Summary

German-US International Workshop on Research and Development in Mathematics and Science Education

Leibniz-Institute for Science Education
Kiel, March 2003

Manfred Prenzel, Joerg Doll and Reinders Duit
(revised by Senta Raizen**)**

1. The participants

71 researchers met at the IPN from March 5-8, 2003, for a workshop on possible collaborative research and development projects in mathematics and science education. Thirty-two of the participants were from the U.S.A. The American group was made up of researchers from the Centers for Learning and Teaching--financed since 2000 by the National Science Foundation (NSF)-- representatives of NSF, and three independent researchers. The German group was made up of two associates from the German Science Foundation (DFG), 34 participants who have been working closely together in the German Science Foundation's priority program "Educational Quality of Schools," as well as four associates from the Leibniz Institute for Science Education. An additional two participants were from the Austrian IMST project and another two were from Switzerland. The workshop was co-financed by the DFG and the NSF within a joint exchange and cooperation program for German and American researchers.

2. Aims and Procedure

The aim of the workshop was to initiate future cooperation between German and American researchers at the level of reciprocal visits; joint symposia at future conferences; joint publications; and/or joint research and development in curriculum, testing and professional development of teachers; and use of videos and software in such work.

The workshop covered the following topics:

- teacher expertise and professional development,
- curriculum development and the optimization of the quality of instruction,
- creating models for and the measurement of students' mathematical and science competencies, and
- the use of information and communication technologies to define and identify student understanding and for teacher professional development.

The workshop started on the evening of Day 1 with a reception. During the two mornings of Days 2 and 3 of the workshop, panels of four participants, two Germans and two Americans, defined the focal points of each topic as input. This was followed each day by a plenary session, in which all participants had an opportunity to discuss the panelists' presentation, based on questions formulated by small ad-hoc groups immediately after the panels concluded. Two sets of small-group workshops followed during both afternoons of days 2 and 3, during which the questions that had been raised were further discussed and common interests sounded out within the smaller groups (see Appendix A: Kiel Workshop Agenda).

In the plenary discussions and small-group meetings, the results of the international PISA study aroused much interest, particularly among the American participants. The American participants agreed that the PISA results had had less effect and fewer consequences for the American educational landscape than in Germany, although the position of American and German students was similar. Because of the high interest, Manfred Prenzel's PISA group presented some PISA analyses, especially concerning the German PISA results, on the morning of Day 4 to lay the groundwork for possible future German-American research cooperation on PISA.

The second half of the morning of day 4 was used to present overviews of the discussions that had taken place in the small working groups on the previous two afternoons. (Brief summaries of these presentations are attached, see Appendix B.) Based on these discussions and the presentations, six specific topics that had special potential for future cooperation were formulated, including one working group on PISA projects. Each of the participants expressed interest in at least one of these topics to form the basis for future working groups. The table in Appendix C reflects the interests of Kiel participants in each of the six topics. Also, one or two coordinators (marked with an asterisk (*) in the table) were identified for each of these proposed working groups. The workshop concluded on the third day by laying preliminary plans for a follow-up workshop to be hosted by NSF in Washington, DC, in fall 2003.

The table below lists starting points developed in Kiel to be followed up for further refinement and possible for possible future cooperative projects between German and American researchers.

