (work sessions, small group sessions, presentations) taking place.

Pilot BMCI Program 2004

As a follow-up to the DIMACS Connect Institute, we held the DIMACS Bio-Math Connect Institute at the DIMACS Center on the Rutgers University campus (July 18 – July 30, 2004). This 2004 program was not supported under this grant; in fact, the support for the teachers in this pilot program was provided by DIMACS as part of our commitment to DCI. This program was a natural extension of DCI, using that as a successful program model. The program was a total of two weeks. We started on Sunday evening and went to late on Friday afternoon.

The overall theme was molecular biology, computational biology, and bioinformatics. There were approximately 45 people involved in this program. Program attendees included 28 high school teachers, 27 in mathematics and 1 in biology.

We chose the math and biology theme for the following reasons. Modern biology has changed dramatically in the past two decades. Driven by large scientific endeavors such as the human genome project, it has become very much an information science, closely tied to tools and methods of the mathematical sciences. New algorithms and mathematical models played a central role in sequencing the human genome and continue to play a crucial role as biology develops models of information processing in biological organisms. Increasingly, undergraduate and graduate students are being exposed to this interplay between the mathematical and biological sciences. In high schools, the biology curriculum has made some advances by including such things as genetics and the human genome project, and even some of the mathematics in the Mendelian genetics model. There are also a few isolated efforts to bring biological examples into the mathematics classroom. But high schools are lagging behind. Current efforts need to be supported and new efforts developed to bring high school education up to speed in the integration of mathematics and biology. Students need to be exposed to the excitement of modern biology from both the biological and mathematical point of view. They need to be informed of the new educational and career opportunities that are arising from the interface between these disciplines. Introducing high school students to the interface between the biological and mathematical sciences will not only enhance the study of biology, but also the study of mathematics. Students interested in studying biology will realize the importance of understanding modern mathematics. New horizons will be opened for those who might find mathematics interesting, but wonder how it might be useful. There is the potential for all students to study mathematics both longer and more seriously because they are aware early of its importance in applications such as protecting us from bioterrorism, responses to public health crises, and understanding modern diseases.

Fred S. Roberts (DIMACS, Rutgers University) was the Director of DIMACS and Principal Organizer, with Midge Cozzens (Colorado Institute of Technology) as Co-Organizer and Shelly Leibowitz (Wheaton College) as Principal Coordinator of the program. Robert Hochberg (East Carolina University) was the Principal Lecturer. L. Charles Biehl (teacher, The Charter School of Wilmington), Bro. Patrick Carney (teacher, The Montclair Kimberley Academy), and Kathleen Gabric (Hinsdale Central High School) were the lead teachers for the education program. The lead teachers assisted Hochberg in running homework sessions, teacher implementation sessions and overall program planning, and assisted the mentors with the research projects. The Research Experience Leaders were Laurie Heyer (Davidson College) and Elizabeth "Z" Sweedyk (Harvey Mudd College). The Module Writing Leader was Shelly Leibowitz, Wheaton College. Educational consultants were Gerald Goldin (Rutgers), Joseph Rosenstein (Rutgers), and Val DeBellis (Shodor Educational Foundation.) Dr. DeBellis helped with the module writing and will work on piloting the modules. Steve Billups (University of Colorado) was a research consultant.

There were two aspects of the education program: the first week and a half consisted of a series of lectures given by Rob Hochberg. The teachers got an introduction to molecular biology, computational biology, and bioinformatics. They learned about sequence alignment algorithms, finding the smallest number of mutations of a certain type to switch one sequence into another, algorithms for finding a sequence from its fragments, preconstruction of phylogenetic (evolutionary) trees, RNA structure prediction, and other mathematical techniques. Computer lab sessions introduced participants to key software tools of bioinformatics such as BLAST. A successful part of the education program consisted of teacher presentations based upon a topic introduced by a Research Resource Person. Also, a library of books and materials was set up for the teachers and researchers to use as reference materials and for developing professional plans and presentations.

In the second week of the program, one group of teachers engaged in a research project (similar to the "traditional" DIMACS Connect Institute research experiences for teachers) under the guidance of researchers in computational biology and bioinformatics. They also prepared research experiences for their students to bring back to their schools. A second group of teachers produced classroom materials (modules) for use in their schools and possible later inclusion in the DIMACS Educational Modules Series, under the guidance of content experts in bio-math and experts in pedagogy. These modules will be piloted by the teachers engaged in the research part of the Institute, as well as by the module writers in their own classrooms. During the 2004-2005 academic year, there will be classroom visits by mentors and/or participants. Students will report on classroom activities at a conference in April, 2005.

We hope to build on our experience with the BMCI program by developing a program for Summer 2005 that will pair math and biology teachers in a program in which they can learn together and from each other and build collaborations that will grow stronger and more productive throughout the following academic year. We expect that this will be the basis for many future programs of this sort at DIMACS and participants will have an opportunity to be in on the beginning of what we hope will be a pioneering venture at bringing the biological and mathematical sciences closer together in the high schools.

III. Project Findings

In the summer of 2002, Fred Roberts gave a lecture on 'Challenges for Discrete Mathematics and Theoretical Computer Science in Homeland Security' to the DCI teachers. In the lecture, he talked about using mathematical models to help policymakers make decisions about prevention of or response to smallpox attacks and described some simple graph-theoretical models he had been working on. All of the teachers responded enthusiastically, many took the ideas back to their schools, and one, Chuck Biehl of the Charter School of Wilmington (Delaware), encouraged two students to do a project on this topic. The result was a quite-sophisticated computational model, prepared by 12th graders Chintan Hossain and Hiren Patel, designed to compare the effect of different vaccination strategies for smallpox. A beautiful paper prepared by Hossain and Patel summarizes their model and conclusions drawn from it.

The model of Hossain and Patel involves generating social networks by random methods. Infected individuals are traced through different stages of the disease, from incubation to the rash and scabbing stages, with different probabilities of infectivity at different stages. The students prepared C++ code to simulate epidemics resulting from initial infections and used the simulations to compare intervention strategies. Roberts put the students in touch with experts on smallpox modeling and their work resulted in several awards. A highlight was the presentation of the work to the DIMACS Working Group Meeting on Spatio-Temporal and Network Modeling of Diseases in April 2003. Their paper has now been submitted to the journal *Mathematical and Computer Modelling*.

The research program led to numerous new research collaborations, the solution of several conjectures, and to a number of papers that have already been written, including papers co-authored by college faculty and high school teachers. Here is just a small selection of these types of outcomes.

John Gimbel (University of Alaska at Fairbanks), Cherie Umstead (High School of Legal Studies, Brooklyn, NY), Nicole Vaiana (Curtis High School, Staten Island, NY), Brian Van Gorden (Port Allegany High School, Port Allegany, PA) and lead teacher Mihaela Nicolescu (Salk School of Science, New York, New York) researched dominating sets of vertices in a graph that have the property that distinct vertices are dominated by distinct subsets of the dominating set. They completely characterized those graphs that have such a set and developed bounds on the cardinality. They applied their findings to familiar families of graphs such as paths, cycles, and trees. This wonderful collaboration involving teachers and a researcher led to a published paper.

