DEPARTMENT OF MATHEMATICS
TECHNICAL REPORT

A Home for RUME: The Story of the Formation of the Mathematical Association of America's Special Interest Group of Research in Mathematics Education

ANNIE SELDEN

NOVEMBER 2012

No. 2012-6

TENNESSEE TECHNOLOGICAL UNIVERSITY
Cookeville, TN 38505

A Home for RUME: The Story of the Formation of the Mathematical Association of America's Special Interest Group on Research in Mathematics Education[1]

Annie Selden

Abstract: This paper recounts the prehistory and history of the Mathematical Association of American's Special Interest Group on Research in Mathematics Education (SIGMAA on RUME) It relates the many events leading up to the formation ARUME, the Association for Research in Mathematics Education, which was the predecessor of the SIGMAA on RUME. It continues with the establishment of SIGMAA on RUME and its growth during the first ten years of its existence.

The Prehistory of the SIGMAA on RUME

An organization, such as the SIGMAA on RUME, does not appear full-blown one day without a great deal of preparation. Some individuals have to see a need for the organization and prepare the way.

Background

Much of the following comes from the recollections of Ed Dubinsky (personal communication, February 10, 2011). Let me say, to begin with, that Ed Dubinsky was the prime mover behind the organization of the first RUME Conferences, which began in 1996, even before the formation of the Association for Research in Undergraduate Mathematics Education (ARUME), the predecessor of the Mathematical Association of America's Special Interest Group on Research in Undergraduate Mathematics Education (SIGMAA on RUME) .

Ed Dubinsky was a well-respected functional analyst for many years. In the 1980s he was awarded several grants[2] to conduct workshops for retraining professors of mathematics so that

[1] This paper is based on, and an extension of, a plenary talk, given at the 14th Annual Conference on Research in Undergraduate Mathematics Education in Portland, Oregon, February 2011. Annie Selden is Professor Emerita of Mathematics from Tennessee Technological University and Adjunct Professor at New Mexico State University.

[2] These grants were from the Sloan Foundation and from the Digital Equipment corporation.

they could teach courses in computer science. He was the Director of the Institute for Retraining in Computer Science (IFRICS) from1983 to 1989. That was a time when there was a shortage of, and a big demand for, computer science faculty, and as yet, few PhD programs in computer science. During those workshops, it is Annie Selden's view that EdDubinsky had an epiphany. He had smart people (mathematicians) in these workshops, yet they had difficulty learning the "new stuff." It was not because they were dumb, nor was it because they were different.[3] It was, presumably, because there are aspects of the teaching and learning of certain concepts that are just hard. Perhaps as a consequence, Ed Dubinsky took some time off and went to the University of California at Berkeley from 1985-1986, during which time he read the works of Piaget and developed the basics of what has become known as APOS theory (Action, Process, Object, Schema).[4] Subsequently, he collected a significant amount of data on students' learning of mathematical induction, function composition, and quantification. He also developed teaching methods using the computer language ISETL, further developed his views on reflective abstraction,[5] and began to publish papers (e.g., Dubinsky, 1986, 1989).

Then, in the early 1990s, according to Ed Dubinsky's recollection (personal communication, dated February 10, 2011), there were not many people with strong mathematics backgrounds working in research in undergraduate mathematics education (RUME), and mathematics education research journals were not anxious to publish papers in RUME, with the exception of Robert Davis, the founding Editor of the *Journal of Mathematical Behavior*. Also, no mathematics departments were interested in having faculty members doing such research. Then things began to change.

Three major developments in the prehistory

Special Session on RUME at the 1991 JMM

Much of the following comes from the recollections of Ed Dubinsky (personal communication, February 10, 2011). In that email, he stated that he saw three major developments as happening next. First, he organized, along with Jim Kaput and Alan Schoenfeld, a Special Session on Research in Undergraduate Mathematics at the 1991San Francisco Joint Mathematics Meetings (JMM) of the American Mathematical Society (AMS) and the Mathematical Association of America (MAA). For this special session, the organizers solicited as many presentations on RUME as they could find. For example, Uri Leron and Shlomo Vinner came from Israel and spoke. John Selden and Annie Selden presented their second calculus paper (Selden & Selden, 1994). The attendance was large, over 100, according to Ed Dubinsky's memory, when other Special Sessions at the JMM sometimes had as few as 15 attendees.

[3] This is an intended reformulation of the title of Sheila Tobias's (1990) book.
[4] For more information on APOS theory, see Asiala, et al (1996).
[5] For more information on reflective abstraction, see Dubinsky's chapter in the AMT book (Tall, 1991).

The CRUME Committee

The second development, according to Ed Dubinsky (personal communication, February 10, 2011), was that the MAA became interested in supporting RUME, and was asked for a Special Interest Group and a journal, but cautiously only agreed in 1992, to form the AMS/MAA Joint Committee on Research in Undergraduate Mathematics Education (CRUME, fondly pronounced by some as "CRUMMY"). There were five members each from the AMS and the MAA, and one member each from NCTM (National Council of Teachers of Mathematics) and AMATYC (American Mathematical Association of Two Year Colleges), with Ed Dubinsky as its first chair. Other members, at various times, included James Kaput, Alan Schoenfeld, Thomas Dick, Warren Page, John Selden, Joan Ferrini-Mundy, Anne Brown, and Gregory Foley.[6] One of the first projects of CRUME was the establishment of the CBMS series of "occasional volumes of papers" on RUME, called *Research in Collegiate Mathematics Education* (*RCME*), with Ed Dubinsky, Alan Schoenfeld, and James Kaput (1994) as the initial troika of editors. To date, seven volumes have been published with various other editors, beginning with *RCME V*. In 2002, the CRUME Committee handed over responsibility for publishing the *RCME* volumes to the SIGMAA on RUME. The idea for these volumes, from the beginning, was to show the "powers that be" that there was enough research in undergraduate mathematics education to warrant a journal, and the idea of a journal for research in undergraduate mathematics education is still being worked on by the SIGMAA on RUME, with the intent that it be called *Collegiate Mathematics Education Research Journal* (*CMERJ*).

CRUME also organized Special Sessions on research in undergraduate mathematics education at the January Joint AMS/MAA Mathematics Meetings (JMM). In addition, CRUME worked on getting a *Mathematical Reviews* subject classification and sub-classifications. Some of these are:

- 97 Mathematics Education
    - 97C Psychology of and research in mathematics education
        - 97C30 Student learning and thinking (misconceptions, cognitive development, problem solving, etc.).

