WISDOM*: A COLLABORATIVE RESEARCH INSTITUTE FOR THE STUDY AND DEVELOPMENT OF MATHEMATICAL EDUCATION

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The Wyoming Institute for the Study and Development of Mathematical Education (WISDOM*) is an emerging virtual center with core purposes to stimulate and support collaborative interactions among a global alliance of participating scholars who are active in particular domains of study in mathematics education. The basic purpose of this planning conference was to bring together an international group of invited participants to initiate collaborative activities organized around focused domains for research: quantitative reasoning and mathematical modeling, technology tools and applications, and lived/living mathematical experience. This paper overviews the vision and goals for the institute set against an historical and programmatic rationale related to the premises and cultural milieu of a new mathematics education doctoral program at the University of Wyoming.

Background
The origins for the ideas that have led to conceptualizing and proposing the Wyoming Institute for the Study and Development of Mathematical Education are anchored in a vision for stimulating and supporting sustainable research communities. Several important needs and rationales were identified to provide initial perspectives that have shaped our thinking and planning. These included our intentional approach to building specific chosen research emphases into our new doctoral program, our need to promote a new sense of connection and involvement in the national and global mathematics education culture, a goal of forging new research teams focused on our four chosen domains of scholarly emphasis, and a desire to explore how emerging technologies might be used to promote and sustain interdisciplinary research collaborations across institutions and distance.

Building a Doctoral Research Culture
In August 2009 we began our serious work to make operational a new Ph.D. program in mathematics education at the University of Wyoming. Among the sources of ideas upon which we drew, I would mention the significant conceptions from the five-year study of the Carnegie Initiative on the Doctorate (Walker et al., 2008), and critically important ideas from the report of the Second National Conference on Doctoral Programs in Mathematics Education (Reys & Dossey, 2008). We were particularly drawn to the concepts of “stewards of the discipline” and to the building of a vibrant intellectual community that is purposeful, knowledge-centered, broadly inclusive, promotes experimentation and risk taking while being flexible and forgiving, and promotes interaction and close relationships in a civil, respectful and generous atmosphere of collaborations. These viewpoints informed and shaped our planning.

Contexts
As noted by Ferrini-Mundy (2008), doctoral education occurs in contexts related to the field, and also to the institution and its capacities. Some aspects of our views on contexts in our field
are discussed in the following section. Some key information about our university context provides the institutional backdrop for our program planning.

Set in the unique context of the Rocky Mountain West, the University of Wyoming is a leader in research and development related to energy, ecology, computational science, and environmental education, to enhanced technology-based distance education, and to socially responsible environmental and cultural preservation in one of the world’s most naturally pristine environments. With an enrollment of about 13,000 students, UW is small enough to provide a highly interactive intellectual community in which interdisciplinary collaborations readily occur within varied research and outreach initiatives and across courses, programs of study, and mentorship of students and faculty. The Science and Mathematics Teaching Center has served as a vital university resource for over forty years for interdisciplinary collaborations for educational outreach and service, and provides a powerful context for doctoral graduate assistantship experiences [http://smtc.uwyo.edu/].

Program Faculty
The UW program faculty members are Dr. Robert L. Mayes (Professor of Secondary Education, Director of the Science and Mathematics Teaching Center), Dr. Linda S. Hutchison (Associate Professor and Head, Secondary Education), Dr. Scott A. Chamberlin (Associate Professor, Elementary and Early Childhood Education), Dr. Michelle T. Chamberlin (Assistant Professor, Mathematics) and myself. Additionally, we routinely collaborate with several key Department of Mathematics faculty members, including Dr. Farhad Jafari (Professor and Head), Dr. Bryan Shader (Professor and former Head), Dr. Lynne Ipina (Associate Professor), Dr. Myron Allen (Professor and Provost), Dr. Ben Roth (Emeritus Professor), and Dr. Robert Kansky (Emeritus Professor). There are also interdisciplinary collaborations involving the two other Endowed Chairs in our College of Education, Dr. George A. Kamberelis (Professor, Secondary Literacy Education) and Dr. Timothy F. Slater (Professor, Secondary Science Education) as they lead in building newly approved doctoral programs in their areas.