Working Groups	Coordinators	Starting-points for bi-national cooperation
I) Metacognitive Scaffolding in ICT-based Science Learning	Detlev Leutner Bruce Herbert	Bi-national projects for the implementation of teaching strategies (focus: metacognitive scaffolding) in online-teaching materials Development of instructional materials and joint usage of data from bi-national evaluation studies Exchange of junior scientists
II) Exploring Competencies in Science Learning and Teaching	Elsbeth Stern Jörg Doll	Development of tests that measure conceptual understanding in different age groups in science Evaluation studies of the effectiveness of instruction and intervention programs for the improvement in scientific understanding
III) Professional Development and Changing Practice	Ilka Parchmann Ed Silver	Analysis of "best practice" concepts Analysis of conditions at different system levels Exchange and further development of evaluation instruments Construction of common comparison studies Development of criteria for the use of certain tools (e.g. video) Exchange of junior scientists
IV) Videobased Studies on Instructional Practice in Mathematics and Science	Reinders Duit Joe Kraijcik	Studies on the actual practice of math and science instruction that uses video-analysis as a major part of the design. Findings provide essential information for quality development in science and math teaching and learning. Exchange of junior scientists
V) Mathematical Proficiency of Teachers	Werner Neubrand Patricia Wilson	Critical dimensions of mathematics teaching Cognitive activation in the mathematics classroom Mathematical problems as indicators of teaching behavior "Profound Understanding of Fundamental Mathematics"
VI) PISA (2006 Science)	Jürgen Rost Mark Wilson	Addition studies based on b-lateral cooperation Additional tests and subsamples Construction of questionnaires for teachers Development of video tools for teacher professional development

3. Interim activities

- Construction of a workshop website: Bruce Herbert of Texas A&M University has constructed a website (http://geoexplorer.tamu.edu/dfgnsf/), containing key information about and papers from the Kiel workshop and planning materials for the follow-up workshop in Washington, DC.

- Exchange of junior associates: Since the Kiel workshop, there have been a number of contacts among the individual participants which may lead to post-doc stays of varying lengths.

- Modification of Group V "Mathematics Didactics": Group V proved not to be viable as there was only one German participant. A modified group V was suggested with the topic "Exploring Competencies in Mathematics Learning & Teaching," to be joined by a number of German participants who could not attend the Kiel workshop.

4. Appendices

Appendix A: Kiel Workshop Agenda

Appendix B: Summaries of Kiel small-group discussions and presentations to the concluding plenary session on Day 3.

Appendix C: Table showing preliminary choices of topics by Kiel (March 2003) participants for follow-up workshop.

Appendix D: Updated Table showing participants working group choices (October 2003)

Appendix A: Kiel Workshop Agenda

Time (day 1: March 5)	Activity
6:00 p.m. – 10:00 p.m.	Opening, Buffet and Poster presentation in the IPN

Time (day 2 & 3)	Activity	Teacher expertise & professionalization **(day 2: March 6)**	Student competencies: models & measurements **(day 2: March 6)**	Approaches in curriculum & instruction **(day 3: March 7)**	ICT: teaching & professionalization **(day 3: March 7)**
8:30 a.m. – 10:00 a.m.	State of the art: panel session and discussion (plenary session)	Rick Duschl Jeremy Kilpatrick Cornelia Graesel Manfred Prenzel		Jo Ellen Roseman Walter Secada Kristina Reiss Elsbeth Stern	
10:00 a. m. – 10:30 a. m.	Break				
10:30 a.m. – 12:00 p.m.	State of the art: panel session and discussion (plenary session)		Ed Silver Mark Wilson Reinders Duit Eckhard Klieme		Kathy Heid Kathy Roth Manfred Euler Detlev Leutner
12:00 – 12:30 p.m.	Formation of workgroups				
12:30 p.m. – 1:45 p.m.	Lunch				
1:45 p.m. – 3:15 p.m.	Exchange of current personal research results with posters (work groups)	WORKGROUPS	WORKGROUPS	WORKGROUPS	WORKGROUPS
3:15 p.m. – 3:45 p.m.	Break				

3:45 p.m. – 5:30 p.m.	Discussion of future research: Preparation of a short presentation (goal, conception, planning) of a joint project (work groups)	WORKGROUPS	WORKGROUPS	WORKGROUPS	WORKGROUPS
	Evening program	7:30 p.m.: joint dinner in the Kiel Ratskeller		Evening at one's own disposal	