This subject classification enables mathematicians and mathematics education specialists applying for academic and other jobs to list 97 on their AMS Cover Sheets. Unfortunately, however, no money to implement actual reviews was appropriated at that time.

CRUME was dissolved – its work having been done – in 2005. (Information from the AMS Council Minutes, dated January 4, 2005.)

[6]The charge to CRUME was: The committee will work to foster development of, and bring before the members of the professional organizations information regarding, activity in the field of research in undergraduate mathematics education. The committee will arrange for program components (presentations, contributed papers, special sessions, etc.) at sectional, regional, and national meetings; serve in a consultative role for publications of the organizations in the field of research in undergraduate mathematics education; promote collaboration among the various communities concerned with research in this field and utilizing its results; and monitor the progress of the implementation of the recommendations contained in the conference report, *Communicating Among Communities*. (Minutes of the AMS Council, September 8, 1992).

ARUME and RUMEC

The third development in the prehistory, as Ed Dubinsky saw it (personal communication, February 10, 2011), was the interest of mathematicians, some coming from his NSF-supported workshop on the teaching of Abstract Algebra using ISETL using his and Uri Leron's (1994) book, in finding out more about RUME. As a result, and since Ed Dubinsky had collected a lot of data by that time, he decided to help those interested in such research by forming a group (later called RUMEC, the Research in Undergraduate Mathematics Education Community) to analyze, as apprentices, his already collected data using APOS theory and to write joint research papers. Ed Dubinsky had some Exxon grant money with which to support the RUMEC group and also got some other people together as RUMEC II and RUMEC III in Chicago in the mid-1990s. To broaden participation, Ed Dubinsky also organized an "offshoot" called RUMEC+. It was at the RUMEC+ meeting in Chicago that one of the participants, in a discussion, said she felt that, as a researcher in RUME, she "wanted a professional home."

Apparently, this remark struck a chord with Ed Dubinsky, for he became a driving force promoting the establishment of a special interest group for RUME within the MAA. Exactly how Ed Dubinsky did this is unclear. The MAA, was not initially very receptive to the idea of special interest groups for fear it might "split the organization" into small subgroups. However, eventually in January 1999, ARUME (the Association for Research in Undergraduate Mathematics Education) was formed at the San Antonio Joint Mathematics Meetings (JMM) of the American Mathematical Society (AMS) and the Mathematical Association of America (MAA). This was followed by a reception, funded in part by the Exxon/Mobil Foundation. The support of Robert Witte of the Exxon/Mobil Foundation was important, if not crucial, at this stage (Ed Dubinsky, personal communication, February 10, 2011).

Other important developments in the prehistory

Another development was the establishment of the NSF-funded newsletter, *UME Trends: News and Reports on Undergraduate Mathematics Education*, which in its first year of publication (1989) was sent free to all mathematicians, in its second year was sent free to all who indicated on a return card that they wanted to continue receiving it, and in further years was sent to all paid subscribers. This was the "heyday" of the Calculus Reform movement (for details see Hurley, Koehn, & Ganter, 1999). *UME Trends* was edited by Ed Dubinsky, and in it, Annie and John Selden had a column called the *Research Sampler* that abstracted mathematics education research articles. Other articles dealt with, not only calculus reform, but general articles on mathematics education at the undergraduate level.

Another important development in this period before the formation of ARUME, or the SIGMAA on RUME, was the publication of two MAA Notes volumes on research in undergraduate mathematics education: *The Concept of Function: Aspects of Epistemology and Pedagogy*, edited by Ed Dubinsky and Guershon Harel (1992); and the subsequent volume, *Research Issues in Undergraduate Mathematics Education: Preliminary Analyses and Results*, edited by Jim Kaput and Ed Dubinsky (1994).

In June 1995, at a workshop of the MAA NSF-funded Project, Cooperative Learning in Undergraduate Mathematics (CLUME), several workshop participants asked for help in getting started in research in undergraduate mathematics education. As the workshop organizers had been "involved in several research projects in which they had generated a large amount of data about students learning calculus, abstract algebra, and discrete mathematics" that needed analysis, "an evening meeting of the CLUME participants was called to see if anyone was interested in collaborating on the research that this data would support." (Dubinsky, 1997). Those interested formed a group called Research in Undergraduate Mathematics Education Community (RUMEC). It was Ed Dubinsky and the RUMEC group that organized the first three *Conferences on Research in Undergraduate Mathematics Education* in Mt. Pleasant, Michigan in 1996 and 1997, and in South Bend, Indiana in1998. These were instrumental in generating interest in such research and provided a venue for presenting such research to colleagues.

The early conferences on research in undergraduate mathematics education

Details regarding the first *Conference on Research in Undergraduate Mathematics Education*, held in September 1996 in Mt. Pleasant, Michigan, are somewhat hard to find. However, a Google search yielded some information on the variety of presentations at the conference. Ed Dubinsky presented a plenary lecture, "A theoretical framework for research in undergraduate mathematics education" on September 6. Anna Sierpinska also presented a plenary lecture, "Problems related to the design of teaching and learning processes in linear algebra," (referenced in Dreyfus, Hillel, & Sierpinska, 1999, p. 221, and in Selden & Selden, 1999, p. 24). Marilyn Carlson had a joint presentation, "Views about mathematics survey." Michelle Zandieh presented, "The concept of derivative: A variety of understandings." David Meel presented "Examination of calculus understandings held by *Calculus&Mathematica* and traditional calculus students." Hortensia Soto-Johnson presented, "Students understanding of series: A quantitative/qualitative study."

At the next conference, held September 4-7, 1997 in Mt. Pleasant, Michigan, the four plenary speakers were: Ed Dubinsky, "Putting constructivism to work: Bridging the gap between research and collegiate teaching practice"; Ricardo Cantoral, "An example of the sociological point of view in math education: The case of analytical functions at the university level"; Jere Confrey, "Learning to listen in new technological environments: Changes to our mathematical thinking"; and Tom Banchoff , "Beyond homework, beyond class discussion: New patterns of interactive response in an internet-based course." There were also three panels, "The role of RUME in a mathematics department" with Joan Ferrini-Mundy, Jim Kaput, Linda Sons, and Richard Fleming as panelists; "Research on specific pedagogical strategies" with Penny Dunham, David Mathews, Norma Presmeg, Barbara Reynolds, and John Selden as panelists; and "Connecting K-12 and collegiate mathematics education research" with Deborah Ball, Robert Davis, Bill Martin, and Anne Brown as panelists. There were 125 participants (Mickey McDonald, personal communication, September 23, 1997). See Appendix A for details.

