

**02 INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and  
co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS**

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**PI/PD Name:** Robert Beezer

**Gender:** ☒ Male ☐ Female

**Ethnicity:** (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

**Race:**  
(Select one or more)

☐ American Indian or Alaska Native  
☐ Asian  
☐ Black or African American  
☐ Native Hawaiian or Other Pacific Islander  
☒ White

**Disability Status:**  
(Select one or more)

☐ Hearing Impairment  
☐ Visual Impairment  
☐ Mobility/Orthopedic Impairment  
☐ Other  
☐ None

**Citizenship:** (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

**Check here if you do not wish to provide any or all of the above information (excluding PI/PD name):** ☒

**REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project** ☐

**Ethnicity Definition:**

**Hispanic or Latino.** A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.

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**PI/PD Name:** Thomas W Judson

**Gender:** ☐ Male ☐ Female

**Ethnicity:** (Choose one response) ☐ Hispanic or Latino ☐ Not Hispanic or Latino

**Race:**  
(Select one or more)

☐ American Indian or Alaska Native  
☐ Asian  
☐ Black or African American  
☐ Native Hawaiian or Other Pacific Islander  
☐ White

**Disability Status:**  
(Select one or more)

☐ Hearing Impairment  
☐ Visual Impairment  
☐ Mobility/Orthopedic Impairment  
☐ Other  
☐ None

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**PI/PD Name:** William A Stein

**Gender:** ☒ Male ☐ Female

**Ethnicity:** (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

**Race:**  
(Select one or more)

☐ American Indian or Alaska Native  
☐ Asian  
☐ Black or African American  
☐ Native Hawaiian or Other Pacific Islander  
☒ White

**Disability Status:**  
(Select one or more)

☐ Hearing Impairment  
☐ Visual Impairment  
☐ Mobility/Orthopedic Impairment  
☐ Other  
☒ None

**Citizenship:** (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

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**PI/PD Name:** Marja-Liisa Hassi

**Gender:** ☐ Male ☒ Female

**Ethnicity:** (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

**Race:**  
(Select one or more)

☐ American Indian or Alaska Native  
☐ Asian  
☐ Black or African American  
☐ Native Hawaiian or Other Pacific Islander  
☒ White

**Disability Status:**  
(Select one or more)

☐ Hearing Impairment  
☐ Visual Impairment  
☐ Mobility/Orthopedic Impairment  
☐ Other  
☒ None

**Citizenship:** (Choose one) ☐ U.S. Citizen ☐ Permanent Resident ☒ Other non-U.S. Citizen

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**PI/PD Name:** Sandra L Laursen

**Gender:** ☐ Male ☒ Female

**Ethnicity:** (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

**Race:**  
(Select one or more)

☐ American Indian or Alaska Native  
☐ Asian  
☐ Black or African American  
☐ Native Hawaiian or Other Pacific Islander  
☒ White

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(Select one or more)

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☐ Visual Impairment  
☐ Mobility/Orthopedic Impairment  
☐ Other  
☒ None

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**PI/PD Name:** Jason N Grout

**Gender:** ☒ Male ☐ Female

**Ethnicity:** (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

**Race:**  
(Select one or more)

☐ American Indian or Alaska Native  
☐ Asian  
☐ Black or African American  
☐ Native Hawaiian or Other Pacific Islander  
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## List of Suggested Reviewers or Reviewers Not To Include (optional)

---

### **SUGGESTED REVIEWERS:**

Not Listed

### **REVIEWERS NOT TO INCLUDE:**

Not Listed

## List of Suggested Reviewers or Reviewers Not To Include (optional)

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Not Listed

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## List of Suggested Reviewers or Reviewers Not To Include (optional)

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## List of Suggested Reviewers or Reviewers Not To Include (optional)

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Not Listed

### **REVIEWERS NOT TO INCLUDE:**

Not Listed

## COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 10-1					<b>FOR NSF USE ONLY</b>	
<b>NSF 09-529</b> <span style="float: right;"><b>01/13/10</b></span>					<b>NSF PROPOSAL NUMBER</b>	
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)						
<b>DUE - CCLI-Phase 2: Expansion</b>						
<b>DATE RECEIVED</b>	<b>NUMBER OF COPIES</b>	<b>DIVISION ASSIGNED</b>	<b>FUND CODE</b>	<b>DUNS#</b> (Data Universal Numbering System)	<b>FILE LOCATION</b>	
				<b>004135930</b>		
EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)		SHOW PREVIOUS AWARD NO. IF THIS IS <input type="checkbox"/> A RENEWAL <input type="checkbox"/> AN ACCOMPLISHMENT-BASED RENEWAL		IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES <input type="checkbox"/> NO <input checked="" type="checkbox"/> IF YES, LIST ACRONYM(S)		
<b>943205114</b>						
NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE			ADDRESS OF Awardee ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE			
<b>American Institute of Mathematics</b>			<b>American Institute of Mathematics</b>			
AWARDEE ORGANIZATION CODE (IF KNOWN)			<b>360 Portage Avenue</b>			
<b>5300011617</b>			<b>Palo Alto, CA. 943062244</b>			
NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE			ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE			
PERFORMING ORGANIZATION CODE (IF KNOWN)						
IS Awardee ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions) <input type="checkbox"/> SMALL BUSINESS <input type="checkbox"/> MINORITY BUSINESS <input type="checkbox"/> IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE <input type="checkbox"/> FOR-PROFIT ORGANIZATION <input type="checkbox"/> WOMAN-OWNED BUSINESS						
TITLE OF PROPOSED PROJECT <b>Collaborative Research: UTMOST: Undergraduate Teaching in Mathematics with Open Software and Textbooks</b>						
REQUESTED AMOUNT \$ <b>332,819</b>		PROPOSED DURATION (1-60 MONTHS) <b>36</b> months		REQUESTED STARTING DATE <b>09/01/10</b>		SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW <input checked="" type="checkbox"/> BEGINNING INVESTIGATOR (GPG I.G.2) <input type="checkbox"/> HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number _____ Exemption Subsection _____ or IRB App. Date _____ <input type="checkbox"/> DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e) <input type="checkbox"/> PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d) <input type="checkbox"/> HISTORIC PLACES (GPG II.C.2.j) <input type="checkbox"/> EAGER* (GPG II.D.2) <input type="checkbox"/> RAPID** (GPG II.D.1) <input type="checkbox"/> VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date _____ PHS Animal Welfare Assurance Number _____ <input type="checkbox"/> INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j) <input type="checkbox"/> HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)						
PI/PD DEPARTMENT		PI/PD POSTAL ADDRESS				
PI/PD FAX NUMBER		<b>360 Portage Avenue</b>				
		<b>Palo Alto, CA 943062244</b>				
		<b>United States</b>				
NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address		
<b>PI/PD NAME</b> <b>Robert Beezer</b>	<b>DPhil</b>	<b>1984</b>	<b>253-879-3564</b>	<b>beezer@ups.edu</b>		
CO-PI/PD						
CO-PI/PD						
CO-PI/PD						
CO-PI/PD						

## CERTIFICATION PAGE

### Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, lobbying activities (see below), responsible conduct of research, nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 10-1). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

### Conflict of Interest Certification

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(If answer "yes", please provide explanation.)

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Yes ☐

No ☒

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AUTHORIZED ORGANIZATIONAL REPRESENTATIVE		SIGNATURE	DATE
NAME			
TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS		FAX NUMBER

\* EAGER - Early-concept Grants for Exploratory Research

\*\* RAPID - Grants for Rapid Response Research

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PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE(if not in response to a program announcement/solicitation enter NSF 10-1					FOR NSF USE ONLY	
NSF 09-529 01/13/10					NSF PROPOSAL NUMBER	
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)					1020957	
DUE - CCLI-Phase 2: Expansion						
DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION	
01/11/2010	2	11040000 DUE	7492	073894727	01/12/2010 10:51am	
EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)		SHOW PREVIOUS AWARD NO. IF THIS IS <input type="checkbox"/> A RENEWAL <input type="checkbox"/> AN ACCOMPLISHMENT-BASED RENEWAL		IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES <input type="checkbox"/> NO <input checked="" type="checkbox"/> IF YES, LIST ACRONYM(S)		
756002514						
NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE			ADDRESS OF Awardee ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE			
Stephen F. Austin State University			Stephen F. Austin State University			
AWARDEE ORGANIZATION CODE (IF KNOWN)			Box 6078			
0036244000			Nacogdoches, TX. 759626078			
NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE			ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE			
PERFORMING ORGANIZATION CODE (IF KNOWN)						
IS Awardee ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)			<input type="checkbox"/> SMALL BUSINESS <input type="checkbox"/> FOR-PROFIT ORGANIZATION		<input type="checkbox"/> MINORITY BUSINESS <input type="checkbox"/> WOMAN-OWNED BUSINESS	
					<input type="checkbox"/> IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE	
TITLE OF PROPOSED PROJECT Collaborative Research: UTMOST: Undergraduate Teaching in Mathematics with Open Software and Textbooks						
REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE			
\$ 45,986	36 months	09/01/10				
CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW						
<input type="checkbox"/> BEGINNING INVESTIGATOR (GPG I.G.2)			<input checked="" type="checkbox"/> HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number _____			
<input type="checkbox"/> DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e)			Exemption Subsection _____ or IRB App. Date Pending			
<input type="checkbox"/> PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D. II.C.1.d)			<input type="checkbox"/> INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)			
<input type="checkbox"/> HISTORIC PLACES (GPG II.C.2.j)			_____			
<input type="checkbox"/> EAGER* (GPG II.D.2) <input type="checkbox"/> RAPID** (GPG II.D.1)			<input type="checkbox"/> HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)			
<input type="checkbox"/> VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date _____						
PHS Animal Welfare Assurance Number _____						
PI/PD DEPARTMENT		PI/PD POSTAL ADDRESS				
Mathematics and Statistics		Box 6078				
PI/PD FAX NUMBER		nacogdoches, TX 759626078				
936-468-1669		United States				
NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address		
PI/PD NAME						
Thomas W Judson	PhD	1984	936-468-2201	judsontw@sfasu.edu		
CO-PI/PD						
CO-PI/PD						
CO-PI/PD						
CO-PI/PD						

## CERTIFICATION PAGE

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AUTHORIZED ORGANIZATIONAL REPRESENTATIVE		SIGNATURE		DATE	
NAME		Electronic Signature		Jan 11 2010 11:52AM	
Baker Pattillo					
TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS			FAX NUMBER	
936-468-2201	bpattillo@sfasu.edu			936-468-2202	

\* EAGER - Early-concept Grants for Exploratory Research

\*\* RAPID - Grants for Rapid Response Research

# COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 10-1					<b>FOR NSF USE ONLY</b>		
<b>NSF 09-529</b>			<b>01/13/10</b>			<b>NSF PROPOSAL NUMBER</b>	
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)					<b>1020378</b>		
<b>DUE - CCLI-Phase 2: Expansion</b>							
<b>DATE RECEIVED</b>	<b>NUMBER OF COPIES</b>	<b>DIVISION ASSIGNED</b>	<b>FUND CODE</b>	<b>DUNS#</b> (Data Universal Numbering System)	<b>FILE LOCATION</b>		
<b>01/07/2010</b>	<b>2</b>	<b>11040000 DUE</b>	<b>7492</b>	<b>605799469</b>	<b>01/12/2010 10:52am</b>		
EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)		SHOW PREVIOUS AWARD NO. IF THIS IS <input type="checkbox"/> A RENEWAL <input type="checkbox"/> AN ACCOMPLISHMENT-BASED RENEWAL		IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES <input type="checkbox"/> NO <input checked="" type="checkbox"/> IF YES, LIST ACRONYM(S)			
<b>916001537</b>							
NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE			ADDRESS OF Awardee ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE				
<b>University of Washington</b>			<b>4333 Brooklyn Ave NE</b>				
AWARDEE ORGANIZATION CODE (IF KNOWN)			<b>SEATTLE, WA 98195-9472</b>				
<b>0037986000</b>							
NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE			ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE				
PERFORMING ORGANIZATION CODE (IF KNOWN)							
IS Awardee ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)			<input type="checkbox"/> SMALL BUSINESS <input type="checkbox"/> FOR-PROFIT ORGANIZATION		<input type="checkbox"/> MINORITY BUSINESS <input type="checkbox"/> WOMAN-OWNED BUSINESS		
			<input type="checkbox"/> IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE				
TITLE OF PROPOSED PROJECT <b>Collaborative Research: UTMOST Undergraduate Teaching in Mathematics with Open Software and Textbooks</b>							
REQUESTED AMOUNT \$ <b>84,156</b>		PROPOSED DURATION (1-60 MONTHS) <b>36</b> months		REQUESTED STARTING DATE <b>09/01/10</b>		SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE	
CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW							
<input type="checkbox"/> BEGINNING INVESTIGATOR (GPG I.G.2) <input type="checkbox"/> HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number _____ Exemption Subsection _____ or IRB App. Date _____							
<input type="checkbox"/> DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e) <input type="checkbox"/> INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)							
<input type="checkbox"/> PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d) <input type="checkbox"/> HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)							
<input type="checkbox"/> HISTORIC PLACES (GPG II.C.2.j)							
<input type="checkbox"/> EAGER* (GPG II.D.2) <input type="checkbox"/> RAPID** (GPG II.D.1)							
<input type="checkbox"/> VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date _____ PHS Animal Welfare Assurance Number _____							
PI/PD DEPARTMENT <b>Mathematics</b>			PI/PD POSTAL ADDRESS <b>C138 Padelford</b>				
PI/PD FAX NUMBER <b>206-543-0397</b>			<b>Box 354350</b>				
			<b>Seattle, WA 981954350</b>				
			<b>United States</b>				
NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address			
PI/PD NAME <b>William A Stein</b>	<b>PhD</b>	<b>2000</b>	<b>206-543-1916</b>	<b>wstein@math.washington.edu</b>			
CO-PI/PD							
CO-PI/PD							
CO-PI/PD							
CO-PI/PD							