Core Knowledge for Doctoral Mathematics Education
Several papers presented at the Second National Conference on Doctoral Programs in Mathematics Education spoke to the areas of study to be included (Reys & Dossey, 2008). The core goals of our UW Mathematics Education doctoral program focus on preparing innovative scholar-leaders in mathematics education worldwide. We have decided that the fundamental programmatic development of each Mathematics Education doctoral student is set against the universal need to build a knowledge base for reforming to improve the mathematical education of all citizens. Core values promoted within the doctoral program are the premises upon which modern reforms are based and include the following goals:

- Construction of deep conceptual understandings of fundamental mathematical ideas and processes of thinking,
- Development of useful proficiencies for applying powerful technological tools to support new learning and solve significant problems using mathematics, and
- Building positive perspectives on the nature and utility of mathematics in human intellectual development and in technological societies.

Traditional professional domains of advanced theoretical and research knowledge in Mathematics Education are fundamental elements of study and competence for every doctoral student, including the following---
• Student development, learning and thinking, and emotional maturation for building a sound educational experience leading to significant mathematical knowledge and competence,
• Mathematics teacher preparation, practice and enhancement, and professional life,
• Mathematics curricular development, implementation and revision, and
• Student, teacher, and mathematics program assessment, evaluation and accountability.

Students may be admitted to the doctoral program with a variety of mathematical backgrounds, but are expected to further their depth and breadth of content knowledge through additional mathematics courses chosen to fit the individual’s needs and interests, and to leave the program with substantial knowledge of graduate level mathematics.

Our Doctoral Program Identities
Beyond these basic domains of doctoral knowledge, we have chosen four specific program identities to foster specializations for scholarship and leadership in our field that build upon the broader UW interdisciplinary strengths. These choices mirror the areas of primary research interests of our program faculty, and the reality that our program is and likely will be, small in comparison to other leading programs (Reys, Glasgow, Teuscher, & Nevels, 2008).

• Quantitative reasoning --- Based upon a growing societal necessity for all citizens to possess numerical and quantitative literacy, this focus addresses the explicit development of our understandings of the mathematical, psychological, pedagogical, and curricular applications of reasoning with, and about, conceptual quantities experienced and used in the world.

• Mathematical modeling --- Reflective of the power of mathematics to provide frameworks and conceptual tools for building, using, and refining abstracted representations of many real world phenomena and problems, this emphasis provides a context for shifting many important aspects of a sound mathematical education toward constructive, dynamic, relevant problem-solving experiences.

• Technological tools and applications --- Increasingly powerful computing, computational science, and informational technologies have changed how mathematics is developed and used in many domains, and in this emphasis UW faculty and students will explore and investigate the potentials and impacts of new tools upon mathematical learning, teaching, curriculum, and assessment.

• Student and teacher mathematical experiences --- Current mathematics education reforms emphasize fundamental shifts in both content and process, with significant attention to promoting higher quality mathematical experiences that develop student sense making, thinking and reasoning, and motivation and engagement, and UW faculty and students will focus explicit attention to understanding deeply the nature of such lived/living mathematical experiences.

As appropriate, each of these focal identities is addressed throughout the courses, research seminars, and graduate assistantship duties and experiences as inherent points of emphasis in the overall Mathematics Education culture we are trying to build. But, even more importantly, we have established three new Research Teams, led by our faculty but involving all students
Currently in the program, as well as participants from Mathematics and other Education departments. During 2009-10, the work of the new teams focused on laying the conceptual foundations for developing a variety of research problems and questions in each of these teams:

- QRaMM --- Quantitative Reasoning and Mathematical Modeling
- TTAME --- Technology Tools and Applications in Mathematics Education
- DIME --- Developing Investigations of Mathematical Experience

Faculty research and development activities incorporate one or more of these programmatic identities, and doctoral students are expected to gain further developmental experiences within these opportunities. As appropriate to the interests and directions of the student and the doctoral committee, dissertation research will also mirror the cited core values and embody aspects of one or more of these programmatic identities.