The *Third Annual Conference on Research in Undergraduate Mathematics Education* was held in South Bend, Indiana, September 17-20, 1998. The conference chairpersons were Georgia Tolias and Anne Brown. Information on the presentations at this conference is somewhat hard to obtain. Plenary speakers were: M. Kathleen Heid, David Henderson, Dina Tirosh, and Rina Zazkis. David Henderson spoke on, "A mathematician looks at research in undergraduate education." There was also a panel on "Undergraduate mathematics education graduate programs" with panelists Christine Browning, Marilyn Carlson, James Cottrill, Ed Dubinsky, and Judith Sowder. (See Appendix B for the conference flyer.)

At the conference, Hortensia Soto-Johnson presented, "The effects of CAI in college algebra incorporating both drill and exploration." Michelle Zandieh presented, "The role of derivative in student understanding of differential equations." Margaret Kinzel presented, "Understanding students' interpretation of algebraic notation in a problem-solving contex." Draga Vidakovic and William Martin presented the joint paper, "The role of collaborative work on individual reconstructions of mathematical concepts." Marilyn Carlson presented, "The mathematical behavior of successful mathematics graduate students: Influences leading to mathematical success." Stacy Brown presented, "An investigation of novice proof writers."

After the conference was over, Anne Brown sent an email to the 129 participants saying, "We are particularly interested in your preference about the date, location, and program for the next conference. … Let us know what you think." (Anne Brown, email communication, September 22, 1998).

Prelude to the formation of ARUME

The holding of these three early, well-received, conferences was an attempt to convince the leadership of the MAA to allow a special interest group for research in undergraduate mathematics education, or some other such organization, to exist under its auspices. At the 1998 South Bend conference, a general interest meeting was held to determine the extent of interest in forming an organization to promote research in undergraduate mathematics education. The response at that meeting was very positive. When it came to deciding how to propose this new organization to the MAA and what its officers should be called, Lida Barrett (who had been President of MAA, 1989-90) said that its presiding officer couldn't be called "president" because only the MAA itself could have a president. That's how the chief presiding officer of ARUME, and later, of SIGMAA on RUME, got the somewhat unusual title of "Coordinator."

Having been delegated by the larger meeting to do so, a few individuals got together after the larger meeting to decide on the structure of the proposed organization. At this smaller meeting, at which Ed Dubinsky, John Selden, David Meel, Julie Clark, Annie Selden and several others were present, the officers to be proposed, the mission of the organization, and the need to propose a set of by-laws were discussed. At this meeting, Annie Selden, David DeVries, and several others were delegated to write a first draft of by-laws for ARUME. Somewhat later, after the SIGMAA on RUME had come into existence as a successor for ARUME, and MAA had

established a Committee on SIGMAAs to standardize their formation, the SIGMAA on RUME replaced its by-laws with a Charter[7] to comply with subsequent policies developed by the MAA.

Summary of events leading up to the formation of ARUME

On May 14, 2000, Annie Selden summarized her perspective on the events leading up to the formation of ARUME in an email sent to Manya Raman as follows:

> We prevailed [sic] on Ed [Dubinsky] to become Coordinator for one year, I [Annie Selden] was to be Coordinator-Elect, Mickey [McDonald] the Organizational Director, David Meel the Secretary/Treasurer, Julie [Clark] the Program Chair. I was put in charge of writing the draft by-laws (except that Ed [Dubinsky] would write the "mission" part so as to align that with what had been agreed to by the MAA in July 1998). … In my opinion, it was a 10-12 year effort [approximately 1990-2000] on the part of a number of people that provided the critical mass for ARUME's formation. The ground had to be prepared. As I said above, *UME Trends*, formation of CRUME and the paper sessions CRUME sponsored at AMS/MAA meetings, publication of two MAA Notes Volumes on RUME, instantiation of the *RCME* volumes by CRUME through CBMS (edited by Schoenfeld, Kaput, and Dubinsky), as well as the first three RUME conferences, were all (in my opinion) instrumental along the way.

ARUME, the precursor of SIGMAA on RUME

Formation of ARUME under the auspices of the MAA

In 1998, the MAA Executive Committee was asked for approval for the founding meeting of ARUME. The MAA seemed to be a natural home for such an organization, because the MAA is dedicated to, amongst other things, the improvement of undergraduate teaching. The mission of the MAA is "to advance the mathematical sciences, especially at the collegiate level. … We support learning in the mathematical sciences by encouraging effective curriculum, teaching, and assessment at all levels." (Information from http://www.maa.org/aboutmaa/mission.html).

In 1998, Tom Dick, who was Chair of CRUME at the time, requested and obtained a session and a room for the initial meeting to form ARUME at the upcoming 1999 JMM in San Antonio. On January 14, 1999, he welcomed the 120 attendees and explained the purpose of the meeting. Ed Dubinsky explained the history/purpose of ARUME. Annie Selden oversaw the discussion of the proposed transitional by-laws (several drafts of which had been discussed previously by the proposed officers in the period Sept-Dec. 1998). These were passed, and the proposed slate of officers was elected for one year and put in charge of writing permanent by-laws. The newly elected officers were Ed Dubinsky, Coordinator; Annie Selden, Coordinator-Elect; David Meel, Secretary/Treasurer; Mickey McDonald, Organizational Director; and Julie Clark, Program Chair. Annie Selden was also elected Chair of the Governance Committee,

[7] After the MAA adopted a model charter for all SIGMAAs, the SIGMAA on RUME was asked to "fold in" its by-laws with its Charter. The current SIGMAA on RUME Charter, as well as information on earlier versions, is available at http://sigmaa.maa.org/rume/sigmaa_charter.html.

which was charged with writing permanent bylaws. (See Appendix C for the agenda of this meeting.)