Time (Day 4: March 8)	Activity	Teacher expertise & Professionalization	Student competencies: models & measurements	Approaches in curriculum & instruction	ICT: teaching & professionalization
8:30 a.m. – 9:45 a.m.	Future research: Preparation of a short Powerpoint presentation (goal, conception, planning) of a joint project (work groups)	WORKGROUPS	WORKGROUPS	WORKGROUPS	WORKGROUPS
9:45 a.m. – 10:00 a.m.	Break				
10:00 a.m. – 12:00 p.m.	Future cooperation: presentation and discussion of the joint projects (Plenary session)	PLENUM	PLENUM	PLENUM	PLENUM
12:00 p.m. – 12:30 p.m.	Planning for Workshop 2 in the USA				
12:30 – 1:30 p.m.	Buffet at the IPN				
2:00 p.m. – 8:00 p.m.	Excursion	Group bus trip to Luebeck (Hanseatic city) with a guided tour of the medieval city			

Appendix B: Summaries of Kiel Small-Group Discussions

(Group A)

Teacher Expertise

Prepared by Vena Long

1. Study/compare tests required in Germany/USA on mathematical knowledge for beginning teachers – e.g. PRAXIS, University specific tests.
2. "Define"/"Attempt to describe" teacher expertise with regard to mathematical knowledge by:

    A. Establish a multinational group to define criteria for identifying "expert" teacher.
    B. Apply criteria to identify teachers in each country.
    C. Determine mathematical knowledge of identified teachers [?How]
    D. Use this data to describe/compare within and between countries.

Working Group C (Student Competencies in Mathematics)
Discussion Notes, prepared by Tom Dick

The use of mathematical tasks that are highly complex and more cognitively challenging can be a means of developing competencies in all students, including lower performing or under performing students (or students from different cultures, socio-economic backgrounds, etc.). Such tasks would likely require differential scaffolding to support different student approaches. The challenge lies in providing effective scaffolding without unnecessarily lowering the cognitive demands of the task.

Documenting the kinds or amount of scaffolding needed by students while working on complex tasks might also provide a diagnostic assessment tool that could shape instructional decisions.

In turn, the skills needed to employ complex, cognitively challenging mathematical tasks and to provide effective scaffolding and diagnostic assessment to students raises important issues in the professional development of teachers. Strong content and pedagogical content knowledge would be particularly important for such teachers.

It is possible that a teacher's conception of a student's mathematical competency incorporates non-cognitive factors. The role that motivational and affective concerns in shaping their instructional goals would be worth examining.

Teachers' views, expectations, and beliefs about student mathematical competencies would appear to be critically important factors to consider. Differences in teachers across countries or cultures and changes in teachers occurring over time (perhaps due to professional development activity) could be studied.

Mutual Problems and Questions

Group E--Underachieving Groups/Equity

1. What is the nature of teachers' conceptions, practices, and beliefs about their students, mathematics, and teaching as they encounter linguistic, cultural, and gender differences?

2. How can we define problems of achievement differences given our different backgrounds, perspectives, and histories?

3. Why do social demographic subgroups of students achieve at lower levels than other subgroups?

4. Where do we have to intervene to solve problems of achievement differences?

5. (a) What kinds of preparation do teachers receive to address linguistic, cultural, and gender differences?

   (b) What kinds of support do teachers receive?

Research Topic Summary:
Topic 3: What does current research tell us about the impact of various approaches in curriculum and instruction?

Sub-topic F: Innovative Instruction

Initial Discussion:
There was consensus from the group that topic 3 encompassed a large area for both discussion and research. Perhaps the topic of *innovative instruction* was too large to be effective as a vehicle for dialogue. Initially, a wide variety of research interests were represented. The research topics were grouped into two major areas - teacher practice and academic constructivist approach. The group realized that the German delegation, with the exception of one researcher were interested in the constructivist approach area, and the American delegation were interested in teacher practice issues. The need for further discussions to realize the potential for future collaborations was recognized.