It is through this planning conference, and the initiation of extended collaborations with other scholars working in these domains beyond UW, we are seeking to inform, strengthen, and extend the work of the UW-based Research Teams.

**Building Inter-institutional Research Communities**

*Some Relevant History*

In the early Seventies, as young faculty members in the embryonic Department of Mathematics Education at the University of Georgia, Les Steffe, Tom Cooney, and I began to formulate ideas for establishing a new research center devoted to the study of learning and teaching mathematics. Our ideas were greatly shaped by the NSF-supported 1970 Conference on Piagetian Cognitive-Development Research and Mathematical Education at Columbia University (Rosskopf, Steffe, & Taback, 1971) and by our interactions with Professor Myron F. Rosskopf, conference director. Funded by a grant from the National Science Foundation, our vision, the Georgia Center for the Study of Learning and Teaching Mathematics (GCSLTM) project, was launched with the conduct of five research workshops held in Athens from January through May 1975.

With our very limited funding, we decided to avoid the concept of a “center as a place” (i.e., an organizational entity within an institution, having facilities and staff, and adopting bureaucratic policies and procedures). We chose instead to develop what we saw as “individual consortia”---groups of individuals who would come together to participate and collaborate because of their interests and commitments to the research problems. To operationalize the idea of a set of consortia of individuals, the five three-to-four-day invitational (without fees) workshops were broadly announced, drawing over 300 attendees from a great variety of universities in the U.S., Canada, and internationally. The conceptual domains for the workshops were Teaching Strategies, Number and Measurement Concepts, Space and Geometry Concepts, Models for Learning Mathematics, and Mathematical Problem Solving. A variety of plenary papers were commissioned and presented by leading researchers for each workshop; the ERIC/SMEAC Center for Science, Mathematics and Environmental Education at Ohio State University published the five workshop proceedings (1976-78).

Twelve working groups emerged from our pre-workshop planning, from the frameworks presented in the plenary papers, and from the discussions of the workshop participants: three in Teaching Strategies, five in Concept Development, and four in Problem Solving. As self-generated and self-funded consortia of individuals, for the next several years these individuals worked collaboratively to produce a large number of studies, presentations, and published monographs and articles.
Additionally, in the following spring, before the 1976 NCTM Atlanta Annual Meeting, eight two-day research working group meetings were organized and held to further the initial workshop developments and planning. Thereafter, over the next several years, such Georgia Center “research collaborative pre-sessions” were organized and held prior to each annual NCTM meeting. Eventually in 1981, the NCTM Research Advisory Committee, learning of these well-attended research sessions, established the first NCTM Research Pre-session at the Annual Meeting (St. Louis). Throughout the subsequent three decades these research pre-sessions (no longer based upon collaborative, volunteer consortia) have become a solidly institutionalized professional program opportunity for researchers in mathematics education, even as the attention to research in the program of the Annual Meeting appears to have declined. The gap between research and practice appears to have widened, and represents a growing problem in our field.

**Some Lessons from the Georgia Center Project**

I have recounted this bit of history of mathematics education research to identify several important ideas that can support and shape UW goals, intentions, and operations of a version of a “virtual Georgia Center” today.

- In that era, the idea of collaborations among individuals based upon a common research focus struck a nerve, drawing together a wide variety of interests and backgrounds. One possible explanation is that many well-prepared researchers work in institutions where they may not recognize real opportunities for collaborations with colleagues interested in their problems of interest; indeed, there may be a widespread sense of isolation of individuals from their primary focus of scholarship, even in large, more research-oriented institutions worldwide. The GCSLTM project provided such contexts for coming together with others for a common focus. Perhaps this is still the case, and could possibly be a catalyst for establishing and sustaining the Wyoming Institute, also.

- The building of each of the Georgia Center research working groups arose primarily from the development of the individual team agendas for action, yet also based upon plenary papers and intellectual leadership provided by key persons and then followed by qualities of working group leaders. Unlike a funded project where the pre-determined proposed and agency-shaped project activities set the agenda, the processes of collaboratively identifying the issues, questions and problems to be analyzed, articulated, investigated, and reported were central to those GCSLTM working groups that were the most productive and sustaining.