“As a direct result of DREI '96 on Computational Geometry and Computer Graphics, our school has a unit on Voronoi Diagrams used to culminate the topics of geometric construction and systems of linear equations, complete with a graphing calculator piece. (2) As a direct result of DREI '96 (same title as before) I have been able to develop a workshop on Voronoi Diagrams and computational geometry which has been presented in several state conferences and twice at the national conference for NCTM. (3) As a direct result of DCI 2000 and 2002, I have developed materials relating to massive graphs and their properties, in collaboration with Bill Aiello (researcher '00) and James Abello ('02), both from ATT Research.” Chuck Biehl, Lead Teacher, DREI/DCI Education Programs. These materials appeared in the September 2003 issue of *Mathematics Teacher*, the professional journal of the NCTM. The cover shows two of Mr. Biehl's students analyzing a massive graph that they have produced.

“John Villalpando and I attended the DCI 02 research week at DIMACS from July 14-19, 2002. We collaborated on a research paper with Fred Roberts and Peter Fishburn during that period, resulting in an article entitled "Parameters on $L(2,1)$ -colorings". We plan to continue doing some more work along this line. Thanks to DIMACS and NSF for this wonderful opportunity,” Renu Laskar, Research Program participant, DCI '02.

“I have a joint paper with Xuding Zhu (another participant) in which some of the results came from discussion during the DCI 02 research workshop. The paper will be submitted to a research journal for publication, once it is ready. The tentative title is: "Circular distance two labeling and the lambda number for outerplanar graphs" by Daphne Liu and Xuding Zhu. Another paper that I am working on is also related to the talk that I gave at DCI '02 (I posted the problem at the workshop and most recently I find a solution myself.) The tentative title of the paper is: "Radio number for cycles," Daphne Liu, Research Program participant, DCI '02.

“We started a joint project of investigating the spectra of the chromatic numbers of graph decompositions during the planning sessions for the DCI Research. Two papers are emerging from this effort: one on general properties of chromatic spectra and the other on lacunary spectra. In February 2004, Jamison invited Mendelsohn to Clemson as the 2004 Andrew Sobczyk lecturer. Mendelsohn delivered a talk on Design Theory aimed for a general audience. His lecture was well-attended and well-received. During that visit, we continued our work on graph decomposition spectra. Jamison is now spending the month of July with Mendelsohn to continue work on this problem. Over the past year, Peter Dukes, a PhD student of Mendelsohn who attended the research part of the conference has been in contact with several of the Auburn participants, as well as Nicole Davis, who attended the teachers' portion and is a MS student of Jamison.” Robert Jamison and Eric Mendelsohn, Research program chairs, DCI '03.

“I am glad to have this opportunity to thank DCI for its support. I was invited by Fred Roberts to present the paper "On Critical Trees Labeled with a Condition at Distance Two" at the "Labelings and Numberings of Graphs" workshop at the DCI '02. It was a wonderful experience to be able to interact not only with researchers in the field but also with High School teachers. From a conversation with Dr. Sin-Min Lee during the workshop, I got inspired to work on a related topic and the final results were compiled in "L(2,1)-labelings of Products of Two Cycles" (DIMACS Tech Report 2003-33) presented a year later in the first meeting of the "DIMACS/DIMATIA/Renyi Working Group on Graph Colorings and their Generalizations." Both articles were submitted for publication. Since I currently work in a business school environment (Babson College), I have very limited support to continue with my research in graph theory. The participation in the DCI program was crucial in helping me disseminate my work and in giving me new research ideas. Indirectly, the articles mentioned above put me in touch with several researchers in the area including John Georges from Trinity College, Ann Trenk from Wellesley College, and Sarah Spence from Olin College of Engineering. I am presently working with Ann and Sarah on some possible links between graph theory and coding theory.” Denise Sakai Troxell, DCI '02

IV. Project Training/Development

Training and career development were major goals of the program. See section on Human Resource Development for comments of participants on the impact DCI had on their careers.

A major goal was to integrate research and teaching and make teachers feel a part of a larger, and alive, mathematical sciences enterprise.

We evaluated our various goals and the evaluations are expanded upon here.

DCI '00

The DCI program was evaluated by professional evaluator Regina Gray, M.S. We cite the following excerpts from Ms. Gray's report. Over 25% of the high school teachers reported they had at least daily interactions with researchers. 64% of the researchers reported that they had at least daily interactions with high school teachers. 41% of the researchers reported their interactions with high school teachers at the Institute were moderate to very valuable. 24% of the high school teachers reported their interactions with researchers were moderate to very valuable. Interactions between teachers and researchers were much more significant than simply exchanging pleasantries or ideas about education. Researchers confirmed what teachers reported. 46% of the researchers who responded to the questionnaire reported they had exchanged information on mathematics with someone from the Education Program two or more times a week. Researchers also reported their conversations with high school teachers went further than just the exchange of information. About half of the Research Program respondents reported that they had collaborated on a project, problem, or work with a high school teacher at least once. True integration continued.

DCI '01

The DCI program was evaluated by professional evaluator Xueyun "Shirley" Xie, M.S. We cite the following excerpts from Ms. Xie's report. Over 46.7% of the high school teachers reported they had at least daily interactions with researchers. 41% of the researchers reported that they had at least daily interactions with high school teachers. 40% of the researchers reported their interactions with high school teachers at the Institute were moderate to very valuable. 100% of the high school teachers reported their interactions with researchers were moderate to very valuable. Interactions between teachers and researchers were much more significant than simply exchanging pleasantries or ideas about education. Researchers confirmed what teachers reported. 37% of the researchers who responded to the questionnaire reported they had exchanged information on mathematics with someone from the Education Program two or more times a week. Researchers also reported their conversations with high school teachers went further than just the exchange of information. The program clearly achieved its objectives.

DCI '02

The DCI program was evaluated by professional evaluator Xueyun "Shirley" Xie, M.S. We cite the following excerpts from Ms. Xie's report. Over 47.6% of the high school teachers reported they had at least daily interactions with researchers. 88.9% of the researchers reported that they had at least daily interactions with high school teachers. 88.9% of the researchers reported their interactions with high school teachers at the Institute were moderate to very valuable. 95.2% of the high school teachers reported their interactions with researchers were moderate to very valuable.

We determined how well the program met its objectives by comparing pre and post answers from participants. Before attending this program, 72.7% of the teachers indicated that they had little or no knowledge of what mathematical researchers do. 50% indicated that they had little or no knowledge of how mathematics is applied to problems of society. At the end of the program, 76.2% indicated they have general or advanced knowledge of what mathematical researchers do. 81% indicated that they had general or advanced knowledge of how mathematics is applied to problems of society. Before attending this program, 36.4% indicated that they brought current research into their teaching and 50% that they brought applications of mathematics to problems of society into their teaching. At the end of the program, 66.7% indicated that they expected to bring current research into their teaching and 90.5% that they expected to bring applications of mathematics to problems of society into their teaching.