Possible Research Focus:
As the discussion continued, the group realized that there was commonality regarding interest in learning environments. A series of questions emerged from the group regarding this topic.

What is an effective learning environment?

- *Define learning environment for each country.*
- *Define the essential elements of an effective learning environment. What are the universal elements of an effective learning environment that transcend international borders?*
- *How do educational systems change and sustain change at every level of the system i.e. classroom, school, district, state, country? What common themes does educational reform share regardless of the country of origin?*

Recommendations:

1. Strand of CLT and DFG at AERA (2004): This strand would facilitate and support further discussions regarding collaborative research interests.
2. Symposium: A symposium focusing on curriculum, *Changes in Curriculum: Communicating, Applying, and Knowing,* would be sponsored by CLT and DFG.
3. Symposium and/or Publication: A symposium resulting in a publication or a publication entitled, *Cognitive Psychologists Involvement in Science and Math Education: Learning environments, Assessment, and Standards,* would be sponsored by CLT and DFG.
4. As Germany explores implementing a standards-based curriculum system, the delegation felt that the United States could provide insight into the process assisting the transition as well as the overall reform movement.

Respectively submitted:
Sharon Sikora, Ph.D
Center for Learning and Teaching of the West
Colorado State University
March 29, 2003

Section H – Role of ICT in Teaching and Professional Development

Chairs: Joan Herman and Fritz Staub

Recorder: Richard Duschl

We began our session with brief introductions. This was followed by a short conversation about PISA, as we were instructed. With regard to PISA, how it could be used to advance a collaborative research agenda was not clear. Some thought that released PISA items could be used in some studies to assess scientific literacy. Due to sample difference between the USA (e.g., national sample) and Germany (e.g., state samples) there were concerns about how cross analysis could take place. How PISA results could inform classroom practice was not clear as well.

If we could have some influence on the 2006 test, then that could give us some common data for future studies. The group identified the USA past and current PISA representatives, respectively Elizabeth Stage, Lawrence Hall of Science, and Roger Bybee, Biological Curriculum Study. We were cautioned to think about the addition burden PISA studies would have on the CTLs. To the extent that PISA is another source of assessment information for teachers, then that is potentially helpful. In the end, our group had a LUKEWARM response to getting engaged with PISA studies. If NSF is interested than they should invest in the effort, recruit interested parties (perhaps from the CTLs) and feed information to the CTLs.

Role of ICT in Teaching and Professional Development

We then turned to the main topic for Section H . Quickly we decided that the important question is how do we use it not whether we should use it. As was stated in one of the plenary sessions by Bruce Herbert, for scientists ICT is now an integral part of inquiry processes – data modelling for example. Some examples of ICT use in science program included:

Physics teacher – worksheets on the internet to work at their own speed
GLOBE (Global Learning and Observations to Benefit the Environment) programme
COACH – put measurements and outcomes on the computer.
WISE – UC-Berkeley (Marcia Linn & Jim Slotta)
Worldwatcher – Northwestern (Dan Edelson)
Model-It – University of Michigan (Elliot Solloway & Joe Kracjik)
Knowledge Forum (OISE, Marlene Scardmalia and Carl Bereiter); KIE – Knowledge Integration Environment (Berkeley, Marcia Linn) and other ICT based discourse support tools.

An important question that was raised was how much do we know about how to use the ICT in an intelligent way? There was general consensus of the need for research that tells us about this?

Another important issue for research is thinking about ways of supporting the development of learning through the scaffolding of student discourse processes. We were cautioned to remember that such approaches to learning requires a strong didactic model to move the conversations beyond superficial conversations.

At this point in our deliberations, Richard Duschl took time to point out to USA participants the European commitment to didactic models and the complexity of didactic models. He stated that for him the closest thing to didactic models was curriculum theory that seeks to blend together various disciplinary knowledge; e.g., structure of knowledge, models of inquiry, psychology, linguistics, etc. Importantly, he pointed out the didactic models within French, German, Dutch and Spanish traditions varied widely. Attempts at collaborative research will need to be sensitive to the ways didactic models are developed and used.