- The impacts from the nearly decade-long activities (only a five-year NSF funding) of the Georgia Center are, to me, highly notable. Personally, the opportunities and challenges for me deeply shaped my thinking and my perspectives on scholarly efforts and progress in our field; it directly led me to accept a call to service as a Program Director and Deputy Division Director at the National Science Foundation during 1984-86. Without specifically identifying anyone else, I can confidently claim that I witnessed dozens of other young mathematics educators (like myself) whose productive participation and leadership in the collaborative efforts of the GCSLTM profoundly influenced their research engagement, productivity, careers and reputations. One interesting, and perhaps significant point: some of the participants who found ways to be productive
contributors within these activities did not demonstrate comparable productivity after the project ended.

- Some original working groups did not develop, and rather quickly disappeared from Center activities. From those experiences and the successfully enduring working groups, I think I learned some of the important factors for establishing and sustaining productive collaborations. Without sufficient elaboration or justification here, I can cite at least these factors:
  - Commit to active participation;
  - Engage deeply in basic, conceptual work in domains of interest to those wanting to collaborate;
  - Identify, define and shape important research problems for both shared and individual pursuit;
  - Organize and conduct regular, timely meetings and group work sessions;
  - Keep everyone informed, challenged and engaged in real work;
  - Foster group work toward varying forms of collaborations;
  - Sustain group progress through individual assignments and productions;
  - Be task- and product-oriented;
  - Develop and support opportunities to publish;
  - Support and respect each other, while grappling with challenging problems and differing perspectives;
  - Work hard yet also socially celebrate as a group what the group and what the individuals achieve;
  - Foster collegial relationships anchored in professional friendships.

- Collaborations are inherently relationships between and among persons who may share to some extent common goals and intentions while also bringing differing, sometimes conflicting, perspectives related to the complexities of the research domains. It is probably impossible to describe adequately the “chemistry” that results in an effective working group to function within significant sustained and productive research collaborations. For me, one critical aspect is an elusive quality of “balance” within and across many different dimensions, and the critical qualities of leadership within these relationships must surely promote such balances—when to lead and when to follow, when to push and when to pause, when to challenge and when to support, when to go forward as groups and when to split and work apart yet within connections that persevere, and many more.

- Leadership for collaborative paradigms must acknowledge that collaborations will change, and may end (as happened with some Georgia Center groups). This may not be a point of intention, but yet designated leadership and other participants must accept the organic nature of collaborative relationships, and strive to be sensitive to how changing dynamics of scholarly problems and the professional and personal states of persons may change the conditions for collaboration.
While the starting points of a specific research domain may inherently involve important research problems and questions, and while initial working group activities, such as the Georgia Center workshops and papers, can further identify and articulate research problems and questions, it is critically important that each scholar who joins a research team must come with a personal agenda of researchable problems and questions. It would seem that this creates a positive tension within the network of activity, fostering a group dynamic that seeks to find the common while maintaining the balances needed to preserve the individual perspectives, curiosities, motivations, and unique goals.

While the experiences of the NSF-supported Georgia Center participants might serve to inform a new effort to build an analogous “consortium of individuals” today, we must be cautious and alert to important differences due to changed circumstances in our field, and for those currently working as researchers. For example, today there are many more opportunities to publish in research-oriented mathematics education journals, worldwide. There appears to be expanded funding to support research in mathematics education (albeit perhaps less open to addressing field-initiated studies arising from scholars rather than agency or foundation-set agendas). It is certainly the case that the very nature and condition of the field of mathematics education has changed dramatically, and this includes changes in the context and circumstances for research activity. Yet, perhaps many of the factors that led to the successful engagements in the Georgia Center project of individuals from a huge variety of home institutions may still be true today.

**Visions for WISDOM**

The Wyoming Institute for the Study and Development of Mathematical Education is foreseen to be a virtual site at the University of Wyoming, existing primarily as a web-based resource for fundamental research and scholarship in the field of Mathematics Education. Its focal purpose will be to stimulate and support collaborative research interactions among a global alliance of participating researchers. The Institute participants at UW will provide initial leadership for activities and productions to function in relation to a specific, identified set of scholarly domains within the field of Mathematics Education. It can serve as a developing basis for initiating a variety of externally funded projects and activities with a common purpose of amplifying the quality and scope of the research-based knowledge within the targeted domains.