At that organizational meeting, the following principles were also agreed upon:

1. The purpose of ARUME is to foster basic research in undergraduate mathematics education (RUME) and its application to improving teaching practice.
2. ARUME will:
    - provide organizational support for the conduct of RUME and its dissemination through talks, conferences and publications.
    - interact with those who teach post secondary mathematics and are the potential consumers of the results of RUME and also can provide critical assistance in the grounding of research efforts in the realities of the teaching enterprise.

It was also stated that as a result, ARUME will maintain a close relationship with the Mathematical Association of America (MAA) as well as seek to build relationships with other organizations concerned with the learning and teaching of mathematics. The meeting included three presentations on RUME: Rina Zazkis, "Students' intuitive rules in number theory"; Mercedes McGowen, "Constructing cognitive collages: A tale of two students"' and Marilyn Carlson, "A Study of graduate students' mathematical behavior." These were followed by a reception. Thus, with this meeting, ARUME was officially born. (Further details can be found at sigmaa.maa.org/rume/minutes990114.html.)

Subsequent events of ARUME

At the July 31, 1999 summer business meeting of ARUME, there was discussion of taking steps to become a Special Interest Group of the MAA. In the Spring of 1999, the MAA had established a Task Force on Special Interest Groups and had resolved that:

> A program be initiated that establishes Special Interest Groups of the MAA (SIGMAAs). The program will begin at the January, 2000 meeting in Washington, DC … During the period between passage of this resolution and the January, 2000 meeting, the Task Force [will] work with groups interested in becoming SIGMAAs. It is anticipated that the first SIGMAAs will be established at that meeting. It is recommended that a brief program and reception be held at the January meeting to celebrate the formation of this program and the inauguration of the first SIGMAAs." (Information downloaded May 22, 2012 from http://sigmaa.maa.org/rume/minutes990731.html).

The *Fourth Annual Conference on Research in Mathematics Education* was held in Rosemont, Illinois, a suburb of Chicago, September 16-19, 1999. The organizers on behalf of ARUME were Anne Brown, Julie Clark, Ed Dubinsky, Clare Hemenway, George Litman, Mickey McDonald, Annie Selden, and Georgia Tolias. A Google search provided some details of the conference. James Cottrill presented, "Avoiding pitfalls in data collection: Are we assessing the facility with a concept or the understanding of it?" Michelle Zandieh presented, "Are all derivatives that, slope? A case study of Ingrid." Marilyn Carlson presented, "A study of

problem-solving behaviors of mathematicians: Metacognitive behavior and mathematical intimacy in expert problem solvers." David Meel presented, "Integrating research into teaching: Examining changes resultant from reading research reports." Sean Larsen and Marilyn Carlson presented the joint report, "Preservice elementary teachers' covariational reasoning abilities: A teaching experiment integrating a model and modeling perspective." Anne Brown presented, "Conceptions of divisibility: Success and understanding." Anne Ryu presented, "Learning differential equations through collaboration: A case study of students in interaction." (See Appendix D for an email announcement of this conference.)

At the January 2000 winter business meeting of ARUME, new officers were elected: Marilyn Carlson as Coordinator-Elect, David Meel as Secretary/Treasurer, Mickey McDonald as Organizational Director, and Julie Clark as Program Chair. Dues in the amount of $10.00 were proposed and unanimously accepted by the membership present. (Information downloaded May 22, 2012 from http://sigmaa.maa.org/rume/minutes000121.html.)

The *Fifth Annual Conference on Research in Undergraduate Mathematics Education*, held in Chicago, Illinois, September 21-24, 2000, was organized by George Litman and Mickey McDonald for ARUME. The announcement of the conference stated:

> This conference is a forum for researchers in collegiate mathematics education and includes the following themes: results of current research, contemporary theoretical perspectives and research paradigms, application of learning theory to teaching practice, technology in mathematics learning, and general issues in the psychology of mathematics education as it pertains to the study of undergraduate mathematics. The program will include plenary addresses, general paper sessions, panel discussions, contributed paper sessions, and poster sessions. (information retrieved from http://atlas-conferences.com/cgi-bin/calendar/d/faaw89)

The plenary speakers were Guerson Harel, Bob Speiser, Anna Sierpinska, and Jean-Luc Dorier, who presented a survey of French research on the teaching and learning of linear algebra in first year of university. There was also a panel consisting of the plenary speakers on "Aspects of Understanding Proof." Other activities at this conference included two themed lunches at which tables were set aside for networking for (a) novice researchers to meet experienced researchers, and (b) researchers with common areas of research. Saturday evening was devoted to "roasting" Ed Dubinsky and recognizing him for his seminal contributions to ARUME (Information downloaded June 1, 2012 from http://atlas-conferences.com/cgi-bin/calendar/d/faaw89.)

The History of the SIGMAA on RUME

The early days

By the time of the January 2001 JMM, ARUME had become the first SIGMAA of the MAA, with Annie Selden as Coordinator. One major order of business was the adoption of a new Charter, as required by the MAA, that amongst other things, called for both a Secretary and a Treasurer. As a result of an election, Chris Rasmussen became Treasurer and David Meel retained the position of Secretary. It was also announced that SIGMAA on RUME had 215 dues paying members at that time.

Various committees, established previously had been hard at work. At the January 2001 business meeting, they reported their progress and accomplishments to date. The Guidelines Committee had been working on a document for how to evaluate mathematics education faculty housed in Mathematics Departments for promotion and tenure, amongst other things. The final version of this document can still be found on the SIGMAA on RUME website at http://sigmaa.maa.org/rume/guidelinesP1.html and has been used several times to good effect in tenure and promotion cases. The Committee on Mentoring had reviewed and identified nine mini-grants for collaborative research between an established mathematics education researcher and someone wishing to be mentored and these had been disbursed. To the best of my knowledge, the funds for these mentoring mini-grants came from monies provided to Ed Dubinsky and RUMEC by the ExxonMobil Foundation for such mentoring activities. Shandy Hauk, for the Website Committee, gave those in attendance a tour of the website, including where to find information on publishing RUME results (which is maintained to this day), the literature database (still in existence, but not regularly updated), mini-grant information (no longer applicable as there are currently no funds for mini-grants), and announcements of upcoming meetings of various mathematics education research conferences, including that for the upcoming *Conferences on Research in Mathematics Education* (still provided today). Thus, by the beginning of 2001, the SIGMAA on RUME had become a thriving organization, serving the various needs of researchers in undergraduate mathematics education.