Following the break we turned attention to ICT and Professional Development. With an eye toward nurturing next steps in collaboration, a suggestion was make to use videos as a mechanism for bringing researchers together – e.g., one video viewed and commented on by different researchers from different research paradigms. This is a model that has been used successfully at AERA conferences. The goal is to look at the videos, establish characteristics of good teaching, and then reflect on how the teaching is being talked about to arrive at some understanding of beliefs, dispositions for good teaching. Some other suggestions for using video in PD included:

Video tape interesting professional development contexts.
Using case studies to reflect on ones own work.
Structuring the watching of the video tapes; e.g., Here is a lesson, watch the video tape What advice would you give them? Or What would you ask them about that episode? What are the strengths? What are the weaknesses?

The group felt that we could learn from past efforts to characterize accomplished teaching. One recommendation was to examine the development of the OECD 2000 Science Framework that led to the development of PISA. The Framework focused on Process, Conceptual, Application domains. Another recommendation was to look at the research from Stanford/Carnegie directed by Lee Shulman that engaged in the assessment of expertise in teaching. The abilities of expertise in areas of textbook analzsis, working with manipulatives, questioning strategies, inquiry, and assessment, for example, could guide the design of research studies and the identification of data sources.

In summary, Section H felt that there were 4 things to communicate back to the group:

1. Think of topics, questions and tools that we can bring to conferences with an eye toward designing different ways to use videos for professional development and research on professional development.

2. Focus on looking at common data sources to help us a researchers explore our ways of thinking about working with teachers. The details about how to work with teachers have yet to be specified.

3. Begin the process of looking at classroom based materials and allow the language issues emerge.

4. Different videos would be needed for math and science communities.

Appendix C: DFG-NSF International Workshop at the IPN, March 2003 - Working Groups 27/05/03

Working Group I	Working Group II	Working Group III	Working Group IV	Working Group V	Working Group VI
Metacognitive Scaffolding in ICT-based Science Learning	Exploring Competencies in Science learning & teaching	Professional Development/ Changing Practice	Video-based Studies on Instructional Practice in Math & Science	Mathematical Proficiency of Teachers	PISA (2006 Science)
Participants:	*Participants:*	*Participants:*	*Participants:*	*Participants:*	*Participants:*
Ehmke, Timo	Hardy, Ilonca	Collins, Angelo	Duit, Reinders*	Bush, Bill	Carstensen, Claus
Herbert, Bruce*	Herman, Joan	Duit, Reinders	Parchmann, Ilka	Glass, Brad	Fischer, Hans
Hofer, Manfred	Jonen, Angela	Duschl, Rick	Prenzel, Manfred	Heid, Kathy	Fischler, Helmut
Leutner, Detlev*	Kircher, Ernst	Fischler, Helmut	Roth, Kathy	Long, Vena	Hannover, Bettina
Prechtl, Helmut	Leopold, Claudia	Glass, Brad	Seidel, Tina	Neubrand, M.	Kessels, Ursula
Renkl, Alexander	Leutner, Detlev	Graesel, Cornelia	IPN Videostudy D/CH, (IPN-projects)	Wilson, Mark	Labudde, Peter
Schielack, Janie	Moeller, Kornelia	Herman, Joan	Videostudy Math, DIPF/Zuerich	Wilson, Pat*	Leutner, Detlev
Wirth, Joachim	Moore, John	Kilpatrick, Jeremy	Dick, Tom	Zbiek, Rose Mary	Prenzel, Manfred
	Scheider, Steve	Krussel, Libby	Glass, Brad		Rost, Juergen*
	Sodian, Beate	Lehrke, Manfred	Kilpatrick, Jeremy		Schneider, Steve
	Stern, Elsbeth	Parchmann, Ilka*	Klieme, Eckhard		Shavelson, Rich
	Wilson, Mark	Roth, Kathy	Krussel, Libby		Sikora, Sharon
	Doll, Joerg*	Schneider, Steve	Lehrke, Manfred		Stern, Thomas
		Schroeder, Hans	Schultz, Jim		Sumfleth, Elke
		Secada, Walter?	Silver, Ed		Wilson, Mark*
		Sikora, Sharon	Staub, Fritz (Reusser)		Wirth, Joachim
		Silver, Ed*	Fischer, Hans		
		Stadler, Helga	Krajcik, Joe*		
		Staub, Fritz	Sumfleth, Elke		
		Stern, Thomas	Wild, Elke		
		Wild, Elke	Reiss, Kristina		
			Stadler, Helga		
		Blum, Werner	Blum, Werner		