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AUTHORIZED ORGANIZATIONAL REPRESENTATIVE		SIGNATURE		DATE	
NAME		Electronic Signature		Jan 7 2010 6:30PM	
Laurie Salehi					
TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS			FAX NUMBER	
206-543-4043	salehil@u.washington.edu			206-685-1732	

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PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 10-1					FOR NSF USE ONLY	
NSF 09-529 01/13/10					NSF PROPOSAL NUMBER	
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)					1020687	
DUE - CCLI-Phase 2: Expansion						
DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION	
01/08/2010	2	11040000 DUE	7492	007431505	01/12/2010 10:52am	
EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)		SHOW PREVIOUS AWARD NO. IF THIS IS <input type="checkbox"/> A RENEWAL <input type="checkbox"/> AN ACCOMPLISHMENT-BASED RENEWAL		IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES <input type="checkbox"/> NO <input checked="" type="checkbox"/> IF YES, LIST ACRONYM(S)		
846000555						
NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE University of Colorado at Boulder			ADDRESS OF Awardee ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE 3100 Marine Street, Room 481 572 UCB Boulder, CO 80309-0572			
AWARDEE ORGANIZATION CODE (IF KNOWN) 0013706000						
NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE			ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE			
PERFORMING ORGANIZATION CODE (IF KNOWN)						
IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)		<input type="checkbox"/> SMALL BUSINESS <input type="checkbox"/> FOR-PROFIT ORGANIZATION		<input type="checkbox"/> MINORITY BUSINESS <input type="checkbox"/> WOMAN-OWNED BUSINESS		<input type="checkbox"/> IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE
TITLE OF PROPOSED PROJECT Collaborative Research: UTMOST: Undergraduate Teaching in Mathematics with Open Software and Textbooks						
REQUESTED AMOUNT \$ 81,981	PROPOSED DURATION (1-60 MONTHS) 36 months		REQUESTED STARTING DATE 09/01/10		SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE	
CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW <input checked="" type="checkbox"/> BEGINNING INVESTIGATOR (GPG I.G.2) <input checked="" type="checkbox"/> HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number _____ Exemption Subsection _____ or IRB App. Date Pending <input type="checkbox"/> DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e) <input type="checkbox"/> INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j) _____ <input type="checkbox"/> PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D. II.C.1.d) <input type="checkbox"/> HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1) _____ <input type="checkbox"/> HISTORIC PLACES (GPG II.C.2.j) _____ <input type="checkbox"/> EAGER* (GPG II.D.2) <input type="checkbox"/> RAPID** (GPG II.D.1) _____ <input type="checkbox"/> VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date _____ PHS Animal Welfare Assurance Number _____						
PI/PD DEPARTMENT Ethnography & Evaluation Research/CARTS			PI/PD POSTAL ADDRESS 572 UCB Boulder, CO 803090580 United States			
PI/PD FAX NUMBER 303-492-2154						
NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address		
PI/PD NAME Marja-Liisa Hassi	PhD	2001	303-735-6168	marja-liisa.hassi@colorado.edu		
CO-PI/PD Sandra L Laursen	PhD	1990	303-735-2942	sandra.laursen@colorado.edu		
CO-PI/PD						
CO-PI/PD						
CO-PI/PD						

## CERTIFICATION PAGE

### Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, lobbying activities (see below), responsible conduct of research, nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 10-1). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

### Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

### Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

### Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency?

Yes ☐

No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

### Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding \$100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding \$150,000.

### Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

- (1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
- (2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.
- (3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

### Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

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Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

- (1) community in which that area is located participates in the national flood insurance program; and
- (2) building (and any related equipment) is covered by adequate flood insurance.

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The undersigned shall require that the language of this certification be included in any award documents for all subawards at all tiers.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE		SIGNATURE		DATE	
NAME		Electronic Signature		Jan 8 2010 4:19PM	
Stefan A Reiss					
TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS			FAX NUMBER	
303-492-0868	stefan.reiss@colorado.edu			303-492-6421	

\* EAGER - Early-concept Grants for Exploratory Research

\*\* RAPID - Grants for Rapid Response Research

## COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 10-1					<b>FOR NSF USE ONLY</b>	
<b>NSF 09-529</b>			<b>01/13/10</b>		<b>NSF PROPOSAL NUMBER</b>	
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)						
<b>DUE - CCLI-Phase 2: Expansion</b>						
<b>DATE RECEIVED</b>	<b>NUMBER OF COPIES</b>	<b>DIVISION ASSIGNED</b>	<b>FUND CODE</b>	<b>DUNS#</b> (Data Universal Numbering System)	<b>FILE LOCATION</b>	
				<b>041103730</b>		
EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)		SHOW PREVIOUS AWARD NO. IF THIS IS <input type="checkbox"/> A RENEWAL <input type="checkbox"/> AN ACCOMPLISHMENT-BASED RENEWAL		IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES <input type="checkbox"/> NO <input checked="" type="checkbox"/> IF YES, LIST ACRONYM(S)		
<b>420680460</b>						
NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE			ADDRESS OF Awardee ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE			
<b>Drake University</b>			<b>Drake University</b>			
AWARDEE ORGANIZATION CODE (IF KNOWN)			<b>2507 University Avenue</b>			
<b>0018606000</b>			<b>Des Moines, IA. 503114505</b>			
NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE			ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE			
PERFORMING ORGANIZATION CODE (IF KNOWN)						
IS Awardee ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)		<input type="checkbox"/> SMALL BUSINESS <input type="checkbox"/> FOR-PROFIT ORGANIZATION		<input type="checkbox"/> MINORITY BUSINESS <input type="checkbox"/> WOMAN-OWNED BUSINESS		<input type="checkbox"/> IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE
TITLE OF PROPOSED PROJECT <b>Collaborative Research: UTMOST: Undergraduate Teaching in Mathematics with Open Software and Textbooks</b>						
REQUESTED AMOUNT \$ <b>55,050</b>	PROPOSED DURATION (1-60 MONTHS) <b>36</b> months		REQUESTED STARTING DATE <b>09/01/10</b>		SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE	
CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW						
<input checked="" type="checkbox"/> BEGINNING INVESTIGATOR (GPG I.G.2) <input type="checkbox"/> DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e) <input type="checkbox"/> PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d) <input type="checkbox"/> HISTORIC PLACES (GPG II.C.2.j) <input type="checkbox"/> EAGER* (GPG II.D.2) <input type="checkbox"/> RAPID** (GPG II.D.1) <input type="checkbox"/> VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date _____ <input type="checkbox"/> HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number _____ Exemption Subsection _____ or IRB App. Date _____ <input type="checkbox"/> INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j) _____ <input type="checkbox"/> HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1) _____						
PI/PD DEPARTMENT <b>Mathematics and Computer Science</b>			PI/PD POSTAL ADDRESS <b>2507 University Avenue</b>			
PI/PD FAX NUMBER <b>515-271-2055</b>			<b>Des Moines, IA 503114505</b> <b>United States</b>			
NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address		
<b>Jason N Grout</b>	<b>DPhil</b>	<b>2007</b>	<b>515-271-3113</b>	<b>jason.grout@drake.edu</b>		
CO-PI/PD						
CO-PI/PD						
CO-PI/PD						
CO-PI/PD						

## CERTIFICATION PAGE

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- (2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.
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The undersigned shall require that the language of this certification be included in any award documents for all subawards at all tiers.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE		SIGNATURE		DATE	
NAME					
TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS			FAX NUMBER	

\* EAGER - Early-concept Grants for Exploratory Research

\*\* RAPID - Grants for Rapid Response Research

**NATIONAL SCIENCE FOUNDATION**  
**Division of Undergraduate Education**

**NSF FORM 1295: PROJECT DATA FORM**

The instructions and codes to be used in completing this form are provided in Appendix II.

1. **Program-track** to which the Proposal is submitted: CCLI-Phase 2: Expansion
2. Name of **Principal Investigator/Project Director** (as shown on the Cover Sheet):  
Beezer, Robert
3. Name of submitting **Institution** (as shown on Cover Sheet):  
American Institute of Mathematics
4. **Other Institutions** involved in the project's operation:  
University of Washington  
University of Puget Sound  
Drake University  
University of Colorado  
Stephen F. Austin State University  
Massachusetts Institute of Technology

**Project Data:**

- A. Major Discipline Code: 21
- B. Academic Focus Level of Project: BO
- C. Highest Degree Code: N
- D. Category Code: --
- E. Business/Industry Participation Code: NA
- F. Audience Code: F \_ \_ \_ \_ \_
- G. Institution Code: NACD
- H. Strategic Area Code: IT \_
- I. Project Features: R C F I A

Estimated number in each of the following categories to be directly affected by the activities of the project during its operation:

- J. Undergraduate Students: 450
- K. Pre-college Students: \_\_\_\_\_
- L. College Faculty: 15
- M. Pre-college Teachers: \_\_\_\_\_
- N. Graduate Students: 6

**NATIONAL SCIENCE FOUNDATION**  
**Division of Undergraduate Education**

**NSF FORM 1295: PROJECT DATA FORM**

The instructions and codes to be used in completing this form are provided in Appendix II.

1. **Program-track** to which the Proposal is submitted: CCLI-Phase 2: Expansion
2. Name of **Principal Investigator/Project Director** (as shown on the Cover Sheet):  
Judson, Thomas
3. Name of submitting **Institution** (as shown on Cover Sheet):  
Stephen F. Austin State University
4. **Other Institutions** involved in the project's operation:  
American Institute of Mathematics  
University of Washington  
University of Puget Sound  
Drake University  
University of Colorado at Boulder  
Massachusetts Institute of Technology

**Project Data:**

- A. Major Discipline Code: 21
- B. Academic Focus Level of Project: BO
- C. Highest Degree Code: M
- D. Category Code: --
- E. Business/Industry Participation Code: NA
- F. Audience Code: F \_ \_ \_ \_ \_
- G. Institution Code: PUBL
- H. Strategic Area Code: IT
- I. Project Features: R C F I A

Estimated number in each of the following categories to be directly affected by the activities of the project during its operation:

- J. Undergraduate Students: 450
- K. Pre-college Students: 0
- L. College Faculty: 15
- M. Pre-college Teachers: 0
- N. Graduate Students: 6

**NATIONAL SCIENCE FOUNDATION**  
**Division of Undergraduate Education**

**NSF FORM 1295: PROJECT DATA FORM**

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1. **Program-track** to which the Proposal is submitted: CCLI-Phase 2: Expansion
2. Name of **Principal Investigator/Project Director** (as shown on the Cover Sheet):  
Stein, William
3. Name of submitting **Institution** (as shown on Cover Sheet):  
University of Washington
4. **Other Institutions** involved in the project's operation:  
University of Puget Sound  
Drake University  
University of Colorado  
Stephen F. Austin State University  
Massachusetts Institute of Technology  
American Institute of Mathematics (AIM)

**Project Data:**

- A. Major Discipline Code: 21
- B. Academic Focus Level of Project: BO
- C. Highest Degree Code: D
- D. Category Code: --
- E. Business/Industry Participation Code: NA
- F. Audience Code: F \_ \_ \_ \_ \_
- G. Institution Code: PUBL
- H. Strategic Area Code: IT \_ \_
- I. Project Features: R C F I A

Estimated number in each of the following categories to be directly affected by the activities of the project during its operation:

- J. Undergraduate Students: 450
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- M. Pre-college Teachers: 0
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**NATIONAL SCIENCE FOUNDATION**  
**Division of Undergraduate Education**

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1. **Program-track** to which the Proposal is submitted: CCLI-Phase 2: Expansion
2. Name of **Principal Investigator/Project Director** (as shown on the Cover Sheet):  
Hassi, Marja-Liisa
3. Name of submitting **Institution** (as shown on Cover Sheet):  
University of Colorado at Boulder
4. **Other Institutions** involved in the project's operation:  
American Institute of Mathematics  
University of Washington  
University of Puget Sound  
Drake University  
Stephen F. Austin State University  
Massachusetts Institute of Technology

**Project Data:**

- A. Major Discipline Code: 21
- B. Academic Focus Level of Project: BO
- C. Highest Degree Code: D
- D. Category Code: --
- E. Business/Industry Participation Code: NA
- F. Audience Code: F \_ \_ \_ \_ \_
- G. Institution Code: PUBL
- H. Strategic Area Code: IT
- I. Project Features: R C F I A

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- J. Undergraduate Students: 450
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- L. College Faculty: 15
- M. Pre-college Teachers: 0
- N. Graduate Students: 6

**NATIONAL SCIENCE FOUNDATION**  
**Division of Undergraduate Education**

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The instructions and codes to be used in completing this form are provided in Appendix II.

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2. Name of **Principal Investigator/Project Director** (as shown on the Cover Sheet):  
Grout, Jason
3. Name of submitting **Institution** (as shown on Cover Sheet):  
Drake University
4. **Other Institutions** involved in the project's operation:  
American Institute of Mathematics  
University of Washington  
University of Puget Sound  
University of Colorado at Boulder  
Stephen F. Austin State University  
Massachusetts Institute of Technology

**Project Data:**

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- B. Academic Focus Level of Project: BO
- C. Highest Degree Code: B
- D. Category Code: --
- E. Business/Industry Participation Code: NA
- F. Audience Code: F \_ \_ \_ \_ \_
- G. Institution Code: PRIV
- H. Strategic Area Code: IT \_
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- K. Pre-college Students: 0
- L. College Faculty: 15
- M. Pre-college Teachers: 0
- N. Graduate Students: 6

## UTMOST Project Summary

This project will demonstrate the use of Sage, which is comprehensive free open source mathematics software, coupled with existing free open textbooks, as a tool for faculty and institutions to more easily bring the power of mathematics software to their students. Authors of open source software and open textbooks provide licenses that permit free copying and modifications of their work, allowing others to modify or extend them to suit their needs or make improvements. Primarily, UTMOST will convert existing open textbooks into web-based electronic texts that integrate traditional mathematical exposition with Sage code and hands-on demonstrations. Ten different undergraduate institutions will help test and refine these materials using a comprehensive, professional evaluation procedure. The main goal driving this project is to create technical and pedagogical tools and methods that greatly simplify the deployment and use of powerful software to increase learning and experimentation in undergraduate mathematics.