DCI '03

The DCI program was evaluated by professional evaluator Xueyun "Shirley" Xie, M.S. We cite the following excerpts from Ms. Xie's report. Over 31.4% of the high school teachers reported they had at least daily interactions with researchers. 44.4% of the researchers reported that they had at least daily interactions with high school teachers. 94.5% of the researchers reported their interactions with high school teachers at the Institute were moderate to very valuable. 91.4% of the high school teachers reported their interactions with researchers were moderate to very valuable.

We determined how well the program met its objectives by comparing pre and post answers from participants. Before attending this program, 58.3% of the teachers indicated that they had little or no knowledge of what mathematical researchers do. 44.4% indicated that they had little or no knowledge of how mathematics is applied to problems of society. At the end of the program, 90.9% indicated they have general or advanced knowledge of what mathematical researchers do. 90.9% indicated that they had general or advanced knowledge of how mathematics is applied to problems of society. Before attending this program, 66.7% indicated that they brought current research into their teaching and 91.6% that they brought applications of mathematics to problems of society into their teaching. At the end of the program, 93.9% indicated that they expected to bring current research into their teaching and 100% that they expected to bring applications of mathematics to problems of society into their teaching.

The following comments provide an excellent summary of the impact of the DCI program on the high school teachers. These were in answer to the question of how DCI will impact your in-class instruction.

"I feel that DCI has equipped me to provide more robust graph theory instruction and to lead students in research. I feel more prepared and energized toward this than I expected. I began with significant doubts. I believe that I can provide more practical applications to students. I also see viable options for student research with the possibility of presenting next spring." Joel Bundt, DCI '03

"I can answer the question: 'How can I ever use this?' I will talk much more about current research and assign research papers. Invite a researcher into my classroom." Janet Indermuehle, DCI '03

"My daily excitement level for math and current math research has become much higher. Certainly, my students will respond to my excitement." Ben Weins, DCI '03

"Enormously. I plan to bring discrete topics, especially games, into my class. I think it will be motivating and I hope to be able to go beyond examples to running at least a small research project." Jessica Van Driesen, DCI '03

“I have wanted to write and thank you for the wonderfully enriching experience that Dimacs Connect Institute afforded me. Everything about it met my highest expectations and beyond. When I heard about the institute it sounded like the perfect opportunity for me. I had developed and taught a Discrete Mathematics course at my school last year for the first time. I teach at Suncoast Community High School, in Riviera Beach, FL. It is a magnet school with four programs, one of which is Computer Science and Technology. We had just instituted Discrete Mathematics as a required, honors level course for the seniors in this program. I was excited to have the opportunity to teach this new course and while I enjoyed the experience very much, it was not an easy process. I had to feel my way as I went and teach myself some of the topics, particularly graph theory, without too many resources at my disposal. None of my colleagues were knowledgeable in this area, and I knew of no one else with whom I could collaborate or turn to for assistance. This isolation was very frustrating. My hope for attending DCI was that my knowledge would be expanded and that I would be able to improve the course for my students this year. Not only was this hope fulfilled, but I benefited in other ways as well. Barry Tessman's graph theory course was excellent. It reinforced and extended my knowledge, which has been a great help this year. He was a wonderful role model as a teacher, providing creative and effective ideas for lesson content as well as for teaching techniques. As a student in a structured class setting for this component of the institute I was able to experience the perspective my own students have, which is a terrific advantage for a teacher. I have also gained invaluable rewards from the second portion of the institute - meeting and working with research mathematicians. Learning firsthand about current mathematics research, observing the process during formal presentations and informal communication, and engaging in a research project with my peers has added a new dimension to my abilities as a high school math teacher. I know that my students have already benefited by being exposed to my newly gained perspective and enthusiasm. It is my intention that as I guide them in their own research projects I will be providing them with an appreciation for mathematics and its place in today's world that they would not otherwise have. I feel that I would be remiss if I didn't mention the mentoring provided by John Gimbel and Evan Wantland, in particular, as being one of the highlights of my learning experience. Their abilities to guide and teach at a level that is at once accessible, challenging, enjoyable, and professional are unsurpassed. In addition to this, they were especially adept at facilitating the dynamics of the personalities involved in group work. And perhaps the result that has been most valuable to me is that I have been able to continue communication through email, providing me with the assistance and continued mentoring that I was lacking previously. This in itself has made a world of difference for me. They are both truly inspirational. Nothing about the program could have been done or handled any better than it was. I look forward with great anticipation to returning next summer and expanding upon this wonderful experience. Please accept my grateful thanks for a program well planned and executed.” Nancy Dorff-Pennea, DCI '03

V. Outreach Activities

A unique aspect of the program was its place within a vital and active research center with many other exciting programs, which overlapped with DCI, and the predecessor program DREI.

Special mention should be made of the DIMACS Research Experiences for Undergraduates Program. More than 20 students from across the US spend eight weeks each summer at DIMACS doing mentored research. The students mingled with the DCI participants and four of them each summer starting in summer 2000 made presentations on their research to an All Institute session consisting of high school teachers and researchers.

Special mention should also be made of the workshops, tutorials, research projects, and seminars ongoing at DIMACS during DCI. In particular, the teachers at DCI were encouraged to make connections with researchers and students in interdisciplinary programs in mathematical and computational molecular biology and in data mining.

Special mention should also be mentioned of the variety of international activities at DIMACS during DCI, including partnership activities with internationally famous research centers such as the DIMATIA Center at Charles University in Prague and the Renyi Institute in the Hungarian Academy of Science in Budapest. Participants in DCI met foreign students, researchers, and educators, and there was considerable interaction with some emphasis on educational issues in foreign countries.

VI. Papers

J. W. Berry, D. Hrozcik, S. Rao, S., and Z. Shen, "Finding Central Sets of Tree Structures in Synchronous Distributed Systems." Accepted for presentation in, and publication in the *Proc. of the 17th International Conference on Parallel and Distributed Computing Systems* (PDCS-2004).

L. C. Biehl, "Massive graphs, power laws, and the World Wide Web," *Mathematics Teacher* **96** (6), (2003) 434-436.

L. C. Biehl, "Biomathematics: Where K. Bacon Meets S. Cerevisiae," submitted to *Mathematics Teacher*.

J. Gimbel, B. D. Van Gorden, M. Nicolescu, C. Umstead, and N. Vaiana, "Location with dominating sets," *Congr. Numer.* **151** (2001) 129-144.

R.E. Jamison, "Bigraceful Labelings of Trees," in preparation.

R.E. Jamison and E. Mendelsohn, "Lacunae in decompositions of graphs," in preparation.

R.E. Jamison and E. Mendelsohn, "On the chromatic spectrum of tree decompositions of graphs," in preparation.

R. J. Kingan, S. R. Kingan, and Wendy Myrvold, "On matroid generation," *Proceedings of the Thirty-Fourth Southeastern International Conference on Combinatorics, Graph Theory, and Computing, Congressus Numerantium* **164**, (2003) 95-109.

R. J. Kingan and S. R. Kingan, "A software system for matroids," *Graphs and Discovery*, DIMACS Series in Discrete Mathematics and Theoretical Computer Science, American Mathematical Society (to appear).