Appendix D: DFG-NSF International Workshop at the IPN, Updated Working Groups (October 2003)

Working Group I	Working Group II	Working Group III	Working Group IV	Working Group V	Working Group VI
Metacognitive Scaffolding in ICT-based Science Learning	Exploring Competencies in Science learning & teaching	Professional Development/ Changing Practice	Videobased Studies on Instructional Practice in Math & Science	Exploring Competencies in Math learning & teaching	PISA (2006 Science)
Participants:	*Participants:*	*Participants:*	*Participants:*	*Participants :*	*Participants:*
Ehmke, Timo	Bruder, Regina	Blum, Werner	Blum, Werner	Blum, Werner	Bybee, Rodger
Herbert, Bruce*	Bercerzak, Phyllis	Bruder, Regina	Dick, Tom	Bruder, Regina	Fischer, Hans
Hofer, Manfred	Chaudhury, Raj	Collins, Angelo	Duit, Reinders*	Bush, Bill ?	Fischler, Helmut
Horwitz, Paul	Doll, Joerg*	Duit, Reinders	Fischer, Hans	Glass, Brad ?	Hannover, Bettina
Leutner, Detlev*	Leopold, Claudia	Duschl, Rick	Glass, Brad	Goldin, Gerald ?	Kessels, Ursula
Prechtl, Helmut	Leutner, Detlev	Fischler, Helmut	Heinze, Aiso	Heid, Kathy ?	Lappan, Glenda
Schielack, Janie	Moore, John	Glass, Brad	IPN Videostudy D/CH, (IPN-projects)	Heinze, Aiso	Leutner, Detlev
Wirth, Joachim	Schneider, Steve	Kilpatrick, Jeremy*	Klieme, Eckhard	Kleine, Michael	Pekrun, Reinhard
	Sodian, Beate	Klein, Christine	Kline, Kate	Long, Vena	Prenzel, Manfred
	Stern, Elsbeth*	Krussel, Libby	Krajcik, Joe*	Martignon, Laura	Quellmalz, Edys
	Wilson, Mark	Lehrke, Manfred	Krussel, Libby	Reiss, Kristina	Rost, Juergen*
		Linn, Marcia	Lehrke, Manfred	Usiskin, Zalman ?	Shavelson, Rich
		Neubrand, Michael	Maloney, Alan	Wilson, Pat* ?	Sikora, Sharon
		Parchmann, Ilka*	Parchmann, Ilka	vom Hofe, Rudolf	Von Davier, Mathias
		Roth, Kathy	Reiss, Kristina		Wilson, Mark*
		Rubel, Laurie	Reusser, Kurt		Wirth, Joachim
		Schneider, Steve	Roth, Kathy		Raizen, Senta
		Schorr, Roberta	Seidel, Tina		
		Schroeder, Hans	Silver, Ed		
		Sikora, Sharon	Stadler, Helga		
		Silver, Ed	Staub, Fritz		
		Stadler, Helga	Sumfleth, Elke		
		Staub, Fritz	Videostudy Math, DIPF/Zuerich		
		Wild, Elke	Wild, Elke		

* denotes working group coordinator.