### INTELLECTUAL MERIT

Research has shown that powerful software for mathematics can increase a student's understanding. Despite decades of experience with these programs, they have not had a broad transformative effect on undergraduate mathematics education. Cost, license restrictions, and weak textbook support are significant obstacles to the adoption of mathematics software in a course. This project will use free comprehensive software, which by design only requires a student to have a connected web browser. By converting open textbooks to electronic worksheets integrated with software, UTMOST will give students the full power of the software, available in their textbook for interactive demonstrations and experimentation. The goal is to make it easier for institutions, faculty, and students to benefit from mathematics software in their courses.

UTMOST will select ten institutions as test sites. They will represent a wide variety of institutional profiles and will include schools serving underrepresented and disadvantaged student populations. In the first year, UTMOST will convert three open textbooks to Sage worksheets, enhanced with Sage code and interactive demonstrations. As part of these conversions, UTMOST will create a system others can use to author similar materials. Five test sites will use these Sage-enhanced materials in their courses in the second year. Work will continue in the second year to convert other open textbooks. For the third year, five more test sites will join the project, so materials will be in use at all ten institutions. During the second and third years, the project will refine the materials and their use, based on workshops with faculty from the test sites and a formative evaluation.

Members of the project team have extensive, wide-ranging, and overlapping experience in undergraduate teaching, software development, textbook authoring, classroom teaching with mathematics software, assessing mathematics education and conducting original research in mathematics, and come from a variety of different institutions. The project will professionally assess the adoption and use of these materials, including their effect in the classroom. The result will be a refined process that other authors and instructors can employ to create and use similar materials.

### BROADER IMPACTS

Free open source software and open textbooks decrease the cost of mathematics education for students and institutions. This is a critical consideration for institutions such as community colleges and those serving disadvantaged groups of students. Through the project's selection of ten test sites, these institutions and students will participate in refining the project's materials and their use. This project will determine effective ways to deliver these materials and tools to institutions and students, while creating a procedure that will allow others to simply and efficiently produce similar materials. With vibrant websites and communities already in place, and through workshops and short courses, UTMOST will disseminate widely the procedures for using and creating these materials, making it easier for institutions, faculty, and students to benefit from mathematics software in their courses.

## TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.B.2.

	Total No. of Pages	Page No.* (Optional)*
Cover Sheet for Proposal to the National Science Foundation		
Project Summary (not to exceed 1 page)	1	_____
Table of Contents	1	_____
Project Description (Including Results from Prior NSF Support) (not to exceed 15 pages) <b>(Exceed only if allowed by a specific program announcement/solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)</b>	15	_____
References Cited	4	_____
Biographical Sketches (Not to exceed 2 pages each)	4	_____
Budget (Plus up to 3 pages of budget justification)	5	_____
Current and Pending Support	2	_____
Facilities, Equipment and Other Resources	2	_____
Special Information/Supplementary Documentation	6	_____
Appendix (List below. ) <b>(Include only if allowed by a specific program announcement/ solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)</b>	_____	_____
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Project Description (Including Results from Prior NSF Support) (not to exceed 15 pages) <b>(Exceed only if allowed by a specific program announcement/solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)</b>	0	_____
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Biographical Sketches (Not to exceed 2 pages each)	2	_____
Budget (Plus up to 3 pages of budget justification)	5	_____
Current and Pending Support	1	_____
Facilities, Equipment and Other Resources	1	_____
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## 1. UTMOST PROJECT DESCRIPTION

### UNDERGRADUATE TEACHING IN MATHEMATICS WITH OPEN SOFTWARE AND TEXTBOOKS

Software for mathematical explorations, including computer algebra systems (CAS), have held great promise for education since their first appearance in the 1960s (Reduce, Macsyma [51, 65]) and the introduction of Maple and Mathematica in the 1980s [49, 89]. Currently, CAS are widely found in the undergraduate classroom and a considerable amount of mathematics education research has focused on the use of CAS in learning undergraduate mathematics. Studies have documented the improvement in students' understanding [33, 34, 43, 57]. For example, the use of technology allows students to avoid tedious or unreasonable computations, avoid long tables of integrals or Laplace transforms, visualize complicated 2-D plots and 3-D mathematical objects, and easily deal with unwieldy matrices in linear algebra. Another example is that technology has allowed a qualitative approach to teaching differential equations. Most differential equations cannot be solved explicitly, but numerical and graphical software has enabled teachers to incorporate a qualitative approach in the courses that they teach [7]. The ability to make large computations, quickly and without errors, with graphical output, can greatly aid students' understanding of difficult ideas in mathematics and provides them with an incredible capacity for experimentation and conjecture.

Computer algebra systems are now common in the undergraduate classroom, yet we rarely see a seamless integration with the curriculum. To accommodate competing commercial systems that divide the market, textbooks typically offer supplements for several different CAS, or they are "technology-enhanced" with generic sidebars. Licensing restrictions for campus use, the expense of personal copies, and underpowered hardware often mean that students can only work with commercial software in campus labs. Some institutions are unable to afford the cost of building such labs for their students.

There have been efforts at seamless integration of technology and curriculum (e.g., calculus [81]). An example of such an experiment is the Calculus & Mathematica project, which generated much excitement in the early 1990s and had demonstrable success in helping diverse students learn more effectively [2, 58]. However, today its use seems limited to the two institutions where it originated [55, 86]. Likewise, the use of interactive Java applets to support teaching mathematics (such as [3, 10, 35]) does not seem to have been widely adopted. The undergraduate curriculum has not seen the broad transformative effect of these powerful tools for increasing the learning and understanding of mathematics. We propose an approach using open source software which we believe will allow for the wide adoption of approaches that have proven to be successful.

**1.1. An open approach.** Sage [5, 75] is free open source software designed to be an alternative to Magma, Maple, Mathematica, and Matlab. Coinciding with the development of Sage, there is a general movement to freely-available open textbooks that includes many quality texts in mathematics ([12, 56], Section 5.1.3). Our proposition is that freely-available open software, open textbooks, and other open curricular materials can allow teachers everywhere to transform the undergraduate mathematics curriculum by tightly and seamlessly integrating mathematics software with more traditional curricular materials. We will test this hypothesis by integrating Sage into existing open textbooks and other curricular materials, placing the full computational power of Sage *directly into* a student's text, usable any time from anywhere via a web browser. For the institution and the instructor, the cost and time-consuming licensing inconveniences of commercial software are removed by open software. Sage can also be used remotely from a standard web browser, eliminating the need for a dedicated local computer lab. Furthermore, the essential nature of open software means that curricular decisions and needs can drive the development of the software, with the classroom teacher actively advising (or actually doing) the software development. Likewise, open curricular materials can be adapted to course needs and teacher preferences, and can be distributed with the software freely in an integrated package. Leveraging these inherent advantages of an open approach to software and curricular materials, the promise of mathematics software in education can be fully

realized by faculty and students. Our work will create and disseminate a model for this integration, addressing both the pedagogical and technical aspects, so that other faculty authors can realize the advantages in their own curricular materials and courses.

More specifically, UTMOST will build and test a model for easily integrating open mathematics software and open educational materials into the mathematics curriculum and classroom as follows.

- We will create a system that makes it easy for authors to convert open textbooks and other curricular materials to Sage worksheets, interspersing runnable interactive demonstrations and exercises and live Sage code with publication-quality typeset mathematics.
- We will convert existing mature open textbooks to this format and create new curricular materials targeting this format, as demonstrations and tests of both the technical and pedagogical aspects of this new approach.
- We will partner with ten diverse institutions to test these materials in a wide variety of courses, and provide support for their use and assistance for the creation of new materials.
- We will evaluate the effectiveness of our model for making it easy to adopt open mathematics software and textbooks and making it easy to create integrated open curricular materials, and we will measure the resulting impact on teaching practices and the learning of mathematics with the expert assistance of professional evaluators.

In addition to workshops and other presentations, materials created or enhanced by UTMOST will be widely distributed with open licenses and made available through the global Sage website ([www.sagemath.org](http://www.sagemath.org) [75]). As appropriate, they will also be available in Sage itself or through a new open textbook initiative at the American Institute of Mathematics [1] as part of this project.

## 2. TRENDS IN SCIENTIFIC COMMUNICATION

The cost of academic research journals, especially in science, combined with dissemination restrictions imposed by copyright law and new dissemination possibilities afforded by technology, are collectively referred to by librarians as the “serials crisis” [9]. Faculty have come a long way in their efforts to return scientific publication to a free exchange of ideas. Electronic journals and public repositories now publish articles with licenses that explicitly allow for sharing new results easily via the Internet without distribution fees. Government initiatives, such as the Public Access Policy of the National Institutes of Health [54] and the Policy Forum on Public Access of the White House Office of Science and Technology [88], are working to accelerate this trend.

Following on the sea change in research publication, the next wave is open textbooks. Faculty are all too familiar with the problems that plague commercial textbook publication, such as high prices, edition churn, and orphaned works. Open licenses are now being used to assert control of these critical resources for education, with faculty in mathematics, computer science, and business as the leaders [22, 79, 85]. Government is poised to accelerate this open textbook trend at all levels, with Senator Durbin proposing legislation directing the Department of Education to award grants for the creation of open textbooks by faculty [19], Washington State’s initiative to provide open textbooks for the eighty highest-enrollment courses in its community college system [87], and California’s initiative to create free digital textbooks for its high schools [71].

With the emergence of viable and comprehensive open source software for mathematics, there is now a spectacular opportunity for mathematics teachers to use, extend, and create this important software for mathematics education and shape it to reach its full potential in the service of educating students. UTMOST will create an easy path for all faculty to make the initial transition to open software, open textbooks, and open curricular materials in their courses. This path will make it easy for diverse schools and faculty to employ mathematics software to transform the classroom into an interactive lab which takes the study of mathematics to a new level.

**2.1. Imagine this!** A student is learning about row-reducing matrices in a beginning linear algebra course. The electronic version of their textbook is an online Sage worksheet they can view from

anywhere. Mathematical equations, with publication-quality typesetting, describe the procedure. An interactive demonstration, embedded in the worksheet where an example normally would be, allows the student to step through row-reducing a matrix that was generated on-the-fly (see the second screenshot in the supplementary documentation). When ready to guide the procedure themselves, the student may choose the row operation to apply at each step of the reduction. The correct notation for each operation is displayed and the operation itself is highlighted with color-coded entries in the displayed matrix. Another example shows the student how to use a built-in Sage command to row-reduce a matrix. With a single click, the student creates an empty code cell under the example to experiment with the command.

In class, the instructor does one simple example on the board. Then the instructor opens a Sage worksheet, displaying the same demonstration that is in every student's electronic textbook. Students guide the choice of row operations at each step for several examples of increasing complexity. At the end of class, the instructor clicks a button to publish the work from that day's class session to the class Sage server. After class, students view the worksheet as they review their notes. They can also, with a click, copy the worksheet into their notes, as well as annotate or make changes.

The book's exercises include an interactive problem generator that creates matrices of student-specified sizes and complexity for the student to row-reduce. There is a "Solution" button which generates a step-by-step solution. An advanced exercise guides a student through investigating numerical issues that arise in row reduction. By changing one parameter within a command, the matrices track numerical error bounds via interval arithmetic, and the student discovers that numerical errors can be a significant problem for some matrices.

A group exercise asks students to collaboratively write and test a short function to implement row-reduction using row operations. The student clicks a button to open a new Sage worksheet and types in a few lines using Sage matrices and commands. The student evaluates the code with a single click. Satisfied with their work, the student clicks another button, publishing the worksheet to the rest of the group for testing. Later that evening, the student checks the worksheet and sees that other students have tested the function, found an error, and repaired it.

The next week, the instructor logs into the online Sage server with a web browser and looks over all of the published worksheets for the group projects. The instructor annotates each worksheet online, using an embedded word processor that supports mathematical typesetting [14, 84].

The instructor writes a quiz on row-reduction techniques. Inside the  $\text{\LaTeX}$  file for the quiz, the instructor includes a Sage command to create a simple matrix in reduced-row echelon form, which will be the *answer* to a quiz problem. The instructor then uses Sage commands inside the  $\text{\LaTeX}$  file to do several simple row operations to transform the answer matrix to the matrix the students will row-reduce. The embedded Sage commands are executed automatically when the quiz is formatted with  $\text{\LaTeX}$  [18], and the resulting question matrix is automatically incorporated in the printed quiz, while the answer matrix and a detailed solution are automatically incorporated in the answer key.

### 3. WHY SAGE?

Sage is a natural choice for software to realize the benefits of an open approach to the undergraduate mathematics curriculum. Sage is a comprehensive program with an open development process, a modular design philosophy, an easy-to-use interface utilizing standard web browsers, tight integration with  $\text{\LaTeX}$ , and an industry-standard programming language. With an open license, the ability to run on a remote server, and a platform-independent interface, Sage removes substantial financial and logistical barriers to classroom use of mathematics software. In this section, we describe the many features of Sage that make it a good choice for integrating mathematics software with open textbooks and other curricular materials.

**3.1. A comprehensive program.** Sage's modular design allows symbolic, exact, and numerical approaches to mathematics to coexist equally. Mathematical objects, such as functions, differential

equations, rings, fields, modules, and vector spaces are “objects” that look and behave as their abstract mathematical definitions intend. Sage incorporates many different computational strategies and so does not rely solely on a single computational strategy, such as pattern-matching, which favors symbolic computation, or floating-point numbers, which favors numerical work.

Institutional, departmental, and classroom decisions about the use of a CAS require a commitment to a particular vendor’s vision for the curriculum. With a modular design that allows for packages specializing in different approaches, Sage can seamlessly support many approaches to exploring mathematical problems. Additions and extensions to Sage, driven by real curricular needs, can be easily and quickly incorporated. As individuals and institutions extend the software, the entire mathematics community benefits from a comprehensive program that students and faculty can employ in courses ranging from pre-calculus and introductory statistics through advanced courses like abstract algebra and number theory, as well as in graduate courses and professional careers.