R. Laskar, F.S. Roberts, and P. Fishburn, "Parameters on $L(2,1)$ -colorings," in preparation.

D. Liu, "Radio number for cycles," in preparation.

D. Liu and X. Zhu, "Circular distance two labeling and the lambda number for outerplanar graphs," in preparation.

T. S. Michael and V. Pinciu, "Multiply Guarded Guards in Orthogonal Art Galleries," in *Proceedings of the International Conference on Computer Science*, San Francisco, Springer, 2001.

T. S. Michael and V. Pinciu, "Art Gallery Theorems for Guarded Guards," *Computational Geometry: Theory and Applications*, **26** (3), (2003) 247-258.

C. Schwarz and D.S. Troxell, "L(2,1)-labelings of products of two cycles" DIMACS Tech Report 2003-33.

C. Schwarz and D.S. Troxell, "L(2,1)-labelings of products of two cycles" submitted to *Discrete Applied Mathematics*.

Z. Shen, "An optimal broadcasting schema for the mesh structures," in *Proc. of ISCA 17th International Conference on Computing and their Applications*, San Francisco, April, 2002, 273-276.

Z. Shen, "An optimal broadcasting schema for multidimensional mesh structures" (Extended Abstract), in *Proc. of the 2003 ACM Symp. on Applied Computing*, ACM Press, New York (2003) 1019--1023.

Z. Shen, "Average diameter and its estimation in the non-linear structures," *Computers & Mathematics with Applications*, **40** (2000), 261-.

Z. Shen, "The calculation of average distance in the mesh structures," *International Journal of Computers & Mathematics with Applications*, accepted.

D. S. Troxell, "On critical trees labeled with a condition at distance two," submitted to *Discrete Mathematics*.

I. E. Zverovich and I. I. Zverovich, "Forbidden induced subgraph characterization of cograph contractions," *J. Graph Theory* **46** (2004) 217-226.

I. E. Zverovich and O. I. Zverovich, "Dominant-matching graphs," *Discuss. Math. Graph Theory* **24** (2004).

VII. Other Products

<http://dimacs.rutgers.edu/dci/>

Here are the Tech Reports produced by high school teachers in the research portion of the program:

DCI '00

"Differentiating Sets, Dimension, Identifying Codes, and An Application to Radiation Detection," Cherie Umstead, Nicole Vaiana and Brian VanGorden.

"k-Domination in Graphs," Joanie Funderburk, Lorraine Lurie and Jennifer Schwartz.

"Dominating And Independent Dominating Number On Various Graphs," Sharon Edelkind, Erich A. Gott and Charles Mullins.

"Harmonious and Line-Distinguishing Colorings On Graphs," Kaho Chan, Christianah Sadiku and Dawn Vega.

"A Comparison of Equitable and Proper Colorings," John Dollhopf, Christine Healy and Janina Rzeszutek.

"Graph Coloring Variations: An Investigation Of Acyclic Chromatic And Cochromatic Numbers," John Francisco, Dan Illaria and Janice Ricks.

“Minimum Total Distance On Cubic Graphs,” Julia Davis, Dan Langbauer and Laurie Rubel.

“Minimum Average Distance Partitioning for Line Networks and Grid Graphs,” Okay Alozie, Kindra Cerfoglio and Joyce Gates.

“Centers And Path Centers In Trees And Graphs,” Lisa S. Gravitz-Weber and Steven P. Wezniak.

DCI '00 – Returning Teachers in Summer 2001

“Metric Dimension of Simple Graphs,” Brian Van Gorden and Nicole Vaiana.

“Conflict Graph Variations: An Investigation Of The K -Defective Independence Number For Cycles,” John M. Francisco, Dan F. Langbauer and Janice D. Ricks.

“Competitive Facility Locations,” Charles Mullins and Laurie Rubel.

“Centroids & Medians,” Lisa S. Gravitz-Weber and Steven P. Wezniak.

“Social Choice Functions And Their Properties,” Sharon Edelkind and Lorraine Lurie.

“ ρ -Labeling of Graphs,” Joanie Funderburk and Janina Rzeszutek.

“Graceful and α - Labelings,” Julia I. Davis, John W. Dollhopf and Erich Gott.

“Harmonious Labeling of Graphs,” Joyce Gates and Dan Ilaria.

DCI '01

“Intersection Graphs with Consecutive Labeling Property,” Alla Bogomolnaya and Ron Murdoch.

“An Analysis of the Properties of Cycles, Wheels, and k -Wheel Intersection Graphs,” Kathy Erickson, Jason Lewis and Carol Oehlbeck.

“Sincere & Sophisticated Voting win Or Lose,” Roberto Suarez, Dolores Endicott and Ron Varnum.

“Kings And Tournaments,” John Bates, Jerry Jared and Gisele Nassif.

“ S_n -Representations of Graphs with Tolerance t ,” David Brouillard and Michael Paul Goldenberg.

“Representing Graphs With Paths,” Leon Edwards and Richard Giantisco.

“ P_s Can be Represented by S_m with Tolerance of T ,” Augusto Ortiz.

DCI '01 – Returning Teachers in Summer 2002

“List Assignments for Proper Graph Coloring Wherein Hall’s Condition Represents An Insufficient Condition,” Alla Bogomolnaya, Ron Murdoch and Gisele Nassif.

“Relationships Between Chromatic Number and List Chromatic Number,” Kathy Erickson, Dee Endicott, Charles Mullins and Brian Van Gorden.

“Chromatic Number, Choice Number, and Defect Coloring for Cycles, the Petersen Graph, and Other Graphs,” Jerry Jared, Ron Varnum and Lisa Gravitz-Weber.

“Defect One Choice Number for Complete Bipartite Graphs,” David Brouillard, Richard Giantisco and Carol Oehlbeck.

DCI '02

“Finding the Search Number for Families of Graphs,” Patrick Flynn, Beth Lazerick and Tara Templeton.

“Acquisition Numbers of Families of Graphs,” Ellen DuBoff, Catherine Franklin and David Hyman.

“Conflict Resolution of Weighted Graphs Using Stress Coloring,” Karen Brown, Kristina Dixon, Ingrid Kretschmann and James Kupetz, Jr.

“The Bandsize of Complete graphs, Cycles, Paths, and Stars,” Yusuf Abdi and Joseph Lucchetta.

“Frequency Assignments for Radio Stations,” Persheen Maxwell, Bruce Spak and Janelle Stuft.

“Two-Player Games and Grundy Labelings,” Sandra Bornstein, Dorothy Donovan and Roberto Reyes.

“Grundy Labeling,” Robert Fraser, Kear Halstater and Christine Spatola.

DCI '02 – Returning Teachers in Summer 2003

“Signed Graphs,” Kear Halstater, Patrick Flynn, Yusuf Abdi, and John Francisco.

“Cyclic and 1-Rotational G-Designs of Order n ,” Janina Wozniak, James Kupetz and Kristina Dixon.

“Decomposition of K_n into Graphs with Three Edges,” Joseph Lucchetta, Charles Mullins and Ellen DuBoff.