By the time of the January 2002 business meeting, Marilyn Carlson had become Coordinator of the SIGMAA on RUME and Annie Selden was Past Coordinator. It was announced that at the most recent meeting of the CRUME Committee, there had been a discussion about the future of the *RCME* (*Research in Collegiate Mathematics Education*) volumes, and that the CRUME Committee decided (with the concurrence of the SIGMAA on RUME Executive Committee) to turn over responsibility for publication of these volumes to SIGMAA on RUME as this seemed an appropriate "home." (Information downloaded May 22, 2012 from http://sigmaa.maa.org/rume/minutes020108.html.) And thus it was that the *RCME* volumes became the responsibility of the SIGMAA on RUME unto this day.

Rather than continuing with information solely from business meetings, next there will be a discussion of what each of the Coordinators feel were there greatest accomplishments during their tenure in office.

The SIGMAA on RUME matures

As the SIGMAA on RUME matured as an organization, there were many new developments and accomplishments, many of which are described below. Others are described in the minutes of the SIGMAA on RUME business meetings that can be found online or in the recollections of past SIGMAA on RUME Coordinators in the Excursus below.

Many website resources have been developed by SIGMAA on RUME

The following resources are available online at the continually updated website, www.rume.org:

- Information on future conferences – ours & others
- List of journals, indicating those accepting RUME manuscripts
- Literature database
- Selden Prize information
- Guidelines for Math. Depts. hiring RUME specialists and for Ph.D.s in RUME
- List of our current and past officers
- List of job hunting resources
- List of North American Doctoral Programs in Mathematics Education
- List of RUME Conferences going back to 2003, with links to full papers beginning 2006.

These resources are available to anyone and are not due to any one person, but rather were undertaken through the efforts of many dedicated SIGMAA on RUME members, often through the work of its various committees.

Research conferences have continued and evolved under SIGMAA on RUME leadership

The organization of the annual *Conferences on Research in Undergraduate Mathematics Education* was taken over and continued by the SIGMAA on RUME. A conference was planned and organized for September 20-23, 2001 in Chicago, but due to the terrorist attacks on the Twin Towers in New York on September 11 of that year and the resulting subsequent restrictions on travel, the SIGMAA on RUME Executive Committee decided to cancel the conference shortly before it was to begin. Thus, the next conference, was the *6th Annual Conference on Research in Undergraduate Mathematics Education.* It was held in Burlington, Vermont in Summer 2002, just prior to MAA's MathFest. This was an experimental change in timing from the previous conferences which had been held in September and that timing was not to be repeated. Details of this and subsequent conferences, including abstracts of the presentations, can be found online at the SIGMAA on RUME website, http://sigmaa.maa.org/rume/Site/Conferences.html.

Conference innovations

Over the years, there have been various innovations in the organization of the conferences. For example, an $200 award for the best paper presented at a *RUME Conference* was instituted under Chris Rasmussen's tenure as Coordinator. The best paper is determined each year by the Executive Committee, in conjunction with the Program Committee, after the conference and is awarded at the following year's conference. This award was first presented at the 10*th Annual RUME Conference*, held February 22 - 25, 2007 in San Diego. That year the best paper award went to David Kung and Natasha Speer for their joint paper, "Teaching assistants learning to teach: Recasting early teaching experiences as rich learning opportunities." Each year an honorable mention paper best paper is also selected. In 2007, that went John E. Donovan II for his paper, "The importance of the concept of function in developing understanding of first-order differential equations in multiple representations." Best paper awardees for subsequent years can be found on the conference webpage athttp://sigmaa.maa.org/rume/Site/Conferences.html.

Full conference papers, as well as abstracts, have been posted on the web starting with the *10th Annual RUME Conference* in San Diego in 2007. These were morphed into a referred online *Proceedings* beginning with the *11th Annual RUME Conference*. The format of these *Proceedings* has been evolving over time. They can sometimes consist of both long (up to 15 pages) and short papers; however, the long papers have always been submitted some three weeks after the conference with authors taking into account comments made, and questions raised, by conference participants attending their conference presentations. Also, beginning with the *11th Annual RUME Conference*, less experienced researchers who chose to write a long paper could opt to have their paper considered for selection for pre-journal submission review by more experienced researchers. This was instituted with the intent to provide an opportunity for less experienced researchers to increase the likelihood of publication in a top journal.

A further innovation instituted at the *12th Annual RUME Conference*, held Raleigh, North Carolina, February 26 – March 1, 2009, was the organization of a presession working group for those interested in "Research about novice teachers of college mathematics." Since then, *RUME Conferences* have continued the practice of having presession working groups.

Other changes and innovations over the years

The SIGMAA on RUME has also experimented with various formats and speakers for its January JMM business meetings and sessions at the annual summer MAA MathFest. Sometimes the January business meetings at the JMM included a speaker whose presentation was open to all JMM participants, but more recently there have been no speakers. Sometimes the sessions at MathFest consisted of contributed papers, whereas more recently the SIGMAA on RUME has organized workshops on various topics.

Membership numbers, electronic voting, and the listserv

The membership of SIGMAA on RUME has grown, and shrunk back somewhat, over the years 2000 -2010. It was the largest SIGMAA through 2009. Here are some membership numbers from over the years. The following numbers were obtained from Annie Selden. In 2000, there were "almost 250 members." In 2001, 330 members. In 2002, 495 paid members. The following additional membership numbers were obtained from Eric Hsu. In 2003, 709 paid members. In 2004, 675 paid members. In 2005, 685 paid members. In 2006, 650 paid members. In 2007, 591 paid members. In 2008, 613 paid members. In 2009, 566 paid members. In 2010, 545 paid members.

Initially, when the SIGMAA on RUME was first formed, elections for officers were conducted at the January business meeting. In Fall 2007, after additional SIGMAAs had been formed, after the MAA had established a Committee on SIGMAAs, and after the possibility of electronic voting through the MAA had become available, the SIGMAA on RUME conducted its first successful electronic election. Early on in the by-laws, a Nominating Committee had been provided for and that Nominating Committee has always asked its slate of nominees to provide a short biographies for posting to the RUME listserv. This listserv was established before the formation of the SIGMAA on RUME, has been moderated for a long time by Eric Hsu, and has been actively used during the entire history of this SIGMAA.