**3.2. Curriculum and open development.** The closed development process for commercial software creates a high barrier for teachers and students to alter or extend the software to meet their curricular needs. For example, while external extensions, such as libraries or packages, can extend proprietary systems, these must be purchased, distributed, and installed by every end-user. However, an open development process allows students and faculty to shape the core technology. Software developed openly and collaboratively, such as Sage, allows the teaching and learning of mathematics to drive the technology, rather than the technology driving the teaching and learning. A concrete example of this important principle is given in Section 4.

**3.3. Building the car, not reinventing the wheel.** Sage unifies over one hundred mature, best-of-breed, open source packages. These packages range from focused libraries that excel at specific types of computations (e.g., Fast Library for Number Theory for integer polynomial arithmetic [23], the Integer Matrix Library for solutions to linear systems over the rationals [36], or M4RI for exact computations with binary matrices [47]) to complete applications or general libraries for broad areas of mathematics (e.g., R for statistics [64], GAP for group theory [25], and SciPy for numeric scientific computations [72]). Sage ties these packages into a single open source system with a consistent interface, making it easy for a teacher or student to smoothly explore vast areas of mathematics seamlessly, using the best tools for each computation. As a student moves from course to course, the Sage notebook interface and commands remain consistent, even if the particular computations may be performed by an entirely different package.

**3.4. Technology independent.** Sage’s notebook interface allows a student to communicate with a Sage server through a standard web browser—interactively running commands, viewing textual and graphic output, and annotating their computations with an online word processor that supports mathematical typesetting. The notebook interface removes many of the logistical barriers to using software in the study of mathematics. A student can employ the full power of Sage using a remote Sage server with only a web browser and a minimal network connection on a desktop computer, a small laptop or netbook, or even a cell phone [69]! This flexibility means that instead of an institution providing an expensive lab of machines with commercial software that can only be used on the dedicated computers, any computer can harness the full power of Sage.

The Sage notebook interface relies heavily on industry-standard JavaScript and acts as a web application similar to Google Docs, Gmail, or wiki software. Students have designed and implemented much of the current notebook. The first screenshot in the supplementary documentation shows an example Sage worksheet in the current Sage notebook.

Every copy of Sage includes the Sage server software. To establish a local server, colleges can download and use the ready-made Sage virtual computer image on a computer that supports their needs. There are also publicly-available servers that can be used to support students and classes. The flagship public Sage server is [www.sagenb.org](http://www.sagenb.org), a \$100,000 rack of servers located at the University of

Washington that was fully funded by an NSF SCREMS grant (DMS-0821725) and is currently home to over 21,000 accounts. Because it is publicly accessible, students from the poorest universities all over the world are running computations on the same version of Sage, on the same hardware cluster, with leading researchers in computational number theory. Constructed in January 2009, this powerful server should be a viable resource for many years to come. Publicly-accessible notebook servers continue to appear throughout the world (e.g., in Korea [68] and Hungary [67]) and many more run behind campus firewalls for dedicated use [70]. Since every copy of Sage includes the server software, when there is no network access, Sage can be installed directly on a computer and used as a private server with exactly the same online notebook interface as the remote Sage servers.

The flexibility of freely-available online access is a key consequence of the open nature of Sage and its importance cannot be overemphasized in education. As student populations become increasingly mobile, having student-driven technology that can be used freely from anywhere, especially from underpowered mobile devices, supports natural trends in student life.

**3.5. Communicating mathematics.**  $\text{\TeX}$ , with its add-on package  $\text{\LaTeX}$ , is another open source success story, and is the typesetting language of choice for mathematicians and other technical disciplines. Every mathematical object in Sage can be typeset in  $\text{\LaTeX}$  automatically. The Sage notebook uses jsMath [14] to typeset mathematics beautifully in a Sage worksheet (within a standard web browser). Furthermore, the Sage notebook interface allows a user to insert new text and automatically typesets mathematics. This is another example of how open standards and open software combine to make powerful tools, and is especially relevant for our plan to convert  $\text{\LaTeX}$  documents into Sage worksheets.

In addition to using  $\text{\LaTeX}$  in the notebook interface, Sage can be used from within any  $\text{\LaTeX}$  file to perform computations and create figures. Dan Drake, a Visiting Professor at Korea Advanced Institute of Science and Technology, authored Sage $\text{\TeX}$  [18], a  $\text{\LaTeX}$  package which allows Sage code in the file to easily be run as part of the process of formatting a  $\text{\LaTeX}$  document. Output (as typeset mathematics or images) is then automatically embedded in the resulting document.

**3.6. A standard programming language.** The many components of Sage are held together with a significant library of new code, written in an industry-standard programming language Python [61]. Through the power of Python, new open source packages written in a variety of programming languages are easily added to Sage, bringing users new functionality or improving existing functionality. More and more packages are appearing for mathematics and science written in Python, often with open licenses [63, 72].

Students may use Sage through point-and-click interactive demonstrations written by others, or they may execute a sequence of single-line commands in the notebook. However, for more involved computations, they can use Python, since it also serves as the user language in Sage. This is in contrast to other comprehensive programs for mathematics that have chosen to create and develop their own programming languages, which are of no use outside of the CAS. A user with knowledge of Python is ready to be productive in Sage immediately, while a student using Sage that is new to programming receives a basic familiarity and education in Python—a skill that is readily transferable to mathematical and non-mathematical applications in a wide variety of fields, including art, business, science, engineering, and many other disciplines [62].

#### 4. AN EXAMPLE OF TEACHERS DRIVING OPEN DEVELOPMENT

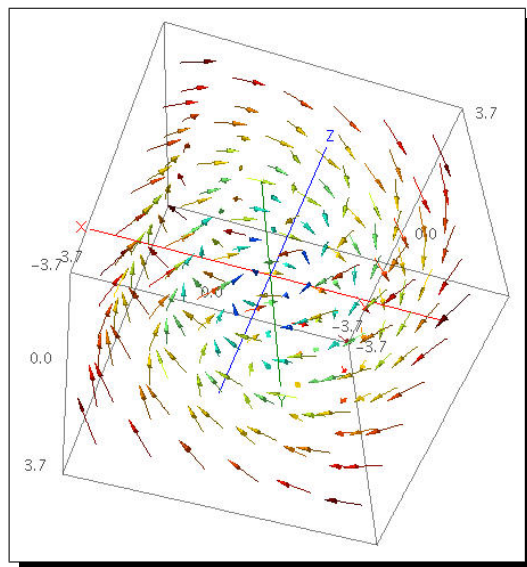
In this section, we provide a concrete example of how teachers and classroom needs drive the development of Sage to directly create better and more comprehensive tools for use in the teaching and learning of mathematics.

Jason Grout, then a postdoctoral associate at Iowa State University, was asked by a meteorology student if Sage had a 3-D vector field plotting function. Grout quickly wrote a simple one. Open development communities encourage sharing even experimental code, so he posted his code online in Sage's

publicly-accessible online database of enhancements and bugs. Robert Bradshaw, a graduate student at University of Washington who had written much of the 3-D graphing code in Sage, suggested a small change that greatly increased the efficiency of the function. Several months later, another person authored a very similar function which had slightly improved options and published their code on the public Sage notebook server. In Fall 2008, Grout needed the 3-D vector field plotting function for his multivariable calculus class. He made a few suggested changes to the function and posted it for his class to use.

In the next few months, improvements were made to the internals of Sage 3-D graphics. Many of these improvements were made by William Cauchois, a University of Washington freshman supported for a summer by an NSF VIGRE grant, and others were made by Jason with an eye towards simplifying the vector field plotting function code. Jason then taught multivariable calculus again. He incorporated the best ideas from the various sources and posted a documented, efficient version of the function, this time asking the community for a formal review (a prerequisite for his code to be added to the core Sage library). Marshall Hampton, an Assistant Professor at University of Minnesota, Duluth, reviewed the function immediately, with the comment “Very nice, positive review. This is great timing since I am about to teach vector fields in a week or two.” The function was incorporated into the next release of Sage, two weeks later, ready for use by the entire Sage community.

Not only do the original students benefit from the invested effort, but the collaborative effort of at least five teachers and students directly led to a function that will serve all who use Sage. This example illustrates many strengths of the open development process, where teachers and curriculum drive the technology. Such activities are generally not possible with a commercial CAS.



$\vec{f}(x, y, z) = y\vec{i} + z\vec{j} + x\vec{k}$  plotted with Sage's `plot_vector_field3d` command

## 5. IMPLEMENTATION

Our goal is to widely disseminate successful approaches for using technology in the teaching and learning of mathematics. By using open curricular materials, integrated with powerful and comprehensive open software, we will realize a transformative effect. UTMOST will revolve around three coordinated efforts: creating Sage-enhanced curricular materials; working with and providing classroom support for teachers using these materials; and providing the Sage infrastructure to support these materials. Specifically, UTMOST can be divided into five main activities.

- (1) We will create a system to convert open mathematics textbooks to Sage worksheets that can incorporate live Sage code, as well as interactive demonstrations and exercises powered by Sage. Our work to make these textbooks Sage-enhanced will provide a model for other authors to create Sage-enhanced textbooks. The first courses we will address are linear algebra, abstract algebra, and number theory. See Section 5.1 for details.
- (2) We will further implement our model for authoring Sage-enhanced curricular materials by creating modules for standard undergraduate courses, especially courses not covered by the textbooks we are converting. These materials will include subject-specific guides to introduce faculty and students to Sage in the context of a particular topic. These materials will be created by members of the UTMOST team and by faculty at our ten test sites. Topics under consideration include single variable calculus, multivariable calculus, differential equations, and complex variables. See Section 5.2.

- (3) We will identify and work closely with teachers at ten different institutions to test, refine, improve, and extend the work described above. We will select a broad range of institutions, including some with diverse student populations. Dedicated Sage workshops (“Sage Days”) will provide opportunities for the UTMOST team and representatives from the test sites to collaborate. These ten sites will provide opportunities for our evaluation team to measure the success of our efforts and the impact on teaching and learning. See Section 5.3 for implementation details and Section 6 for evaluation details.
- (4) We will disseminate our materials and the results of UTMOST through Sage Days workshops, and we will apply for MAA PREP workshops and MAA minicourses (national and regional). We will use these opportunities to train faculty outside of the ten test sites in the use of these materials for their courses, and in the process for creating their own new materials. Our materials will all carry open licenses and be available through the global Sage website. As appropriate, they will also be available in Sage itself or through a new open textbook initiative created at the American Institute of Mathematics as part of this project. See Section 7.
- (5) We will improve the Sage library and its surrounding infrastructure (e.g., server design, notebook usability, and collaboration tools) where the improvements have a direct and obvious benefit for undergraduate education. See Section 8.

**5.1. Sage-enhanced open textbooks.** Our first main activity is the design and creation of Sage-enhanced textbooks.

**5.1.1. Infrastructure for textbooks.** UTMOST proposes creating and fully testing a system for integrating Sage and textbooks. Pilot projects have already demonstrated the feasibility of this process for short documents, and technical improvements have been identified which will make integrating Sage and book-length documents easy for authors. The primary tool is the existing `tex4ht` translator (NSF IIS-0312487) [82], which converts  $\text{\LaTeX}$  into the jsMath format adopted by the Sage notebook for rendering publication-quality mathematics. The end result will be a folder of Sage worksheets, each a mixture of text, typeset mathematics, Sage input cells, and Sage interactive demonstrations and exercises. Since  $\text{\LaTeX}$  is the accepted standard for authoring mathematics, we expect this process to be applicable to a broad range of current and future mathematics textbooks.

**5.1.2. Targeted textbooks.** Listed below are our initial candidates for conversion to Sage-enhanced textbooks that bring the full power of mathematics software to the student *directly within their book*. In addition to converting existing content to Sage worksheets, we plan to add interactive demonstrations and exercises, live Sage code, and guidance on the Sage library. There is significant care and thought required to integrate these uses of mathematics software properly. Our work will provide a tested model for other authors when writing new textbooks. We expect to have the three texts below available for use in the Fall 2011 term at our test sites. Each of these is authored by a project member and so provides an excellent testbed for the enhancement process.

- Beezer’s *A First Course in Linear Algebra* [4]. This is a mature textbook designed from the start to be open source and thus has a highly modular design. The first version of this book was released in December 2006 and has been used as the primary text in courses at 13 different universities. The author has taught from various versions of the book ten times. It is an ideal choice as a full-scale test of the technical conversion process, the integration of Sage code, and classroom use.
- Judson’s *Abstract Algebra: Theory and Applications* [37]. This book was originally published by PWS-Kent in the early 1990s, but the author has received the copyright back and released it under an open source license. Beezer has taught from this text the past two years and created supplementary material utilizing Sage and contributed code to the Sage library to

support the book. First released as open source in Spring 2009, eight universities adopted the book for the Fall 2009 term.

- Stein’s *Elementary Number Theory* [74]. This text has an extensive collection of Sage examples. Additionally, the author has taught from the book four times. It is currently being published by Springer-Verlag, but Stein has the rights to make it freely available starting May 2010, so will be able to create a Sage-enhanced version for free distribution. While it will not carry a true open license allowing modifications by others, it will be a good test of the technical aspects of the conversion process and will be made freely available.

5.1.3. *Open mathematics textbooks.* The catalog of open mathematics textbooks is growing rapidly and will likely have many more entries by Summer 2012 when we will select more textbooks for conversion. There is a wide range of books available now that could be converted to cover parts of the standard undergraduate curriculum, including mathematics for liberal arts [46], trigonometry [15], college algebra [76], single and multivariable calculus [16, 17, 26, 29, 50, 78], linear algebra [4, 32], differential equations [42], numerical analysis [59], number theory [52, 74], cryptography [38], logic [6, 48], probability [27], combinatorics [8], real analysis [20, 21, 41], and abstract algebra [37]. Almost without exception, these textbooks are licensed with a GNU Free Documentation License (GFDL) or a Creative Commons License (CC) that allows anyone to distribute modified versions, typically only requiring attribution of the original author’s work and the use of the same license. Authors come from a wide range of institutions, representing community colleges [17, 46, 76], liberal arts colleges [4, 8, 29], and research institutions [41, 74, 78].