“Path, Star and Matching Designs,” Brian Van Gorden, Jerry Jared, and Catherine Franklin.

DCI '03

“Finding Maximum Team Divisions for Families of Graphs,” Misty Maib, Sister Elizabeth Graham, Melissa Spencer and Laurene McKenna.

“Packing 4-Cycle Systems,” Jason Bershatsky, Godfred Tong, Russell Rogers and Halle Kananack.

“Finding the Clique Covering of Graphs.” Catalina Anca Isofache, Mogos Carmen Elena, Lois Rashkin and Segal Rosenfeld-Kirsch.

“C₄ Decompositions: Conditions & Restrictions,” Amy M. Bray, David Mellor, Willie Taylor and Jessica VanDriesen.

“Containing an n-stage Fire on the Hexagonal Grid,” Joel Bundt, Brenda Hartmann and Janet Indermuehle.

“Containing an n-stage Fire on the Rectangular Grid,” Erin Cerchio, Nancy Dorff-Pennea, Michael Greene and Kenneth Smith.

“Tournaments with ties represented by no arcs: The Dominators,” Nicolae Breazu, Melvin Fox, Thomas Kehinde and Jeffrey Lesser.

“Tournaments with ties represented by double arcs: Euler’s Angels,” Ramona Besleaga, Nicole A. Davis, Marta Magiera and Sonja Lynne Mitchell.

“Domination in Communication Center Selections: Trail Mix,” Victoria Barrameda, Fred G. Campillo, Heather Robinson and Ben Weins.

BMCI '04 (including Returning DCI '03 Teachers in Summer 2004)

Technical Reports

“Shortest Common Superstring,” Ramona Besleaga, Fred Campillo, Mogos Carmen Elena, Elena Kaczorowski, Marta Magiera, and Charles Mullins.

“Spikes, Speckles, Canyons and Craters: Noise Reduction in MAGIC Tool Images,” Cathy Franklin, David Hyman, James Kupetz, and Keara Pompliano-Gallegher.

“Oligo Cross-Hybridization and Microarray Analysis,” Kear Halstater, Jerry Jared, and Misty Maib.

Modules

“BioMatrices,” Rick Adkisson, Segal Rosenfeld-Kirsch, Turi Swan.

“The Riddle of the Genes A Biomathematics Module,” Amy Bray, Lou Giglio, and Catalina Isofache.

“Occam’s Razor Combinatorics and DNA,” Dee Endicott, Halle Kananack, and Ron Murdoch.

“Genetic Inversion Rearrangement: Are you a rotated mouse?” Kathy Erickson, Tom Fleetwood, Pat Flynn, Brian VanGorden.

“Your Condition is Conditional,” Callie Welstead and Linda Wohlever.

VIII. Contributions within Discipline

Most of the research results obtained were in the fields of discrete mathematics and theoretical computer science, broadly defined. These are areas in which DIMACS is very strong and has a world-wide reputation. Still, it is remarkable how much research activity resulted from the research workshops. The most important contribution to the disciplines of discrete math and theoretical computer science in

particular, and to the discipline of mathematical sciences broadly speaking (including all areas of mathematics, computer science, operations research, statistics, etc.) was the opening up of new horizons to some very dedicated high school teachers and, in turn, their students of all backgrounds. The other very important contributions to the discipline were the opening up of important new lines of communication between researchers, resulting in new collaborations, and the creation of continuing partnerships between researchers and teachers, resulting in the excitement about current research being brought into the classroom.

These contributions were shared with the mathematics education community at the April 22, 2004 meeting of the National Council of Teachers of Mathematics in Philadelphia in a panel discussion, "DIMACS Connect Institute." The panelists included high school teachers Laurie Rubel, Brian VanGorden, Lisa Weber, and their students, a lead teacher, Brother Pat Carney, and the education program director, Barry Tesman. Brother Pat reported on the success of the panel as follows:

"All of our panel ... did an excellent job. It worked just as planned. Barry went first and told about the class and researching the researchers, then Laurie spoke about her experiences at Collegiate and she introduced her student Neal (now at Penn) who told about it from the student point of view. He was followed by Lisa who talked about her work with minority students who had more trouble with math and many would have dropped it after taking the minimum courses. Then Brian spoke about the value in a rural area where the nearest university is 100 miles away. He let them know about the contacts via e-mail with researchers. Pooja (my student) then told them about her current work (with the help of John Gimble) on a problem that has never been solved and how while she did not succeed in either proving or disproving it, she felt she learned a lot from the process. ... I had introduced the whole thing by saying a bit about DIMACS, the program, and the evolution. I then finished by showing some of the pictures which related to people who spoke or who were mentioned. Lisa had also shown pictures." Brother Pat Carney, DCI lead teacher.

IX. Contributions -- other Disciplines

DCI emphasized applications. Here is a sample of talks given that related to applications.

DCI 2000

Chuck Biehl and Sheel Ganetre, The Charter School of Wilmington, Wilmington, DE, "Traffic Flows Theory and Transportation Networks:

Alan Hartman IBM Research Laboratory, Haifa, Israel, "The Mathematics of Software Engineering"

Fred S. Roberts, DIMACS/Rutgers University, "From Garbage to Rainbows: The Many Applications of Graph Coloring"

David Erwin, Western Michigan University, "Radio Labelings of Graphs"

Sudipto Guha, Stanford University, "Improved Approximation Algorithms for Fault Tolerant Facility Location"

Teresa Haynes, East Tennessee State University, "Power Domination in Graphs Applied to Electrical Power Networks"

Peter Slater, University of Alabama – Huntsville, "Distance, Centrality and Facility Location"

DCI 2001

Michael L. Gargano, Pace University, "A Genetic Algorithm Approach to Solving the Archaeology Seriation Problem"

Fred S. Roberts, DIMACS/Rutgers University, "From Genes to Archaeological Digs and from Traffic Lights to Childhood Development: The Many Applications of Interval Graphs"

Jozsef Mala, Budapest University of Economic Sciences and Public Administration, "Lambda-Majority Voting Paradoxes"

DCI 2002

James Abello, DIMACS, Rutgers University, “Massive Graph Mining”

Fred S. Roberts, DIMACS, Rutgers University, and Peter Fishburn, AT&T Labs, “Full $L(2,1)$ -colorings of Graphs and the Channel Assignment Problem”

Fred S. Roberts, DIMACS, Rutgers University, “Discrete Math and Homeland Security”

Denise S. Troxell, Babson College, “On Critical Trees Labeled with a Condition at Distance Two”

John Villalpando and Renu Laskar, Clemson University, “ $L(2,1)$ -Colorings Parameters”

Xuding Zhu, National Sun Yat-sen University, “ $L(2, 1)$ - Labelings of Outerplanar Graphs”

DCI 2003

Vladimir Boginski, University of Florida, “Graph Representation of Sportsmen’s Professional Relationships: Social Networks in Sports”

Vladimir Boginski, University of Florida, “Network-Based Approaches to the Analysis of Financial Data”

Alan C.H. Ling, University of Vermont, “An application of permutation arrays to block ciphers”

Group research projects from the DCI teacher program also connected to applications. Here are some of the group research paper topics that related to applications:

DCI 2000

Cherie Umstead, Nicole Vaiana and Brian Van Gorden, “Differentiating Sets, Dimension, Identifying Codes, and An Application to Radiation Detection”

DCI 2000 – Returning Teachers Summer 2001

Charles Mullins and Laurie Rubel, “Competitive Facility Locations.”