What might WISDOM look like? What activities might occur in relation to the Institute? What strategic approaches would be used to initiate, develop, and sustain it? Imagine for the moment, the Institute as it could be in 3-4 years. [This is intended to be an initial vision, which will obviously be subject to alterations, as we would proceed in reality.]

It could become a national and international web-based resource for collaborative research in a focused set of scholarly domains in Mathematics Education. Employing state-of-the-art IT capacities, it could offer the following kinds of resources:

- Information about the Institute—mission, purpose, working groups, projects, etc.
- Identification of Affiliated Scholars who have agreed to be involved in, and contribute to, the programs and projects of the Institute.
- Identification of the current membership within each of the Research Teams or Working Groups of the Institute.
- An on-line “WISDOM newsletter” (with links to archived “copies”).
- Information for interested scholars to become involved in the Institute and its efforts.
INSTITUTE OVERVIEW

- A calendar of Institute-related activities, including information about future conferences, meetings or teleconferencing (e.g., video-streamed) sessions of teams, forthcoming Institute publications (theory papers, reports, monographs), schedules of project activities, etc.
- One or more “blogs” related to current research issues or problems being discussed.
- “Calls for Contributions” in areas of need within the research domains.
- A searchable (annotated) database of published references (from our site, and any other sources) relevant to each Institute research domain.
- A collection of down-loadable files of Institute-produced publications and videos (theory papers, research reports, monographs, conference proceedings, videos from conference presentations or discussions, videos of exemplary models featuring research methods or protocols).
- Links to other related web sites (e.g., the video database at Rutgers).

A biennial summer WISDOM* International Mathematics Education Research and Practice Conference could be held in one of our beautiful Wyoming venues. A major focus would be upon involving young developing researchers (including doctoral students), as well as precollege teachers and administrators interested in research-based practices. Invited, commissioned plenary papers would provide a major stimulus to further each of the focal research domains. Reporting sessions would feature refereed papers from research conducted within the Working Groups. Each reporting participant would also contribute a related “research into practice” presentation aimed at mathematics teachers and administrators. Ample conference time for working sessions, led by members of each Working Group, would provide venues for discussions to build upon presentations, and to further the plans and research activities. A “conference proceedings” would be edited and published on the Institute web site; videos from conference presentations (or highlights) would also be available on-line.

Working meetings of the Institute Research Teams could routinely be held in conjunction with regularly scheduled professional meetings (e.g., NCTM, AERA, SIG/RME, PME/NA, PME, ICME). These would be planned and set up by the leadership of each Research Team, and serve as opportunities to work together for an extra day before and/or after society meetings which many in a team may be attending anyway. This approach would help to limit the extra costs for participating in Institute collaborations, and provide regular opportunities for collaborative work to proceed.

A WISDOM* Advisory Board could provide conceptual and intellectual input to the improvement and extension of the Institute. The Board would meet mainly via virtual conferencing, but biennially before or after the summer Institute conference.

A monograph series could be planned to produce a variety of thematic publications to present theoretical analyses and results from investigations, as well as discussions focused on mathematical education practices. These would be led by editors from active Institute participants, and afford a venue for disseminating ideas that would not preclude subsequent publication in other, refereed outlets. In conjunction with the series, a variety of Contributing Editors would be invited to be associated with the Institute publications, and thereby lend their names and identities to building up the Institute’s reputation.

There could eventually be several Institute-related externally funded research projects underway. Most of these would each be connected to (and probably have grown out of) the Research Teams, and based at the institutions of the Affiliated Scholars leading the work.
Summary
The concept of a virtual Institute with actively collaborative scholars may not be unique across academic research communities. Yet, as envisioned here there does not exist such an entity in Mathematics Education. It is the goal of this conference to explore and stimulate such a concept, arising from an intentional approach to building a new doctoral education program with aims of fostering and promoting research collaborations.

References