5.2. **Sage-enhanced curricular materials.** In addition to enhancing selected open textbooks, we will also enhance and develop smaller-scale curricular materials for other undergraduate courses.

5.2.1. *Subject-specific guides.* For selected courses where we do not provide a Sage-enhanced textbook, or no suitable open book currently exists, we will create subject-specific tutorials. These short guides will explain how to use Sage to investigate questions in a standard course, following a typical order for such a course. Existing examples of these smaller-scale materials include John Perry’s course notes for a Mathematical Computing course [60], drafts of multivariate calculus worksheets by Jason Grout and Ben Woodruff [28], and Stein and Mazur’s Riemann Hypothesis book [52], which targets curious undergraduates. These will be designed from the start for conversion to Sage worksheets, providing further small-scale tests of our system for conversions. Guides will be authored by UTMOST project members, and faculty at our test sites.

5.2.2. *Interactive demonstrations and exercises.* Sage has a powerful, but extremely simple-to-use framework for creating web-based interactive demonstrations. Input boxes, sliders, selectors, and other controls are simple to create. Output can use HTML, tables, typeset mathematics, and 2-D or 3-D graphics. Computations have the full Sage library at their disposal. The second screenshot in the supplementary documentation contains an example of such an interactive demonstration. Stein created the first implementation and continues to improve it with significant contributions from Grout and many other Sage developers. Current work by Mitesh Patel, supported by an NSF FRG grant (DMS-0757627), will allow embedding these interactive demonstrations into standard web pages, usable without having to log into a Sage server.

For selected courses, we will create comprehensive collections of demonstrations for inclusion in our Sage-enhanced textbooks and into Sage itself. We will also create an easily-searchable repository of high quality, reviewed Sage interacts, which will be included in every copy of Sage.

5.3. **Sage into the classroom.** The heart of UTMOST is putting Sage-enhanced materials in the hands of teachers and students to assist them in teaching and learning mathematics. We will work with selected faculty at ten partner institutions by providing support for using Sage in their classrooms, offering technical support for Sage, assisting with the Sage-enhanced materials that



we have created, and helping them write their own Sage-enhanced materials. Our teacher-authors and their students will receive access to Sage on a server dedicated to the UTMOST project, with dedicated technical support provided through this project.

We will recruit two groups of teacher-authors for UTMOST, with the first group beginning in Summer 2011 for a two-year commitment and the second group beginning in Summer 2012 for a one-year commitment, for a total of ten test sites. Teacher-authors will receive a stipend for their participation in UTMOST and support to attend workshops on using Sage in the classroom. In order to forge a strong relationship with the teacher-authors and provide the best possible support, each teacher-author will be paired with a member of the UTMOST team who will serve as a contact and adviser. This adviser will also make visits to the test site to provide support and gather evaluation data. We will expect the following from these participants.

- Teacher-authors will use Sage in their classrooms during their time with UTMOST. More specifically, they will use Sage-enhanced materials extensively in a semester-long course.
- Teacher-authors will write and test comprehensive Sage-enhanced curricular materials for the class that they are teaching.
- Teacher-authors will collect evaluation data from their students, and organize focus groups to gather feedback on the design and use of Sage-enhanced curricular materials. Focus groups will be led by the project member who is advising the teacher-author.
- Teacher-authors will offer training to others at their institution on how to use Sage and how to use Sage-enhanced materials in the classroom. Such training could be offered as departmental workshops or seminars.
- Teacher-authors from the first group will be selected to mentor the new teacher-authors in the second group.
- Teacher-authors will submit a report each year on their teaching experiences with Sage and new curricular materials.

5.3.1. *Recruitment plan.* Selection of the teacher-authors for UTMOST will be based on the following.

- A narrative statement by the applicant regarding rationale for applying, the course or courses in which they plan to use UTMOST materials, and their familiarity with Sage.
- Limited or no familiarity with Sage, since we aim to make it easy for all faculty to integrate mathematics software into their courses, not just those who already have this experience.
- A letter of support from the department chair indicating the flexibility to schedule faculty for the appropriate courses, a commitment to using Sage and new curricular materials in their department, and an awareness of evaluation activities.
- Consideration will be given to achieving a diverse mix of institutions and student populations, along with geographic proximity to a member of the UTMOST team.

5.3.2. *Initial test sites.* In response to a single posting in the sage-edu online forum, eight institutions expressed interest in being test sites. By casting a wider net, we are confident we could attract much more interest. From these eight institutions, we have selected and invited three to be part of our initial group of five sites. Letters of commitment from department chairs are included in the supplementary documentation. The three schools are:

- **Reed College** A highly selective, national liberal arts college where 50% of the students major in mathematics and science.
- **Steven F. Austin State University** A large comprehensive, regional institution primarily serving rural East Texas.
- **California State University, Dominguez Hills** A medium-sized public institution in the LA area that is “among the most ethnically-diverse universities in the US” [13].

We will have community colleges included in the remaining seven sites and have had discussions with one interested community college located very close to the University of Washington.

## 6. EVALUATION

Formative and summative evaluation will be conducted at different phases of the project to address questions about the effectiveness of the project in creating and implementing the UTMOST model and Sage-enhanced materials for undergraduate mathematics teaching and learning. Dr. Judson will coordinate internal evaluation data-gathering, and will serve as the liaison to external evaluators from Ethnography & Evaluation Research at the University of Colorado at Boulder. The evaluation questions include:

- (1) What aspects of the Sage-based tools and open materials are beneficial to instructors, what challenges do they face, and what kinds of support do they need in integrating these to mathematics teaching?
- (2) How do instructors use and apply the Sage-integrated curriculum materials, and how do these benefit (or fail to benefit) their teaching of mathematics?
- (3) How do the tools and materials impact instructors' content knowledge, pedagogical content knowledge, classroom instructional practice, and their students' learning?

Information will be gathered on both the processes and outcomes of the project at different stages, and results will be organized as case studies of participating instructors and their students. Formative components will focus on monitoring the quality of project activities, enabling the project to make mid-course corrections and plan for future development. Summative components will focus on the impact of the project on instructors' instruction and student learning at the test sites. Instructors and classrooms will be sampled, taking into account instructor interest and local institutional cooperation.

**6.1. Study design.** The study design includes pre- and post-surveys, follow-up surveys included in yearly self-reports, and interviews of the participating instructors. In addition, students will answer an online post-survey focusing on their experiences and gains in learning mathematics, including their classroom use of the Sage-enhanced materials. The design is informed by previous evaluation studies on professional development, education, and workshops in STEM fields [11, 24, 44, 73, 83] and on student outcomes of active instructional methods in undergraduate mathematics [30, 31].

**6.1.1. Pre-survey.** While registering for the summer workshops, participants will complete a short pre-survey to gather demographic and contact data, and information about their classes, institution, current teaching practices, and pedagogical needs. This information will also help the project leaders to plan workshops and later support.

**6.1.2. Post-survey and feedback.** Participants will complete a survey on the summer workshops so that project leaders can make adjustments for future workshops and implementation support. The survey will ask about participants' plans for using the model and Sage-enhanced materials to help guide later components of the study. Evaluators will observe the summer workshop and conduct a focus group with current and past participants.

**6.1.3. Follow-up survey and reports.** After using the model and Sage-enhanced materials for one year, the participants will file a report on their implementation, including some follow-up survey questions. They will report their use of the model and Sage-enhanced materials in their own classrooms and their future plans. Additional data on implementation will be gathered by the project team during site visits; they will conduct student focus groups using a protocol co-developed with the evaluators and share site visit notes that will be used as data sources.

**6.1.4. Student learning assessment.** Student learning will be evaluated after the first year of implementation with a post-survey based on the NSF-supported SALG instrument (DUE-0920801) [77], in which students report about their experiences of and learning gains from their mathematics course. This will provide information on student outcomes as well as formative feedback for the

instructors using the model and Sage-enhanced materials in their classroom. A mathematics-specific version (SALG-M) has already been validated and used in a large evaluation study, and is sensitive to differences by student group and classroom practice [30, 40].

**6.1.5. Follow-up interviews.** Based on instructor and student responses on other measures, a sample of instructors will be interviewed to study factors that affect their success in implementing Sage-enhanced materials. The interviews will explore classroom use of the model and Sage-enhanced materials, impacts on instructional practices, and instructors' perception of students' response.

**6.2. Management and dissemination.** The evaluation will be led by Dr. Marja-Liisa Hassi from Ethnography & Evaluation Research (E&ER) at the University of Colorado at Boulder. E&ER has extensive experience evaluating large mathematics and science education projects (NSF DUE-0920126, DUE-0723600, DUE-0450088).

Drs. Hassi and Judson will collaborate with the project director, members of the project, and partner institutions to conduct the evaluation study. Dr. Judson and the project PIs will conduct site visits to partner institutions to observe and document the use of Sage-enhanced materials. Dr. Judson will have primary responsibility for extracting information from the site visits and workshop data to feed back to developers to improve the technology and classroom resources. Surveys and interview protocols will be prepared and conducted by Drs. Hassi and Judson. They will analyze all data and will prepare an annual report to document the evaluation activities and results. This will provide formative evaluation feedback to the project PIs and participating instructors to inform design decisions and mid-course corrections. A final report will gather results after the implementation of the tools and material by the second group of instructors in 2013. These findings will be shared also with the broader mathematics education community through a presentation and a coauthored article about the impacts of using CAS-integrated materials in teaching and learning undergraduate mathematics.

## 7. DISSEMINATION

UTMOST is principally about dissemination—the focus issue is how we can enable the widespread implementation of approaches which have already been proven to work. In addition to working with our test sites, we will broadly disseminate the results of UTMOST through a variety of forums, several of which are already in place.

**7.1. Sage website.** The Sage website, [www.sagemath.org](http://www.sagemath.org), is an established venue for sharing materials related to Sage. This central location receives 90,000 visits each month, with 42% of the visits from the Americas and 45% of the visits from Europe. What we learn and create will be made available on the Sage website with open licenses. Furthermore, some of our work will be incorporated into Sage itself, which already has an effective distribution system. Complete, integrated documentation ships with every copy of Sage (such as the 4,701 page reference manual) and it is possible that much of our material, *including complete textbooks*, could ship as a core component of Sage itself. A library of high-quality interactive demonstrations will also be included in Sage, where they can be searched or browsed topically. These demonstrations will benefit from Sage's automated test suite that users routinely run on a wide variety of hardware.

**7.2. Sage Days workshops.** Sage Days, which are a series of conferences and workshops devoted to the development of Sage, are an ideal venue for dissemination. To date there have been nineteen Sage Days conferences, with nine more planned. These workshops now include sessions dedicated to using Sage in the undergraduate classroom, with the first such session taking place in December 2009 at the Clay Mathematics Institute during a week-long workshop on Sage and number theory. It attracted roughly thirty college faculty (and a few high school faculty) from around the Northeast, all eager to learn more about the use of Sage in educational settings.

Sage Days workshops devoted to training others to use our model and Sage-enhanced materials, and receiving and incorporating feedback and new ideas, will be entirely consistent with the way Sage Days have been used to drive Sage development. The first Sage Days workshop sponsored by the project will be held in Summer 2011 and will primarily involve UTMOST and representatives from the first five test sites. A second Sage Days event will occur in Summer 2012, involving UTMOST and all ten test sites, as an opportunity to discuss the project, initiate the second group of five test sites, and begin the mentoring relationships between the sites in the two groups. Faculty, students, and Sage developers with interests in education will be encouraged to attend these events.

**7.3. National workshops.** We will apply to offer special sessions and workshops on the use of Sage in the classroom at the national Joint Mathematics Meetings and MathFest conferences, where we will be able to share the results of UTMOST with the undergraduate teaching community. We will also publish articles about the impact of using our Sage-enhanced materials on the teaching and learning of undergraduate mathematics. Drs. Beezer and Grout are part of a team delivering a workshop in Summer 2010 on how to use Sage in the classroom as part of the NSF-funded Mathematical Association of America Professional Enhancement Program (DUE-0817071). We will apply to lead future PREP workshops that will incorporate the results of UTMOST. Notably, Stein has been invited to propose an AMS Short Course on Sage for the 2011 Joint Meetings.

**7.4. AIM open textbook initiative.** The American Institute of Mathematics (AIM) is a respected NSF-funded institute that has supported both leading research mathematicians and mathematics educators at all levels. As the sponsoring organization for UTMOST, AIM will conduct a pilot project to test the feasibility of sponsoring and supporting a series of open mathematics textbooks. A hindrance to the adoption of open textbooks is the lack of an acknowledged authority to vouch for the content. Usually this is a role played by a publisher, so a recognized organization within the mathematics community with a trusted reputation, such as AIM, will be another component to broadly disseminating our materials. This has the potential to positively impact open textbooks, in mathematics and more generally.

AIM will constitute an editorial board to guide this initiative by developing policies and programs to promote the development of high quality textbooks and associated course materials for mathematics courses at all levels of the post-secondary curriculum. During the first year, the new board will oversee the creation of a website for publicizing the project and for electronic dissemination of the materials. In order to compete with the traditionally published texts, we expect to establish a way to provide examination copies in hard copy and to provide course outlines, syllabi, exercise sets, and exams from instructors who have already used the books. We anticipate that the board should be able to review and edit approximately five textbooks in the first year.

Because the faculty in community colleges are much more sensitive to the high cost of traditional texts and more likely to adopt open source alternatives, we expect the editorial board to begin to work with the Community College Consortium for Open Educational Resources (CCCOER), which is an initiative of the Foothill-De Anza Community College District, where AIM is also located. This consortium recently received a two-year grant of \$1.5 million from the William and Flora Hewlett Foundation to manage the Community College Open Textbook Collaborative.