Sharon Edelkind and Lorraine Lurie, “Social Choice Functions and Their Properties.”

DCI 2001

Roberto Suarez, Dolores Endicott, and Ron Varnum, “Sincere & Sophisticated Voting Win or Lose.”

DCI 2002

Karen Brown, Kristina Dixon, Ingrid Kretschmann, and James Kuptez, Jr., “Conflict Resolution of Weighted Graphs Using Stress Coloring.”

Persheen Maxwell, Bruce Spak, and Janelle Stuft, “Frequency Assignments for Radio Stations.”

DCI 2003

Misty Maib, Sister Elizabeth Graham, Melissa Spencer and Laurene McKenna, “Finding Maximum Team Divisions for Families of Graphs”.

Joel Bundt, Brenda Hartmann and Janet Indermuehle, “Containing an n-stage Fire on the Hexagonal Grid”.

Erin Cerchio, Nancy Dorff-Pennea, Michael Greene and Kenneth Smith, "Containing an n-stage Fire on the Rectangular Grid".

Victoria Barrameda, Fred G. Campillo, Heather Robinson and Ben Weins, "Domination in Communication Center Selections: Trail Mix".

Here are some of the high school student research projects presented at the High School Student Research Conferences that related to applications:

DCI 2000: Saturday, April 28, 2001

Maria Areiz, Victor Danny Cardozo, and Elvert Restrepo (White Plains High School, Supervised by Lisa Gravitz), "Distance and Facility Location."

Alex Cunha and Danielle Rosenberg (White Plains High School, Supervised by Lisa Gravitz), "The Traveling Salesman Problem."

Whitney Donaldson and Christine Cordova (San Marcos High School, Supervised by Steve Wezniak), "Solving Shortest Path, Minimal Distance, and Traveling Salesman Problems Using Weighted Graphs and Various Algorithms."

Leo Perez (High School of Telecommunications Arts and Sciences, Supervised by Lorraine Lurie), "k-Domination in Grid Graphs as it Relates to a Cooperative Learning Situation."

Hannah Portello-Swagel (Sitka High School, Supervised by Dan Langbauer), "Alternative Voting Methods - A Closer Look."

Jahvette Smidth and Sherry-Ann Peters (Curtis High School, Supervised by Nicole Vaiana), "Fire Detection in Curtis High School."

Ainie Soetanto and Jennifer Gordon (Marple Newtown Senior High School, Supervised by Janice Ricks), "Braces for Bridges and Buildings - Where and How Many?"

DCI 2001: Saturday, May 4, 2002

Melissa Andrews, Amanda Beck, Kristina Bellis, Luke Cavagnaro, Val Centola, Greg Donnellan, Rachel Eckert, Nicole Gonzalez, Julie Grinnell, Franz Holzinger, Leah Levine, Rachele Lingard, Brittany Meyers, Anthony Mikiciuk, Sean Patterson, Nicole Pecoraro, Sarah Salminen, Julia Simm, and Julie Thorpe (Greece Arcadia High School, Supervised by Carol Oehlbeck), "TSP Used For Grocery Store Distribution."

Amanda Denmark and Christie Williams, (The Charter School of Wilmington, Supervised by Chuck Biehl, DCI Lead Teacher), "The Human Factor in the Art Gallery Problem."

DCI 2002: Saturday, May 10, 2003

I. Amjad, N. Giurato, S. Light, J. Williams, (White Plains High School), "Three Door Entrance Problem."

S. D'Auria, M. Freeman, N. Hurl, J. Joseph, L. Joseph, E. Pearce, Z. Zuschlag, (Kennedy Catholic High School), "Orcs, Goblins, and Trolls, Oh My! The Domination of Middle Earth."

A. Denmark, B. Fawcett, N. Fisher, M. Sheno, (The Charter School of Wilmington), "Exploiting the Senior Class."

V. Braga, D. Brady, M. Sobrinski and A. Young, (Upper Township Middle School), "The Ins and Outs of Guarding the Art."

J. Aufiero, M. Paonessa, L. Zoller, (White Plains High School), "Restaurant Dilemma."

G. Erisnor, Y. Feng, J.P. Lopes, C. Chicaiza, X.L. Zhao, S. Dabre, (The International High School), "Radio Frequency Assignment."

J. Eason, (White Plains High School), "Konigsberg Bridge Problem."

Y. Hu, N. Begun, M.J. Carangui, Y. Vanchytesky, A. Tarasov, Q. Li, (The International High School), "Optimizing Networks (Traveling Salesperson Problem)"

J. Kerr, P. Maginnis, J. Tencer, (Dobyns-Bennett High School) "The Olympic Ring Problem"

D. Mosley, J. Rotonde, A. Morales, J. Siino, (White Plains High School), "Abstract for Domination: Video Camera Surveillance"

J. Hernandez, E. Fuentes and A. Rios, (White Plains High School), "Scheduling Abstract"

C. Morelock, M. Spain, (Dobyns-Bennett High School), "Finding the Search Number of a Graph"

M. Duskin, A. Genovino, J. Alston, E. Schlam, L. Isaksen, L. Heteji, J. Heoke, (Presentation via video tape), (Livingston High School), "How Well-Connected is the Senior Class at Livingston High School?"

DCI 2003: Saturday, May 8, 2004

Brett Richardson, Gwenn Santoro, Kathleen Zanone, Cresskill High School, "Search Numbers."

Jason Yu, Deanna Santigo, Eric Kwan, Cresskill High School, "The Game of Nim."

Alec Sobel, Ji Hoon Kim, Jordan Glanzberg, Albert Garcia, Cresskill High School, "Art Gallery."

Brent Heeke, David Rutter, Brian Wile, Grayson High School, "Voice of the People? An Investigation of a Hypothetical Student Council Election."

Eric Zelinski, Salvatore Sciacca, Michael Sowinski, Richard Kosik, Seton Catholic High School, "Comparing Algorithms for Searching Graphs using C++."

Casey Chance and Samin Green, Charter School of Wilmington, "Optimizing Location Using Topics from Graph Theory."

Thomas Schuck, Charter School of Wilmington, "On the Optimization of the Snowplow Routes for the Town of Elsmere, Delaware."

X. Contributions -- Human Resource Development

The DCI program has had dramatic effects on the lives and careers of all participants: teachers, researchers and staff. Here is a sample of feedback we got about this.

"I incorporated parts of the course I took at Rutgers into my other classes, such as Statistics, Geometry. I learned how to do a real research and how to teach students to do a research," Alla Bogomolnaya, high school teacher, DCI '01 Education Program.