Changes in the SIGMAA on RUME sessions at the JMM and MathFest

The SIGMAA on RUME has regularly asked and been granted contributed paper and other sessions at both the January JMM and the MAA summer MathFest. The JMM contributed paper sessions have generally had ten- or fifteen minute presentations on RUME, selected by the organizers, one of whom is generally the Program Chair. Lately, however, the organizers have included half-hour presentations by three researchers whose papers at the previous *RUME Conference* were deemed of special interest to the mathematics community. The sessions at the MAA MathFest were initially contributed paper sessions much like those at the January JMM. However, more recently, the SIGMAA on RUME has requested and gotten time slots for the presentation of workshops on the teaching and learning of single topics, such as calculus, linear algebra, and limits. No doubt as the SIGMAA on RUME leadership changes, there will be further changes in the sessions it sponsors.

The SIGMAA on RUME is a thriving organization of researchers in undergraduate mathematics education and of mathematicians interested in such research. The topics of the papers considered at the *RUME Conferences* and at the JMM and MathFest sessions have expanded to include, not only research in undergraduate mathematics education, but also research on mathematics teaching assistants and mathematicians' proving and reading. No doubt, the future holds additional changes in research.

Acknowledgements: Thanks to [a colleague] for her willingness to read various early versions of this manuscript and provide valuable advice. Any errors or omissions are my own.

REFERENCES

Asiala, M., Brown, A., DeVries, D. J., Dubinsky, E., Mathews, D., & Thomas, K. (1996). A framework for research and curriculum development in undergraduate mathematics education. In J. Kaput, A. H. Schoenfeld, & E. Dubinsky (Eds.), *Research in Collegiate Mathematics Education. II*. CBMS Issues in Mathematics Education (Vol. 6, pp. 1-32). Providence, RI: American Mathematical Society.

Dreyfus, T., Hillel, J., & Sierpinska, A. (1999). Cabri based linear algebra transformations. In I. Schwank (Ed.), *Proceedings of First Conference of the European Society in Mathematics Education*, Vol. I (pp. 209-221). Osnabrueck: Forschungsinstitut fuer Mathematikdidaktik.

Dubinsky, E. (1986). Teaching mathematical induction, I. *Journal of Mathematical Behavior*, *5*, 305-317.

Dubinsky, E. (1989). Teaching mathematical induction, II. *Journal of Mathematical Behavior*, *8*, *285*-304.

Dubinsky, E. (1991). Reflective abstraction in advanced mathematical thinking. In D. Tall (Ed.), *Advanced mathematical thinking* (pp. 95-126). Dordrecht, The Netherlands: Kluwer.

Dubinsky, E. (1997). Research on undergraduate mathematics education: A way to get started. *MAA Online*. Retrieved June 1, 2012 from file:///E:Documents/Stuff we're working on/A Home for RUME paper/RUME Info – A Way to Get Started.html.

Dubinsky, E., & Harel, G. (1992). *The concept of function: Aspects of epistemology and pedagogy*, MAA Notes Vol. 25. Washington, DC: Mathematical Association of America.

Dubinsky, E., & Leron, U. (1994). *Learning abstract algebra with ISETL*. New York: Springer-Verlag.

Dubinsky, E., Schoenfeld, A. H., & Kaput, J. (Eds.) (1994). *Research in collegiate mathematics education. I*. Providence, RI: American Mathematical Society.

Hurley, J. F., Koehn, U., & Ganter, S. L. (1999). Effects of calculus reform: Local and national. *The American Mathematical Monthly*, *106*(9), 800-811.

Kaput, J., & Dubinsky, E. (1994). *Research issues in undergraduate mathematics education: Preliminary analyses and results*, MAA Notes Vol. 33. Washington, DC: Mathematical Association of America.

Selden, A., & Selden, J. (1999). Tertiary mathematics education research and its future. *Tennessee Technological University Mathematics Department Technical Report* No. 1999-6. Available online.

Selden, J., Selden, A., & Mason, A. (1994). Even good calculus students can't solve nonroutine problems. In J. Kaput and E. Dubinsky (Eds.), *Research issues in undergraduate mathematics learning: Preliminary analyses and results* (MAA Notes No. 33, pp. 19-26). Washington, DC: Mathematical Association of America.

Tall, D. (Ed.) (1991). *Advanced mathematical thinking.* Dordrecht, The Netherlands: Kluwer.

Tobias, S. (1990). *They're not dumb, they're different: Stalking the second tier*. Tucson, AZ: Research Corporation.

They following websites of individuals were also consulted:
http://www.math.kent.edu/~edd/publications.html
http://www.unco.edu/nhs/mathsci/facstaff/soto/talks.html
http://math.la.asu.edu/~zandieh/modifiedcv.htmInformation from
http://math.boisestate.edu/~kinzel/vita.html
http://www2.gsu.edu/~matdnv/CV%20sept%2008.htm
http://mathed.asu.edu/media/pdf/cv/Marilyn_Carlson_CV.pdf
http://pzacad.pitzer.edu/~sbrown/Stacy_Brown_Vita_2011.pdf
http://www.mth.pdx.edu/~slarsen/Research/SLarsen%20CV%20Oct%202011.pdf
http://mypage.iu.edu/~yusong/Math/CV/Brown_cv.pdf
http://sigmaa.maa.org/rume/minutes990731.html
http://www.education.umd.edu/MathEd/info/ryu.htm

EXCURSUS

Greatest accomplishments of the SIGMAA on RUME Coordinators during their tenures in office from 1999 to 2010

In preparation for my plenary at the *14th Annual Conference on Research in Mathematics Education*, which was requested by the organizers to be on the history of SIGMAA on RUME, the author emailed the previous coordinators asking for what they thought their greatest accomplishments had been during their tenures of office. Here is a synopsis of their replies:

Ed Dubinsky, who was instrumental in getting both ARUME, and its successor, the SIGMAA on RUME started, also served as its first Coordinator from 1999-2000. His accomplishments include: (1) All the preparatory work for ARUME, including serving as editor of *UME Trends*, organizing the first three *Conferences on Research in Undergraduate Mathematics Education* with the help of RUMEC members, serving as chair of CRUME, serving as an editor of *RCME* and serving as an editor of the two MAA Notes volumes mentioned above. Also, when serving as 2nd Vice President of the MAA, he was able to convinced the MAA to institute a program of SIGMAAs and served as Chair of the MAA Task Force on Special Interest Groups (1999-2001). Also, he was instrumental in convincing the ExxonMobil Foundation to award the MAA a 3-year grant for $285,000 to fund the initial operation of ARUME and the SIGMAA on RUME. (Personal communication, February10, 2011)