During the second and third years, we plan to increase the number of books included in the series and to solicit and develop textbooks for at least one high-enrollment mainstream course. The board will also consider the logistics of distributing texts to students. Although many may be satisfied with electronic versions to read on their computer screen, others will want traditionally bound texts, and the board will develop means to provide them, perhaps in partnerships with custom publishing firms, such as Lightning Source [45]. Determining best practices for making open textbook metadata available for the National Science Digital Library (NSDL) is another aspect of dissemination to explore.

## 8. SAGE INFRASTRUCTURE

The Sage notebook interface and server configurations are key elements of a successful experience for students and faculty using Sage in their courses. A portion of our work will be to improve Sage itself in those areas where the improvements *directly support* educational applications of Sage. Discussions and initial queries in the sage-edu email list indicate that faculty around the world are excited about setting up Sage servers for their students' use [70]. We see three main areas for work on Sage.

**8.1. The Sage library.** Experience has shown us that teaching with Sage invariably suggests new capabilities or exposes needed commands. Our work enhancing textbooks, and our teacher-authors at test sites, will certainly suggest extensions and corrections to the Sage library. We will continue to refine and enhance Sage at an accelerated pace with support from this grant. All changes will undergo the existing code review process and will then become permanent contributions to Sage, maintained and further extended by the worldwide Sage community. We have already identified specific improvements for linear algebra, abstract algebra, calculus, differential equations, number theory, and combinatorics, as well as broader areas like 2-D and 3-D graphics. Targeted fixes and improvements will greatly improve the educational experience for students. In many cases, undergraduate students can, and already have, contributed code and other suggestions; we plan to employ several students in these efforts with funding from this grant.

**8.2. Notebook development.** The Sage notebook interface is a powerful tool for experimentation and collaboration. Stein worked full-time during Fall 2009, supported by the University of Washington, on improving the robustness and scalability of the notebook. In Fall 2009, we have typically seen two thousand new accounts created on [www.sagenb.org](http://www.sagenb.org) every month. The notebook interface is the face of Sage for students and we intend to improve it by fully implementing labels and folders, support for much more sophisticated interactive demonstrations, offline access to worksheets, user-customizable styles, and enhanced security and authentication support.

**8.3. Sage servers the easy way.** Sage servers allow a user with just a standard web browser to use Sage over the network. Initiating and maintaining a server will be made as simple as possible, making it easy for faculty and system administrators to get their students started with Sage.

A virtual computer solution provides a very easy way to set up and securely maintain a Sage server. VirtualBox [80] is a leading free, open-source product for creating and running virtual computers. We will create a VirtualBox Sage notebook server appliance with a graphical interface. Users will be able to easily install this appliance on Windows, Linux, Mac OS X, and Solaris (x86) servers. The management interface will provide clear and easy documentation about setting up this server, creating new notebook servers for specific classes or instructors, starting and stopping notebook servers, monitoring resource usage, adding users and authentication frameworks (such as LDAP), and upgrading Sage with minimal user downtime.

For users at our ten test sites, we will create a new mailing list for server administration issues, and in addition to the help we provide ourselves, we will hire a knowledgeable system administrator to answer support questions on a daily basis.

Several specific goals for notebook and server development include the following.

- We will improve the notebook so that it will robustly handle up to 250 simultaneous users viewing worksheets and doing typical computations for an undergraduate course when running on a single high-end server, as demonstrated by a robust automated test suite.
- We will implement management tools so administrators can manage the notebook load and better balance resources.
- We will create tools for educators to get automatic feedback on their students' use of Sage.

In summary, we propose to provide high-quality software infrastructure and support to educators.

## 9. QUALIFICATIONS AND PREPARATION

The UTMOST team consists of five mathematics faculty and an experienced evaluator of STEM education initiatives. The five faculty together have many years of experience teaching undergraduates at a wide range of institutions, four are active Sage developers (including its founder), three are authors of open textbooks, all have significant mathematics research experience, and one specializes in mathematics education research. As Sage developers, they are in a position to quickly and accurately shape changes in Sage based on the experience of working with faculty at other institutions that are new to Sage. Each is familiar with, and has extensive experience using, open source software and tools in their teaching and other professional activities. Besides the applicability of this experience to the project's central theme, they are also adept at working collaboratively while still being separated geographically. Working together, they have the wide range of complementary experience and skills that will make UTMOST a success.

**Dr. Robert Beezer**, Professor of Mathematics at the University of Puget Sound, is an undergraduate teacher with 31 years of experience, an active researcher in algebraic graph theory, one of the first open textbook authors, and a Sage developer. He began writing his open source linear algebra textbook in 2004 and has assisted Dr. Judson with the recent release of his very successful open source abstract algebra text. He began using Sage in 2007 and began contributing code in early 2009. He will lead the technical process of converting textbooks from L<sup>A</sup>T<sub>E</sub>X to Sage worksheets, producing a simple system for other authors to use. The pedagogical implications of this new capability will be explored as he incorporates Sage into existing textbooks on topics he teaches frequently, such as linear algebra, abstract algebra, combinatorics, calculus and cryptography. He will continue to contribute code to Sage where the new functionality enables a more complete experience for undergraduate students, and will suggest, review and test the project's improvements to interactive demonstrations and the notebook interface.

**Dr. Thomas Judson**, Associate Professor of Mathematics at Stephen F. Austin State University, is an active researcher in both mathematics and mathematics education, with 32 years of teaching experience. He is the author of an open source undergraduate abstract algebra textbook, and will work with Dr. Beezer to produce Sage-enhanced materials for abstract algebra. Dr. Judson has worked extensively with undergraduate mathematics teachers and has mentored graduate students in the teaching of mathematics. In addition to his teaching and research accomplishments, Dr. Judson brings added experience in working with diverse groups both in the US and abroad. He will work with Dr. Hassi to guide research and evaluation efforts for UTMOST. With experience in working with undergraduate faculty and graduate student mentoring, Dr. Judson will also provide insight and assistance in the implementation of Sage-enhanced materials in the undergraduate classroom. He will direct project efforts connected to research in mathematics education.

**Dr. William A. Stein**, Associate Professor of Mathematics at the University of Washington, is a leader in both computational and theoretical number theory, and the author of two published number theory books. He started the Sage project in 2005, and has passionately led its development ever since, including co-organizing over 25 workshops during the last 4 years and directing dozens of Sage development projects by students at Harvard, UC San Diego, and U of Washington. Dr. Stein will implement improvements to Sage, direct work by students, contribute curricular materials he has authored, supervise test sites, and co-organize workshops.

**Dr. Jason Grout**, Assistant Professor of Mathematics at Drake University, is an undergraduate teacher, an active researcher in combinatorial matrix theory and graph theory, and a Sage developer. Dr. Grout has contributed extensively to the Sage code base over the last three years in the linear algebra, graph theory, graphics, and notebook interface components of Sage. Dr. Grout has used Sage in research and in teaching a number of undergraduate courses. He has also given numerous presentations and tutorials on Sage, and in Summer 2010 will be co-directing an MAA PREP workshop with Drs. Beezer and Karl-Dieter Crisman to help participants develop new curricular

materials in Sage. Dr. Grout will implement improvements to Sage, direct work by students, supervise test sites, help organize workshops, and contribute curricular materials.

**Dr. Marja-Liisa Hassi**, Ethnography & Evaluation Research, University of Colorado at Boulder, has a Master's Degree in Mathematics and a PhD in Education. She has expertise in both theory and methodology of mathematics education research, as well as teaching experience in education, mathematics education, and research methods for undergraduate and graduate students. Her recent publications address theory and measurement of affect in undergraduate and adult mathematics learners and comparative student outcomes of inquiry-based and traditional undergraduate mathematics courses. She will be assisted by Dr. Sandra Laursen, co-director of E&ER and an experienced evaluator of STEM education initiatives in higher education.

**Dr. Kiran S. Kedlaya**, Associate Professor of Mathematics at Massachusetts Institute of Technology and UC San Diego, is a leading researcher in arithmetic algebraic geometry. He has received an NSF CAREER grant, a PECASE award, and a Sloan Fellowship, and was selected to speak at the 2010 International Congress of Mathematicians. Dr. Kedlaya brings extensive experience in undergraduate and graduate education at all levels, from calculus to mentoring Ph.D. students. He is also deeply involved with mathematics competitions and other programs for exceptional students, such as the USA Math Olympiad, the Putnam competition, and the Art of Problem Solving Foundation. In addition, Dr. Kedlaya brings extensive knowledge of the Sage system, having been an active user and developer since 2005. Dr. Kedlaya will review improvements to Sage related to the project, supervise test sites, and provide additional overall guidance.

**9.1. Grant experience and support.** The UTMOST project members have a wide variety of experience in administering grants.

- As a sponsoring organization, the American Institute of Mathematics has a ten-year history of successfully administering, supporting and executing 38 NSF grants in mathematics.
- Dr. Stein has successfully administered many grants supporting Sage development from varied organizations such as NSF, UC San Diego, University of Washington, Google, Sun, Microsoft, and the US Department of Defense. National Science Foundation grants include awards from the SCREMS program for the [www.sagenb.org](http://www.sagenb.org) computing cluster (DMS-0821725), the FRG program (sponsored by the American Institute of Mathematics, DMS-0757627) and the COMPMATH program to fund two postdoctoral positions (DMS-0713225).
- Dr. Judson works with middle and high school mathematics teachers from high-needs school districts to help them become teacher-leaders in their schools and districts, and prepare them to deliver pedagogical content and mathematical content to their colleagues. He also collaborates with the PIs on two NSF grants to help direct the mathematics education research component (DUE-0934878, DUE-0227128).
- Dr. Beezer has been awarded a competitive year-long sabbatical leave from the University of Puget Sound for the 2010-11 academic year. This will allow him to begin converting textbooks, increasing the possible textbooks available for test sites to use beginning in the Fall 2011 term.
- Dr. Grout co-directed the 2008 IMA Participating Institution Summer Program for Graduate Students: Linear Algebra and Applications at ISU (program was supported by IMA and NSF; Dr. Grout was supported by an NSF conference grant).
- Drs. Beezer and Grout will co-direct (with Dr. Karl-Dieter Crisman) an MAA PREP workshop on Sage in Summer 2010, as part of a program funded by the NSF (DUE-0817071).
- Dr. Hassi is an expert in the research and evaluation of mathematics education and is currently working with a large evaluation study focused on inquiry-based learning and teaching of undergraduate mathematics at four large research universities [31, 39]. She is also currently working with an evaluation study of NSF DUE-funded workshops on inquiry-based learning for instructors (DUE-0920126).

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- [47] M4RI, Linear Algebra over  $GF(2)$ , <http://m4ri.sagemath.org/performance.html>
- [48] P.D. Magnus, forall X: An Introduction to Formal Logic, <http://www.fecundity.com/logic>
- [49] Maplesoft, *Maple*, <http://www.maplesoft.com/Products/Maple>
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- [55] The Ohio State University, *Calculus & Mathematica*, <http://socrates.math.ohio-state.edu>
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- [65] REDUCE, A portable general-purpose computer algebra system. <http://reduce-algebra.sourceforge.net>
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- [68] Sage Server (public), Korea, <http://sagenb.kaist.ac.kr>
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- [70] Sage Wiki, *Sage Notebook Servers*, <http://wiki.sagemath.org/sagenb>
- [71] Governor Arnold Schwarzenegger, Press Release, Free Digital Textbook Initiative, <http://gov.ca.gov/press-release/12225>
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- [75] William Stein et al., *Sage Mathematics Software (Version 4.3)*, <http://www.sagemath.org>
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- [78] Gilbert Strang, *Calculus*, <http://ocw.mit.edu/ans7870/resources/Strang/strangtext.htm>
- [79] The Student PIRGs, *Open Textbook Catalog*, <http://www.studentpirgs.org/open-textbooks/catalog>

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- [85] Textbook Revolution, <http://textbookrevolution.org/index.php/Book:Lists/Subjects/Mathematics>
- [86] University of Illinois at Urbana-Champaign, *Calculus & Mathematica*, <http://www-cm.math.uiuc.edu>
- [87] Washington State Board for Community and Technical Colleges, Washington State Student Completion Initiative, [http://www.sbctc.ctc.edu/college/e\\_studentcompletioninitiative.aspx](http://www.sbctc.ctc.edu/college/e_studentcompletioninitiative.aspx)
- [88] White House Office of Science and Technology Policy, *Public Consultation on Public Access Policy*, <http://www.whitehouse.gov/blog/2009/12/09/ostp-launch-public-forum-how-best-make-federally-funded-research-results-available-f>
- [89] Wolfram Research, *Mathematica*, <http://www.wolfram.com/products/mathematica/index.html>

# Biographical Sketch

## Robert A. Beezer

- Email: [beezer@ups.edu](mailto:beezer@ups.edu)
- Web: <http://buzzard.ups.edu>
- Phone: 253-879-3564

## Professional Preparation

University of Santa Clara	Mathematics, Computer Science, B.S. 1978
University of Illinois at Urbana-Champaign	Statistics, M.S. 1982
University of Illinois at Urbana-Champaign	Mathematics, Ph.D. 1984

## Appointments

- Professor of Mathematics, University of Puget Sound, 1996–present.
- University Professor, University of Puget Sound, Fall 2001–Spring 2006.
- Chair, Mathematics and Computer Science Department, Univ. of Puget Sound, 1999–2002.
- Research Visitor, University of Western Australia, Fall 1997.
- Associate Professor of Mathematics, University of Puget Sound, 1990–1996.
- Visiting Lecturer, University of the West Indies, Trinidad, Spring 1991.
- Assistant Professor of Mathematics, University of Puget Sound, 1984–1990.