"What I considered the most beneficial experience of my two times at DIMACS was the interaction I had with the high school teachers. My respect for what they do was already high, but it increased dramatically after these contacts. They also inspired me to work with a local high school student last year as she prepared for science fairs. I expect to continue to work with her this year. I would not have done this had it not been for the positive experience at DIMACS," Robert C. Brigham, Research Program participant, DCI '02.

"(1) One of the most amazing was when Brooks Reed wrote a 3-paged single spaced reply to a young man's question about tournaments. Besides more than answering the student's question, I know he impressed him with how seriously he took the question and the time he put into the answer. (2) One which really made an impression was a young man to whom he assigned Ron Graham. The boy kept sending e-mails to Ron but was not getting any answers. But in the meantime, he was researching him and discovering that he was quite an important name in math. He became more and more impressed with his "topic". It turned out that Graham was out of the country. When he returned, he saw all of this e-mail from some high school kid. So Ron called him on the phone. (3) I will be teaching DM this year and I have already planned to incorporate some of the ideas we saw this summer dealing with homeland security both with the students AND with the parents when they come to "Back to School Night" because some of them had questioned what this course was," Bro. Patrick Carney, Lead Teacher, DREI/DCI Education Programs.

"I focus more on students developing and defending their own understanding; I try to spend more time guiding and challenging students rather than disseminating information," Bro. Patrick Carney, Lead Teacher, DREI/DCI Education Programs.

"Participating in the DCI program has changed how I think about teaching and learning. I focus more on students developing and defending their own understanding; I try to spend more time guiding and challenging students rather than disseminating information," Kathy Erickson, high school teacher, DCI '01 Education Program.

"The 3-week experience in graph theory was useful to me in several ways. First, it allowed me to expand my knowledge of mathematics in the area of graph theory and discrete mathematics. Secondly, it allowed me the opportunity to conduct research with high quality researchers. Most importantly it allowed me the opportunity to observe and interact with other educators in a structured setting. These three elements will have a definite impact on the quality of instruction given to my students.... Being able to understand the current research that is conducted in mathematics is valuable to teachers. This knowledge allows teachers to better interpret and convey the big picture of what mathematics means to students. Also, having dealt with some brilliant minds really allows a great perspective on the beauty and elegance of mathematics.

Furthermore, being able to learn new material and experience the frustration of learning again has a real impact on the way in which I present material to students,” Robert Fraser, high school teacher, DCI `02.

“The DREI/DCI program has given me a chance to see what is going on in high schools, to meet with teachers, hear their stories and understand better the students that are showing up as freshman in my classrooms. It has given me a chance to do research with students and mathematicians. This led to the publication of a joint paper with several high school teachers. Further, a second paper is in production, based on a talk I heard during an All Institute lecture,” John Gimbel, DCI Mentor, Education Program.

“(1) Learned a great deal of graph theory; (2) Learned how to apply graph theory in societal applications; (3) Learned how to improve the hands-on activities that can be run in a classroom environment; (4) Expanded my knowledge of how to write a technical math paper; (5) Improved my researching ability; (6) Was reminded of the importance of cooperative learning; (7) Gave me the renewed energy and inspiration to enhance the quality of my math lessons in order to rejuvenate the joy of math learning for my students; and (8) Inspired me to attempt exposing my students to an area of research that I have never discussed with my students before. What more could one ask for?! Thank you again for such an enriching experience,” Ingrid Kretschmann, high school teacher, DCI `02.

“DIMACS increased my problem solving ability, and gave me real motivational techniques for training students in higher order thinking. It has given me the skills to **“wake up mathematically and motivate”** the students I had previously written off. e.g. I did a lesson from Dr. Scarlet: on cake cutting. 3 students that had been "sleeping " in my class at Pace, solved the problem. They demanded to know whether they were right. I was so excited that I had gotten through to students that I had just dismissed,” Lorraine Lurie, high school teacher, DCI `00 Education Program.

“I participated in DCI in 2000 and 2001. I believe that my participation in these programs advanced my goals in both of my careers, as a software professional and as a PhD candidate in Mathematics. As a developer, my job involves matching buyers and sellers in a web-based exchange. While free of explicit recourse to theory, this task requires a combinatorial and algorithmic intuition, for which exposure to theory is invaluable. This sort of exposure is even more clearly essential for a graduate student. I found Benny Sudakov's talk on "Asymptotically optimal tree-packings in regular graphs" particularly inspiring,” Geoffrey McKenna, Research Program participant, DCI `00 and `01.

“Last summer, I met Kathy Erikson, a HS teacher from western Mass. at one of the summer programs (I can't keep the acronyms straight). In the spring of 2002 Kathy wrote to say that some of her students were doing research projects in discrete math. (These were not original research projects, but rather the students were exploring questions on their own, in groups of 3 or 4, with guidance from Kathy). After some email correspondence, we arranged a visit. Kathy came with several other teachers, and her students (10 or 11 of them) to visit me at Wellesley on a Wednesday in April, during their vacation week. The students sat in on my number theory class, took a tour of campus, ate in the dining hall, and then in the afternoon I met with each group. They presented their findings to me and I tried to give them directions for future investigation. The visit was a lot of fun for everyone. I enjoyed meeting the HS students and teachers, my students enjoyed seeing such motivated HS students, and I think the HS students enjoyed being on a college campus,” Ann Trenk, Research Program participant, DCI `01.

“Well, there has been quite a positive impact on my teaching, as well as research after participating in the DCI, REI, RCI(?) activities during the last few years. Besides letting me know quite something that I did not about my own research fields, these workshops open up my mind to other areas, together with the associated problems, and provide me with opportunities to meet and work with people sharing the same interest. ... I really appreciate these opportunities and am looking forward to participating in such activities in the near future.” Z. Shen, Research Program participant, DCI `01.

“I found the DIMACS conference I attended last year very interesting. It has widened my horizons to see and talk to so many mathematics teachers. I was unaware of the scope of innovative mathematical teaching opportunities to able and less able high school students. Since the conference I have had contact with one participant who was interested in an idea from the OU (Open University) teaching materials I displayed. I put her in contact with the author of the material, and hopefully gave her some interesting ideas of possible investigations.” Bridget Webb, Research Program participant DCI '03