Annie Selden, who served as Coordinator from 2000-2002, saw as one of her important contributions to the SIGMAA on RUME as Chair of the Governance Committee, the drafting of ARUME's bylaws and the drafting of the subsequent SIGMAA on RUME Charter and subsequent revisions thereof. She conceived of the idea of having half of the officers elected each year, and of having the Coordinator's job be essentially for 4 years (Coordinator-Elect, 1 year; Coordinator, 2 years; Past-Coordinator, 1year) in order to provide an institutional memory during transitions in the composition of the Executive Committee. She also sees as very important, although it did not occur during the time she served as Coordinator, the establishment, through the MAA, of the Selden Prize for Research in Undergraduate Mathematics Education, with its specific criteria. During her tenure, she also saw the establishment of the precedent of having candidates for office write their biographies and goals for the SIGMAA on RUME and post them to the listserv. She was also instrumental in working to get the SIGMAA on RUME to take over responsibility for the publication of the *Research in Collegiate Mathematics Education RCME* (RCME) volumes, seeing this as their proper home.

Marilyn Carlson, who served as Coordinator from 2002 to 2004, saw as her most noteworthy accomplishment the "spearheading [of] and then serving as Co-Editor with Chris [Rasmussen] on the now published MAA Notes Volume Number 73, *Making the connection: Research and teaching in undergraduate mathematics education*." (Personal communication,

February 15, 2011). Also, she saw "… our joint [with Annie Selden] efforts to move SIGMAA on RUME to be more diverse in its membership, and inclusive of a broad range of theoretical perspectives. As you likely recall, there was some pretty strong resistance and some intense exchanges during this transition period."

Barbara Edwards, who served as Coordinator from 2004 to 2006, mentioned as important the development of closer ties of the SIGMAA on RUME to the MAA, as well as her work on the Mentoring Mini-Grants, both before and after serving as Coordinator. These were small grants (up to $2,000) to facilitate collaborations between RUME researchers and those wanting to get into RUME. She said, "… it really gave some people a chance to get started when they probably couldn't have been awarded a large grant at the time." (personal communications, February 12 and 13, 2011). The funds initially came from the ExxonMobil Grant to the MAA that was mentioned above.

Chris Rasmussen, who served as Coordinator from 2006 to 2008, indicated that some of his most important accomplishments were that he "began the process of writing a proposal to start a new journal focusing on research in collegiate mathematics education [to replace the *RCME* volumes] and to obtain funding from NSF." Unfortunately, that proposal was not funded, so this new journal has still to come to fruition. He also encouraged publication, dissemination , and recognition of high quality research by (1) starting the $200 prize for the best paper at the *RUME Conference*, (2) establishing the *Annual RUME Conference Proceedings*, and (3) initiating the practice of inviting the 2-3 best RUME conference papers to be presented at the next JMM. Chris Rasmussen also furthered research-to-practice initiatives by (1) starting the extended research to practice sessions at MathFest (with Marilyn Carlson doing the first one and Sean Larsen doing the next one); and (2) seeing the MAA Notes volume, *Making the connection: Research and teaching in undergraduate mathematics education*, through to publication with Marilyn Carlson. (Personal communication, February 2011).

Karen Marrongelle, who served as Coordinator from 2008 to 2010, saw as some of her accomplishments that she reconstituted the Committee on Mentoring (Hortensia Soto-Johnson, Chair), which produced a document reviewing RUME's past mentoring activities and made recommendations to strengthen and improve how to mentor new RUME researchers. She also worked closely with Chris Rasmussen, Pat Thompson, and Annie Selden to try to convince the MAA that it is the right organization to publish the new journal, *Collegiate Mathematics Education Research Journal* (*CMERJ*), and applied to NSF for funding of this proposed journal, which was not forthcoming. (Personal communication, February 16, 2011).

APPENDIX A
Email communication regarding the RUME Conference held September 4, 1997 – September 7, 1997

Date: Fri, 29 Aug 1997
From: Mickey McDonald <mickey@oxy.edu>
Subject: RUME Conference - Final Update
To all RUME Conference attendees:

This is a rather long email message with important travel information included.

We are really looking forward to seeing all of you at the conference beginning at 7:00 pm on Thursday, September 4. The conference runs through 11:30 on Sunday, September 7. The final program can be found at:

http://galois.oxy.edu/mickey/RUME.html

Please note some special events that will be taking place at the conference.

PLENARY SPEAKERS:
Ed Dubinsky - Thursday, 7:30-9:00
"Putting Constructivism to Work: Bridging the Gap Between Research and Collegiate Teaching Practice"

Ricardo Cantoral - Friday, 1:30-3:00
"An Example of the Sociological Point of View in Math Education: The Case of Analytical Functions at the University Level"

Jere Confrey - Saturday, 11:00-12:30
"Learning to Listen in New Technological Environments: Changes to Our Mathematical Thinking"

Tom Banchoff - Saturday, 7:00-8:30
"Beyond Homework, Beyond Class Discussion: New Patterns of Interactive Response in an Internet-Based Course"

PANELS:

Friday, 9:30-11:00

"The Role of RUME in a Mathematics Department" with Joan Ferrini-Mundy, Jim Kaput, Linda Sons, and Richard Fleming
Saturday, 3:30-5:00

"Research on Specific Pedagogical Strategies" with Penny Dunham, David Mathews, Norma Presmeg, Barbara Reynolds, and John Selden

Sunday, 10:10-11:10

"Connecting K-12 and Collegiate Mathematics Education Research" with Deborah Ball, Bob Davis, Bill Martin, and Anne Brown

APPENDIX B
Flyer for the Third Annual Conference on Research in Mathematics Education
September 17-20, 1998

Preliminary Announcement and Call for Papers

Research in Undergraduate Mathematics Education Community (RUMEC) presents

The Third Annual Conference on Research in Undergraduate Mathematics Education

September 17-20, 1998

Century Center
South Bend, Indiana

This conference is a forum for researchers in collegiate mathematics education and includes the following themes: results of current research, contemporary theoretical perspectives and research paradigms, application of learning theory to teaching practice, technology in mathematics learning, and general issues in the psychology of mathematics education as it pertains to the study of undergraduate mathematics. The program will include plenary addresses, invited speakers, panel discussions, and contributed paper sessions.