## Most Relevant Publications

- *The Truly Free Textbook*, EDUCAUSE Review Magazine, **44**, no. 1 (2009) 22–24.
- *A First Course in Linear Algebra*, 806 pp., GFDL licensed textbook, <http://linear.ups.edu>.
- *Sage (Version 3.4)*, Featured Review, SIAM Review, **51**, no. 4 (2009).
- *Sylow subgraphs of self-complementary vertex transitive graphs*, *Expositiones Mathematicae*, **24**, no. 2 (2006) 185–194.
- *Counting configurations in designs*, *Journal of Combinatorial Theory, Series A* **96** (2001), no. 2, 341–357.

## Other Publications

- *Using minimum degree to bound average distance*, with B. Smith and J. Riegsecker, *Discrete Mathematics*, **226** (2001) 365–371.
- *Closing in on the internal rate of return*, *The UMAP Journal*, **17**, no. 2 (1996).  
Reprinted in *Tools for Teaching 1996*, 47–78. COMAP, Inc.. Lexington, Mass. 1997.
- *The matching polynomial of a regular graph*, with E.J. Farrell, *Discrete Mathematics*, **137** (1995) 7–18.
- *Trees with very few eigenvalues*, *Journal of Graph Theory*, **14**, no. 4 (1990) 509–517.
- *Trivalent orbit polynomial graphs*, *Linear Algebra and Its Applications*, **73** (1986) 133–146.

## Synergistic Activities

- **Sage** Contribute and review code for Sage in the areas of linear algebra, group theory, graph theory and  $\text{\LaTeX}$  integration. Sage is a comprehensive open source program for mathematics.
- **Open Textbooks** Author of an open textbook for linear algebra. Production Editor for Judson's open source abstract algebra book. Advocate for wider acceptance of open educational resources, through writings and presentations, both in mathematics and more widely.

## Collaborators and Other Affiliations

- **Collaborators and Coauthors** T. Judson (Stephen F. Austin State U.), Sage Developers (various).
- **Ph.D. Advisor** Paul Weichsel, University of Illinois at Urbana-Champaign.
- **Graduate Students Supervised** None.

# Biographical Sketch (Kiran S. Kedlaya)

## a. Professional Preparation

Undergraduate: Harvard University, Mathematics/Physics *summa cum laude*, A.B., 1996.

Graduate: Princeton University, Mathematics, M.A., 1997.

Graduate: MIT, Mathematics, Ph.D., 2000.

Postdoctoral: Clay Mathematics Institute, Mathematics, summer 2000.

Postdoctoral: MSRI, Mathematics, fall 2000.

Postdoctoral: University of California, Berkeley, Mathematics, 2000–2003.

Postdoctoral: Institute for Advanced Study, Mathematics, fall 2003.

## b. Appointments

University of California, San Diego, Associate Professor, 2009–present.

Institute for Advanced Study, member, 2009–2010.

MIT, Assistant Professor, 2003–2007; Associate Professor without tenure, 2007–2009; Associate Professor with tenure, 2009–present; Cecil and Ida Green Career Development Professor, 2008–2011.

Université de Rennes, Professeur invité, May–June 2002, June 2003.

## c. Publications

*Publications/projects related to current research:*

- Sage project, <http://www.sagemath.org/>.
- *The William Lowell Putnam Mathematical Competition 1985–2000: Problems, Solutions and Commentary* (with Bjorn Poonen and Ravi Vakil), Mathematical Association of America, Washington, 2002.
- Search techniques for root-unitary polynomials, in K.E.Lauter and K.A. Ribet (eds.), *Computational Arithmetic Geometry*, Contemporary Math. 463, Amer. Math. Soc., 2008, 71–82 (uses Sage).
- Hyperelliptic curves,  $L$ -polynomials, and random matrices (with Andrew Sutherland), in *Arithmetic, Geometry, Cryptography, and Coding Theory (AGC<sup>2</sup>T 2007)*, Contemporary Math. 487, Amer. Math. Soc., 2009.
- Bounding Picard numbers of surfaces using  $p$ -adic cohomology (with Timothy G. Abbott and David Roe), to appear in *Arithmetic, Geometry and Coding Theory (AGCT 2005)*, Sminaires et Congrès 21, Societ Mathmatique de France, 2010, 125–159 (uses Magma).

*Other significant publications:*

- Fast modular composition in any characteristic (with Christopher Umans), in *49th Annual IEEE Symposium on Foundations of Computer Science 2008 (FOCS '08)*, 2008, 146–155.
- Slope filtrations for relative Frobenius, *Astrisque* **319** (2008), 259–301.

- Semistable reduction for overconvergent F-isocrystals, III: local semistable reduction at monomial valuations, *Compositio Mathematica* **145** (2009), 143–172.
- Some new directions in  $p$ -adic Hodge theory, *Journal de Theorie des Nombres de Bordeaux* **21** (2009), 285–300.
- Good formal structures for flat meromorphic connections, I: Surfaces, *Duke Math. Journal*, to appear (probably 2010).

#### d. Synergistic Activities

- The PI has pursued explicit methods in algebraic geometry, demonstrating that some techniques thought only to have theoretical value are in fact relevant to applications involving algebraic geometry (e.g., cryptography). Some of these techniques have now been implemented in the *Magma* and *Sage* computer algebra systems.
- The PI has participated extensively in the development of activities for students of exceptional mathematical abilities, including competitions such as the USA Math Olympiad, the International Math Olympiad, the USA Math Talent Search, and the Putnam competition; summer programs such as the Math Olympiad Summer Program and the Canada/USA Mathcamp; the Art of Problem Solving Foundation; and the web site [cogito.org](http://cogito.org).
- The PI has given a number of expository talks, to high school students, undergraduates, and high school teachers, on a wide variety of topics in algebra, combinatorics, and number theory.
- The PI has engaged undergraduates in ongoing research (largely through MIT's Undergraduate Research Opportunities Program), in an attempt to bridge the gap between the undergraduate curriculum and the research frontiers in number theory.
- The PI has developed a number of pedagogical materials; some, such as the book with Poonen and Vakil, use mathematical problem solving as a device for bringing students towards the frontiers of current research.

#### e. Collaborators and Other Affiliations

Collaborators: T. Abbott (KSplice), M. Baker (Georgia Tech), J. Balakrishnan (MIT), R. Bradshaw (Washington), B. Conrad (Stanford), S. Dasgupta (California–Santa Cruz), D. Gulotta (Princeton), R. Liu (McGill), J. Propp (Massachusetts–Lowell), D. Roe (Harvard), D. Savitt (Arizona), X. Shao (MIT), A. Sutherland (MIT), J. Teitelbaum (Connecticut), D. Thakur (Arizona), C. Umans (Caltech), L. Xiao (Chicago), S. Yekhanin (IAS).

Advisors: A.J. de Jong (graduate, MIT/Columbia), Ken Ribet (postdoctoral, Berkeley).

Advisees: J. Balakrishnan (doctoral, MIT), C. Davis (doctoral, MIT), R. Liu (doctoral, MIT), J. Suh (postdoctoral, MIT), F. Tan (doctoral, MIT), L. Xiao (doctoral, MIT). Total of 5 doctoral advisees, 1 postdoctoral advisee.

**Thomas W. Judson, Project Faculty****Professional Preparation**

- **Ph.D.** – University of Oregon, Mathematics, 1984.
- **M.A.** – University of Oregon, Mathematics, 1979.
- **B.S.** – University of Illinois, Mathematics, 1975.

**Appointments**

- 2008 – Present Associate Professor, Department of Mathematics and Statistics, SFASU
- 2002 – 2008 Preceptor, Department of Mathematics, Harvard University
- 2001 – 2002 Visiting Assistant Professor, Department of Mathematics and Computer Science, University of Puget Sound
- 1993 – 2001 Associate Professor, Department of Mathematics, University of Portland
- 1984 – 1993 Assistant Professor, Department of Mathematics, University of Portland
- 1978 – 1984 Graduate Teaching Fellow, Department of Mathematics, University of Oregon
- 1987 – 1988 Graduate Teaching Assistant, Department of Mathematics, Univ. California, Irvine

**Most Relevant Publications**

- Judson, T. with Alvine, A., Schein, M. Yoshida, T. What Graduate Students (and the Rest of Us) Can Learn from Japanese Lesson Study. *College Teaching*, 55(2007), 109-113.
- Judson, T. with Nishimori, T. Concepts and skills in high school calculus: An examination of a special case in Japan and the U.S. *Journal of Research in Mathematics Education*, 36(2005), 24-43.
- Judson, T. Teaching a laboratory based linear algebra course, *1995 Proceedings of the Asian Technology Conference in Mathematics*.
- Judson, T. Experiences from the ATLAST Project: Implementing a laboratory based linear algebra course, *1993 Proceedings of the International Conference on Technology in Collegiate Mathematics*.
- Judson, T. *Abstract Algebra: Theory and Applications*, PWS Publishing Company, Boston, 1994.

**Other Publications**

- Judson, T. Complete Filtered Lie Algebras over a Vector Space of Dimension Two. *Journal of Lie Theory*, 12(2002), 423-447.
- Judson, T. Amerika ni okeru suugaku kyouiku ni suite no ronsou (in Japanese), *Journal of Higher Education and Lifelong Learning*, 9(2001), 10-15.
- Judson, T. Japan: A Different Model of Mathematics Education, *1996 Proceedings of the Symposium on the Future of Mathematics Education at Research Universities*, The Mathematical Sciences Research Institute, Cambridge University Press, Cambridge, 1999.
- Judson, T. Calculus Education in the United States, *Proceedings of ICME-EARCOME~1*, 1998.
- Judson, T. Complete Filtered Lie Algebras and their Spencer Cohomology, *Journal of Algebra*, 25(1989), 66-109.

**Synergistic Activities**

- Texas Leadership Initiative: Mathematics Instruction Transformed (Texas LIMIT). NSF Award #0934878. Conducting teacher development workshops and educational research (2009 to present).
- Texas Middle and Secondary Mathematics Project - Supplemental Funds. NSF Award #0227128. Conducting teacher development workshops and educational research (2008 to present).



- Graduate teaching fellow training programs at Harvard University and Stephen F. Austin State University. Worked with a small group of faculty in each department to create and oversee teacher training programs for graduate students who are teaching in the undergraduate curriculum (2001 to present).
- Undergraduate Faculty Program at the IAS/Park City Mathematics Institute (2001).
- National Science Foundation ATLAST Workshop at Michigan State University, East Lansing, MI (1993).

**Collaborators and Other Affiliations**

Dr. Amanda Alvine, Harvard University  
Dr. Robert Beezer, University of Puget Sound  
Dr. Bret Benesh, College of Saint Benedict, Saint John's University  
Dr. Lesa Beverly, Stephen F. Austin State University  
Dr. Kimberly Childs, Stephen F. Austin State University  
Dr. Andrew Engelward, Harvard University  
Dr. Matthew Leingang, NYU  
Dr. Toshiyuki Nishimori, Hokkaido University  
Dr. Deborah Pace, Stephen F. Austin State University  
Dr. Michael Schein, Bar-Ilan University  
Dr. Teruyoshi Yoshida, Harvard University

# Biographical Sketch

## William Stein

- Email: [wstein@gmail.com](mailto:wstein@gmail.com)
- Web: <http://wstein.org>
- Phone: 206-419-0925

## Professional Preparation

Northern Arizona University  
University of California at **Berkeley**  
**Harvard University**

Mathematics, B.S. 1994  
Mathematics, Ph.D. 2000  
Postdoc, 2000–2005

## Appointments

- Associate Professor of Mathematics (with tenure), University of Washington, September 2006–present.
- Associate Professor of Mathematics (with tenure), UC San Diego, July 2005–June 2006.
- Benjamin Peirce Assistant Professor of Mathematics, Harvard University, July 2001–May 2005.
- NSF Postdoctoral Research Fellowship under Barry Mazur at Harvard University, August 2000–May 2004.
- Clay Mathematics Institute Liftoff Fellow, Summer 2000.

## Most Relevant Publications

- *Average Ranks of Elliptic Curves: Tension Between Data and Conjecture*, with B. Bektemirov, B. Mazur, W. Stein, and M. Watkins, *Bulletins of the AMS* **44** (2007), no. 2, 233–254.
- *Modular forms, a computational approach* (xvi+268 pp.) Graduate Studies in Mathematics (AMS) 79 2007, with an appendix by Paul Gunnells.
- *Verification of the Birch and Swinnerton-Dyer Conjecture for Specific Elliptic Curves*, with G. Grigorov, A. Jorza, S. Patrikis, and C. Patrascu (26 pages), 2005, to appear in *Mathematics of Computation*.
- *Computation of  $p$ -Adic Heights and Log Convergence*, with B. Mazur and J. Tate (36 pages), *Documenta Mathematica*, 2006, Extra Vol., 577–614.
- *Visible Evidence for the Birch and Swinnerton-Dyer Conjecture for Rank 0 Modular Abelian Varieties* (31 pages), with A. Agashe, *Mathematics of Computation* **74** (2005), no. 249, 455–484.

## Other Publications

- *The Manin Constant*, with A. Agashe and K. Ribet, Pure Appl. Math., (2006), no. 2., 617–636.
- *Studying the Birch and Swinnerton-Dyer Conjecture for Modular Abelian Varieties Using Magma* (22 pages), a chapter in the Springer–Verlag book “Computational Experiments in Algebra and Geometry”.
- *Shafarevich-Tate Groups of Nonsquare Order*, Progress in Math., **224** (2004), 277–289, Birkhauser.
- *Constructing Elements in Shafarevich-Tate Groups of Modular Motives*, (19 pages) with N. Dummigan and M. Watkins, “Number theory and algebraic geometry—to Peter Swinnerton-Dyer on his 75th birthday”, Ed. by M. Reid and A. Skorobogatov.
- $J_1(p)$  has connected fibers, with B. Conrad and B. Edixhoven, Documenta Math., **8** (2003), 331–408.