“I developed research projects for my discrete math class last semester. I had them choose groups of three and gave them a list of the topics in graph theory we either had already studied or would be studying. Each group selected a topic they were interested in, and then I proposed two questions for them to explore on that topic. Some of the topics were transitivity in tournaments, the TSP, knight's circuits on various size chess boards, using Dijkstra's algorithm for finding the fastest route to school, finding chromatic polynomials for various types of graphs. I was apprehensive because I had never done anything like this before with a class, so I wasn't at all sure how to structure their work and my assessment. What I ended up doing was giving them a schedule of products I would expect from them with a timeline. These products consisted of a brief written summary of their understanding of the questions and their thoughts on how they would approach them, a list of terminology and definitions they would be using, an update on the summary, an abstract, a written report, and a presentation. I graded each of these out of ten points and the total points was their grade. I allowed a class period each week for them to meet with their groups and work on their project. I thought that it went very well. For the most part, the students seemed to be interested in what they were doing - they had more enthusiasm for this work than for the normal class work we had been doing. I was very satisfied with their work at each stage, and with their presentations. I would like to repeat the process with next year's class. I feel that DCI has impacted my career, how and what I teach, and my students tremendously. First of all, I had started teaching discrete math the school year before I attended DCI. It was a new course at my school, and new to me as well. So I had to teach a lot of it to myself as I went along. It was a difficult year because I had no one to turn to for collaboration or help. Finding out about DCI was like having a prayer answered! I learned a lot more about the subject, the things I had already learned were reinforced, and most importantly I developed an incredibly supportive network of people I could contact when I had questions or needed help. There were numerous times during the following school year that I took advantage of this, and my students knew that I was contacting one of my "expert" friends at a university for an answer to their question if I was unable to answer it. Secondly, **I returned to school with a renewed love for and appreciation of mathematics, and a deeper understanding of what mathematicians do and how the body of mathematical knowledge grows and develops.** I shared this with all of my students (not just my discrete math class) on a continual basis. I have to believe that witnessing a teacher's passion for a subject on a daily basis brings intangible qualities to a student's education. It causes some to see mathematics with new eyes, gives permission to some to actually enjoy it and to share that enjoyment, and at the very least causes even the most die-hard "math hater" to look at the subject from a different point of view for a few minutes here and there. And lastly, **DCI has given me impetus to begin PhD studies.** I had been contemplating this for several years - I knew that I had the desire to further my education in mathematics, but I didn't have an interest in a particular area that I wanted to pursue. Studying graph theory with the mathematicians that were brought together at DCI - both at the Dimacs research conference and the DCI research mentors - gave me that interest. I don't know if I will be able to work out all of the logistical issues of doing this while I am still working. But as I mentioned above, I have taken a first step and will continue to just take things a step at a time. In any event, I know that the process, wherever it leads, will be enriching and enjoyable.” Nancy Dorff-Pennea, high school teacher DCI '03

“The fact that I initiated the process of setting up dual enrollment classes for my students is also directly attributable to DCI. By meeting other high school discrete math teachers I learned that the level at which

I was teaching it to my students was much higher than is typically done in a high school course. By talking with both high school teachers and college professors at DCI I realized that my students were doing college level work and saw no reason why they shouldn't be receiving college credit for it. Also, my knowledge and abilities as a mathematics teacher were bolstered by DCI, giving me the confidence to pursue the issue as well as the necessary credibility with the decision makers at my school and at FAU.” Nancy Dorff-Pennea, high school teacher DCI `03

The programs had impact not just on teachers and researchers, but also on its students. The following comments sum up very well the exciting impact of our program on high school students.

“Pooja Gupta... presented as did so many other kids at the Rutgers conference and also spoke on out panel at the NCTM in Phila. What was interesting is that she worked all year on a theorem nobody had ever proven or disproved which was posed to us by John Gimbel of the Univ. of Alaska in Fairbanks. It was "Any graph embedded on a torus has a set of 3 points which, if removed, renders the rest of the graph 4-colorable." It was interesting to work with her. We spent about as much time trying to prove it as to disprove it -- each time being totally convinced that this was the way to go. In the end, one could say she was not successful. BUT, I gave her an A because she succeeded in learning how to do research, in not giving up, in discovering three or four other things along the way (which, we were to learn, had already been discovered by others, but we did not know that), and, in fact, came up with a logical idea of what would be needed to disprove it although neither of us was ever able to construct a graph with that property.” Brother Pat Carney, Lead Teacher, DREI/DCI/BMCI

“I was back at DIMACS twice in the summer of 2001 as an invited speaker in the "Intersection Graph" conference organized by Buck McMorris and the "Tournament" conference organized by Garth Isaak. Those were great experiences, too, and I hope to participate in DIMACS programs in the future.” T. S. Michael, Research Program participant, DCI `01.

“My visits to DIMACS have played an important role in my research program. They gave me opportunities to broaden my research horizons. I couldn't have got these opportunities anywhere else. There is something about the format of your events and meals that encourages friendships and collaborations. I made many friends there. **The atmosphere is very relaxed without the usual one-up-manship and attitude prevalent at other conferences. No one is excluded. These are intangibles, but I think they are crucial features for women and minorities and actually for anyone.** I met one of my coauthors Wendy Myrvold there. We have one paper published and several in the works. I also have a paper in the DIMACS series following the workshop on Computer Generated Conjectures. You have a good thing going at DIMACS.” Sandra Kingan, DCI `03

“Last year, I participated to the combinatorial design theory conference (July 13-18, 2003) at Dimacs. It was a very nice conference since I had the opportunity to meet one of the organizers Prof. Jamison for the first time. One of the nice features was meeting the high school teachers. A group of them had to present to the other teachers what I as doing as research. This made me think about my own research since I had to explain my research to people not working within my research area. I also met other colleagues for the first time, or which I had not met in a long time. Meeting them and talking to them about mathematics is very important. Even if this does not lead immediately to joint projects, it might lead to projects in the long term. I am keeping Prof. Jamison up to date on my research. Presently, we have not started a joint project, but this could happen in the future, or also joint projects could be started with other participants to this conference.” Leo Storme, DCI `03

The impact on high school students was also dramatic. Perhaps this is best illustrated by the four very successful high school research conferences we held. It was remarkable to see and hear students - many

previously not high-achieving in mathematics - get up in front of our audience and talk about research they engaged in.

To view the Official Press Releases for the DCI 2000, 2001, 2002, and 2003 High School Student Research Conferences via the Rutgers University Relations web site, please go to the following web sites:

<http://ur.rutgers.edu/medrel/viewArticle.phtml?ArticleID=1343>

<http://ur.rutgers.edu/medrel/viewArticle.phtml?ArticleID=2391>

<http://dimacs.rutgers.edu/dci/2002/PressRelease.doc/>

<http://dimacs.rutgers.edu/dci/2003/PressRelease.doc/>

The following comment summarizes in a dramatic way the impact of these student research experiences.

“I found the conference exciting. The students (and their teachers) asked me probing questions during and after my talk, and in fact throughout the entire day. Their presentations were remarkably well-prepared and professional. But most exciting of all, their research was substantive, either grappling with the right questions (unaware that others had tread that path before them), or sometimes rising to truly original insights. A group of middle-school students rediscovered the key idea in a mildly famous and non-obvious construction for visibility in polyhedra, and I have since been corresponding with their teacher and a researcher who wrote a not-yet-published paper on that topic. Several students worked on Nim-like games, and I was able to steer them to unsolved coin puzzle problems. Two high-school students were struggling with a difficult coloring problem in 3D, and upon my return I faxed them an answer to one subquestion they were dancing around: seven cylinders can mutually touch pairwise (so seven colors are needed for cylindrical countries). One high-school teacher has invited me to visit his school in Delaware and give a presentation to his math class, and I have agreed. In short, I found both the students and the teachers to be inquisitive and actively engaged; and now I am engaged with them. I congratulate DIMACS on a wonderful program!” Joseph O’Rourke, Professor of Computer Science, Smith College, and Keynote Speaker at 2002 High School Student Research Conference for the DCI 2001 Education Program.