Call for Proposals

One-page proposals for papers should be submitted via e-mail by May 1 to:
Georgia Tolias tolias@calumet.purdue.edu

Conference Chairpersons

Georgia Tolias
Purdue University Calumet
tolias@calumet.purdue.edu

Anne Brown
Indiana University South Bend
abrown@iusb.edu

Conference Co-Organizers
Julie Clark, Ed Dubinsky, Jennifer Kleiman, Dave Mathews, Mickey McDonald, and Draga Vidakovic

Conference WWW Page
http://galois.oxy.edu/mickey/rume98.html

Sponsor

Exxon Education Foundation

Hosts

Indiana University South Bend
Southwestern Michigan College

APPENDIX C

Agenda for the Meeting on January 14, 1999 that Officially Launched ARUME

Inaugural Meeting of ARUME - Association for Research in Undergraduate Mathematics Education, Thursday, January 14,1999

Agenda

- 7:00 p.m. Welcome, Thomas P. Dick
- 7:05 p.m. "Pre-history of ARUME and Some Initial Goals," Ed Dubinsky
- 7:30 p.m. Business Meeting: Organizational Structure, Annie Selden Election of Officers. Thomas P. Dick Discussion of future directions.
- 8:30 p.m. Three papers reporting RUME

    - Students ' intuitive rules in number theory, Rina Zazkis
    - Constructing Cognitive Collages: A Tale of Two Students, Mercedes McGowen
    - A Study of Mathematics Graduate Students' Mathematical Behavior, Marilyn Carlson

- 9:30 p.m. Reception [funded by Exxon Educ. Foundation]

APPENDIX D

Email announcing the 4th Annual RUME Conference sent September 8, 1999

Conference on Research in Undergraduate Mathematics Education

Radisson Hotel O'Hare
Rosemont (Chicago), IL

Dear Colleague,

It is our pleasure to welcome you to Rosemont for the 4th annual Research Conference in Collegiate Mathematics Education. As you will see from the enclosed program, we have a tremendously exciting conference lineup. There are more than 100 pre-registered participants with speakers coming from across the United States, Mexico, France, Italy, Israel, and Brazil.

This is the first time the conference is being held under the auspices of ARUME. The Association for Research in Undergraduate Mathematics Education was formed at the Joint Meetings in San Antonio. It's purpose is to foster a professional atmosphere for quality research in the teaching and learning of undergraduate mathematics. In addition to this conference ARUME will sponsor contributed paper sessions for mathematics educators and professional mathematicians interested in research on undergraduate mathematics education at the January 2000 Joint Meetings in Washington, D.C.

If you are arriving early in the day on Thursday, you will find a restaurant in the hotel. If you have transportation, the hotel will be glad to assist you in selecting and providing directions to nearby eateries. As you know the conference fee includes both lunch and dinner on Friday and Saturday as well as coffee breaks each morning and afternoon, so plan ahead for breakfasts and late night snacks. There's also a reception with cold refreshments on Thursday night.

In addition to talks, panel discussions, and poster sessions we hope that the program will provide you with opportunities to continue discussions from the sessions, to visit with old acquaintances, and to make new ones.

We would like to highlight a few special notes about the program:

- New this year – Poster sessions. (8:30 to 10:00 p.m. Thursday and 5:15- 6:30 Saturday). Presenters will be available for discussion and questions during these scheduled times. Posters will be on display before and after these sessions.
- New this year – Themed dinners...we hope these will catalyze your discussion around interesting and exciting topics.
- There will be a Research Interest Meeting Saturday evening at 8:00 sponsored by the ARUME committee on Mentoring.
- Books available

A conference evaluation form is enclosed. We hope you will use it to give us feedback.

Finally, we want to take this additional opportunity to thank Exxon Education Foundation and National-Louis University for their support.

We hope that you will feel free to contact any one of us if you have any questions or concerns during the conference. We are looking forward to an outstanding conference.

Sincerely,

Anne Brown, Julie Clark, Ed Dubinsky, Clare Hemenway,
George Litman, Mickey McDonald, Georgia Tolias, Annie Selden
Conference Organizers

Appendix E

Outline of the History of SIGMAAs (downloaded from http://sigmaa.maa.org/sigmaahistory.html)

- **January 1999:** MAA Board of Governors forms study group to establish recommendations to guide the MAA into the new century
- **Spring 1999:** A New Agenda for the 21st Century, developed through the MAA's strategic planning process, includes the recommendation of the task force to "Facilitate the Formation of Special Interest Groups"
- **Spring 1999:** MAA Task Force on Special Interest Groups created to develop guidelines for the establishment of Special Interest Groups within the MAA
- **Summer 1999:** Task Force's Resolution on Establishing Special Interest Groups approved by MAA Executive Committee and Boardof Governors. The Resolution officially names the groups "SIGMAAs"
- **Fall 1999:** Task Force's Procedures for Establishing a SIGMAA approved by MAA Executive Committee
- **December 1999:** New SIGMAAs program officially announced in FOCUS
- **January 2000:** SIGMAA RUME approved as the first SIGMAA
- **May 2000:** SIGMAA STAT-ED approved as the second SIGMAA
- **January 2001:** BIG SIGMAA approved as the third SIGMAA
- **Summer 2001:** MAA Board of Governors disbands the Task Force and creates the MAA Committee on SIGMAAs
- **November 2001:** HOM SIGMAA approved as the fourth SIGMAA
- **January 2002:** First Annual SIGMAA Officers Meetings held at the Joint Mathematics Meetings
- **August 2002:** SIGMAA EM approved as the fifth SIGMAA
- **November 2002:** POM SIGMAA approved as the sixth SIGMAA
- **June 2003:** WEB SIGMAA approved as the seventh SIGMAA
- **January 2004:** SIGMAA QL approved as the eighth SIGMAA
- **January 2005:** SIGMAA TAHSM approved as the ninth SIGMAA
- **August 2006:** BIO SIGMAA approved as the tenth SIGMAA
- **October 2006:** SIGMAA ARTS approved as the eleventh SIGMAA
- **January 2009:** SIGMAA MCST approved as the twelfth SIGMAA