## Synergistic Activities

- **Research Tools:** Principal author of Sage, which is a major new piece of software. Author of the modular forms, modular symbols and modular abelian varieties parts of the Magma computer algebra system (425 pages (26000 lines) of code plus documentation). These are tools used by mathematicians who do computations with modular forms.
- **Databases:** Created and maintain the Modular Forms Database. This contains continually expanding data about elliptic curves and modular forms: <http://wstein.org/Tables/>.
- **Outside Service:** IDA/CCR consultant. Also, Defense Science Study Group member 2002–2003: DSSG is a DARPA funded program administered by the Institute for Defense Analysis; paper on GPS vulnerabilities.
- **Outreach:** SIMUW 2007; SIMUW 2006; Canada/USA MathCamp mentor (2002); Several Math Circles talks in Boston.

## Collaborators and Other Affiliations

- **Coauthors:** A. Agashe (Florida State U.), K. Buzzard (Imperial College, London), R. Coleman (UC Berkeley), B. Conrad (Univ. of Michigan), N. Dummigan (Sheffield, UK), S. Edixhoven (Leiden, Netherlands), F. Leprévost (Univ. Joseph Fourier, Technische Univ. Berlin), E. V. Flynn (Liverpool, UK), D. Kohel (Univ. of Sydney), B. Mazur (Harvard), L. Merel (Paris 6), K. Ribet (UC Berkeley), E. F. Schaefer (Santa Clara Univ.), M. Stoll (Inter. Univ. Bremen, Germany), J. Tate, H. A. Verrill (Louisiana State), M. Watkins (Bristol.), J. L. Wetherell (CCR, San Diego)
- **Graduate and Postdoctoral Advisors:**
  - **Ph.D. advisor:** Hendrik Lenstra, University of Leiden, Netherlands.
  - **NSF Postdoctoral advisor:** Barry Mazur, Harvard University.
- **Thesis Students:** 2 Ph.D. students: Robert Bradshaw’s Ph.D. thesis at Univ. of Washington and Ifti Burhanuddin’s at Univ. of Southern California. Advised eight undergraduate senior theses at Harvard.

Marja-Liisa Hassi (prev. Malmivuori)  
Ethnography & Evaluation Research, CARTSS, University of Colorado, 580 UCB, Boulder, CO  
80309-0580, (303) 735-6168; [hassi@colorado.edu](mailto:hassi@colorado.edu)

#### Professional Preparation/Honors and Awards

- 1989 M.Sc. Mathematics, University of Helsinki, Finland. Additional: undergraduate studies in statistics, education, and computer science.  
1992 M.Ed. Education, University of Helsinki, Finland.  
2001 Ph.D. Education, University of Helsinki, Finland.  
2001 Best of the Year 2001 Educational Ph.D. Dissertation Award, The Finnish Educational Research Association (FERA).  
2007 Teacher's pedagogical qualification, Haaga-Helia School of Vocational Teacher Education, Finland.

#### Appointments

2007 – present. *Research Associate*, Ethnography & Evaluation Research, Center to Advance Research and Teaching in the Social Sciences (CARTSS), University of Colorado, Boulder. Studies on: processes, contexts, and outcomes of inquiry based learning on four US campuses (IBL Evaluation Research Project, EAF); faculty development of inquiry-based methods in teaching and learning mathematics (NSF CCLI); university climate for facilitating women's representation, advancement, and leadership in academia (ADVANCE programs).  
2004 – present. *Adjunct Professor in Education*, Faculty of Behavioral Sciences, University of Helsinki, Finland.  
2001 – 2007. *Senior Lecturer and Post-Doc Researcher*, Department of Education, University of Helsinki, Finland.  
Educational research methods, educational psychology, and research on teaching. Supervising undergraduate/graduate students' studies and research of education/mathematics education. Studies on: personal learning and self-regulation processes; affect in mathematics education; undergraduate math students' views and learning; adults' basic mathematical skills.  
2000 – 2001. *Researcher*, Department of Education, University of Helsinki, Finland. Studies on: theory on personal learning and self-regulation processes in mathematics learning, affect, and problem solving in social environment.  
1994 – 1999. *Researcher, Research Associate and Lecturer in Mathematics Education*, Department of Teacher Education, University of Helsinki, Finland.  
Mathematics education courses and seminars for elementary/secondary student teachers and doctoral students. Studies on: secondary school mathematics education; student mathematical affect and beliefs, gender differences in mathematics, learning and self-regulatory processes.

#### Five Most Relevant Publications

- Hassi, M.-L. (2009). Empowering undergraduate students through mathematical thinking and learning. In K. Safford-Ramus (Ed.), *A Declaration of Numeracy: Empowering Adults through Mathematics Education, Proceedings of the 15th International Conference of Adults Learning Mathematics (ALM)*, pp. 53-69. Lancaster, PA: DEStech Publications.  
Hassi M.-L., & Laursen, S. (2009). Studying undergraduate mathematics: Exploring students' beliefs, experiences and gains. In S.L. Swars, D.W. Stinson, & S. Lemons-Smith (Eds.), *Proceedings of the 31<sup>st</sup> Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education (PME-NA)*, pp.113-121. Atlanta, GA: Georgia State University.  
Malmivuori, M.L. (2007). Understanding student affect in learning mathematics. In C.L. Petroselli (Ed.), *Science Education: Issues and Developments*, pp. 125-149. NY: Nova Science Publishers.

- Malmivuori, M.L. (2006). Affect and self-regulation. *Educational Studies in Mathematics*, 63 (2), 149-164.
- Malmivuori, M.L. (2001). *The Dynamics of Affect, Cognition, and Social Environment in the Regulation of Personal Learning Processes: The Case of Mathematics. Research Report 172*. Hki, Finland: Helsinki University Press.  
<http://ethesis.helsinki.fi/julkaisut/kas/kasva/vk/malmivuori/>

#### Five Additional Papers and Reports

- Hassi, M.-L. & Laursen, S.L. (2008). *Faculty climate survey: Climate, collegiality, leadership, mentoring, diversity and institutional support according to research and teaching faculty, 2003-2007*. Report to the LEAP Project. Boulder, CO: University of Colorado at Boulder, Ethnography & Evaluation Research.
- Malmivuori, M.L. (2004). A dynamic viewpoint: Affect in the functioning of self-system processes. In M.J. Høines & A.B Fuglestad (Eds.), *Proceedings of the PME-28 Conference*, Vol.1, Bergen University College, Norway, pp. 114-118.
- Malmivuori, M.L. (1996). Self-confidence in students' belief structures. *International Reviews on Mathematical Education (=ZDM)*, 4, 121-126.
- Hannula, M., & Malmivuori, M.L. (1997). Gender difference and their relation to mathematics classroom context. In E. Pehkonen (Ed.), *Proceedings of the PME-21 Conference*, Vol.3, Lahti Research and Training Centre, University of Helsinki, Finland, pp. 33-40.
- Risnes, M., Hannula, M., & Malmivuori, M.L. (1999). The impact of teachers' instructional practice on students' mathematical beliefs and achievement. In G. Philippou (Ed.), *Research on Mathematical Beliefs. Proceedings of the MAVI-8 European Workshop*, University of Cyprus, Nicosia, pp. 106-115.

#### Synergistic Activities

Member of the evaluation team on the IBL in undergraduate mathematics project, Ethnography & Evaluation Research (E&ER), University of Colorado at Boulder, 2007 - present.

Reviewer for the EARLI (European Association for Research on Learning and Instruction) Biennial Conference (2009); ALM-15 (Adults Learning Mathematics) Conference Proceedings (2008).

Reviewer for Journal for Research in Mathematics Education (JRME), 2001 – present; Adults Learning Mathematics – An International Journal (ALMJ), 2009; Journal of Mathematics Teacher Education (JMTE), 2007; Educational Research Review (EdRR), 2006 – 2007; European Journal of Psychology of Education (EJPE), 2006 -2007.

Associate Editor for The International Journal of Learning, 2009.

Member of The Scientific Pool Experts of the University of Helsinki, Finland, 2006 - present.

#### Collaborative and Other Affiliations

At University of Colorado, Boulder: A.-B. Hunter, S. Laursen, H. Thiry, T. Weston.

At University of Helsinki, Finland: A. Hannula, M. Hannula.

Elsewhere: L. Brown, University of Bristol, UK; V. DeBellies, G. Goldin, Rutgers University; G. D. Goben, Kings College, London; J. Evans, Middlesex University Business School, London; D.B. McLeod, San Diego State University; J. Kantner, Joliet Junior College, Illinois; K. Safford-Ramus, Saint Peter's College, New Jersey.

Doctoral Student Advisor: D. Kilasi; L. Salo i Nevado, University of Helsinki, Finland.

Sandra L. Laursen

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Ethnography & Evaluation Research  
580 UCB  
Boulder, CO 80309-0580

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Professional Preparation

A.B. with honors in chemistry and French, Grinnell College, Grinnell, IA, 1984. President's Medalist.  
Ph.D. in physical chemistry, University of California, Berkeley, CA, 1990.  
Pew Teacher-Scholar Postdoctoral Fellow, 1990-91.  
James Franck Institute, University of Chicago, Chicago, IL, and St. Olaf College, Northfield, MN.

Appointments

Co-director (since 2007) and research associate (since 2000), Ethnography & Evaluation Research (E&ER), Center to Advance Research and Teaching in the Social Sciences (CARTSS), University of Colorado.

Science & mathematics education research and evaluation, specializing in qualitative methods.  
Recent studies on: outcomes of undergraduate research; career paths of women scientists; science outreach programs; faculty development and institutional change; graduate student professional development; inquiry-based learning in college mathematics; outreach in biology and geoscience.

Research associate and instructor in geological sciences, Education/Outreach Group, Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado (since 2000).

Earth and physical science courses for pre-service and in-service K-12 teachers; teacher professional development; collaboration with CIRES scientists to develop outreach programs related to their research; liaison to Colorado Science Education Network and steering committee member.

Editor and writer, ChemLinks Coalition, Beloit, WI, 2000-2004.

National Research Council Senior Fellow, NOAA Aeronomy Laboratory, Chemical Kinetics, 1998-2000.

Assistant professor of chemistry, Kalamazoo College, Kalamazoo, MI, 1991-1998.

Five Most Relevant Publications

Laursen, S., Hunter, A.-B., Seymour, E., Thiry, H., & Melton, G. (2010). *Undergraduate Research in the Sciences: Engaging Students in Real Science*. San Francisco: Jossey Bass (forthcoming).

Laursen, S. L., & Rocque, B. (2009). Faculty development for institutional change: Lessons from an ADVANCE project. *Change* (March/April), 18-26.

Hassi M.-L., & Laursen, S. (2009). Studying undergraduate mathematics: Exploring students' beliefs, experiences and gains. In S.L. Swars, D.W. Stinson, & S. Lemons-Smith (Eds.). *Proceedings of the 31<sup>st</sup> Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education (PME-NA)*, pp.113-121. Atlanta, GA: Georgia State University.

De Welde, K., & Laursen, S. (2008). The "Ideal type" advisor: Helping STEM graduate students find their 'scientific feet'. *The Open Education Journal* (1), 49-61

Thiry, H., Laursen, S. L., & Hunter, A.-B. (2008). Professional development needs and outcomes for education-engaged scientists: A research-based framework and its application. *Journal of Geoscience Education* 56(3), 235-246.

Five Additional Publications

Laursen, S., Liston, C., Thiry, H., & Graf, J. (2007). What good is a scientist in the classroom? Participant outcomes and program design features for a short-duration science outreach intervention in K-12 classrooms. *CBE-Life Sciences Online* 6, 49-64. <http://www.lifescied.org/cgi/content/abstract/6/1/49>

Laursen, S., & Dauber, R., co-directors (2008). *Upward and Outward: Scientific Inquiry on the Tibetan Plateau*. Educational documentary film (20 min). Boulder: University of Colorado.

De Welde, K., Laursen, S., & Thiry, H. (2007). *SWS Fact Sheet: Women in Science, Technology, Engineering and Math (STEM)*. Sociologists for Women in Society <http://www.socwomen.org/index.php?ss=25>.

Hunter, A.-B., Laursen, S.L., & Seymour, E. (2007). Becoming a scientist: The role of undergraduate research in students' cognitive, personal and professional development. *Science Education* 91(1), 36-74.

Marschke, R., Laursen, S., Nielsen, J., & Rankin, P. (2007). Demographic inertia revisited: An immodest proposal to achieve equitable gender representation among faculty in higher education. *J. Higher Education* 78(1), 1-26.

### Synergistic Activities

Evaluation project leadership:

Inquiry-Based Learning in Mathematics Project, Educational Advancement Foundation (Coordinator, R. Douglas, Texas A&M). Director of the Assessment and Evaluation Center, 2007-present. Includes evaluation for NSF CCLI Phase 2 grant, "Collaborative Research: Research, Dissemination, and Faculty Development of Inquiry-Based Learning (IBL) Methods in the Teaching and Learning of Mathematics," 2009-12.

Leadership Education for Advancement and Promotion (LEAP), NSF-ADVANCE grant (PI P. Rankin, U. Colorado at Boulder). Evaluation team leader, 2002-2008.

Biological Sciences Initiative, U. Colorado at Boulder (PI J. Graf). Co-director, 2002-2010.

Earth Science Women's Network (ESWN) (PI M. Hastings, Brown U.), NSF ADVANCE PAID grant. Evaluation director, 2009-13.

Principal investigator or co-PI on grants funded by NSF and private foundations:

"Scientific Inquiry for Scientists: Workshops, Resources, and Research to Support the Professional Development of Scientists Engaged with K-12 Education." NSF Geoscience Education. PI, 2004-07.

"Mapping the Extent and Character of the Undergraduate Research Experience at Public Research Universities: An Exploratory Study." NSF Chemistry Special Projects. PI, 2006-10.

"What Do We Know about What Works? Review of US Foundations' Programs in K-12 Chemistry Education." Camille and Henry Dreyfus Foundation. PI, 2006-07.

"Professional Socialization and Career Selection in Ph.D. Science Education: An Empirical Research Study." NSF Division of Research and Learning. PI, 2007-10.

"Partnerships for Adaptation, Implementation and Dissemination (PAID): An Analysis of NSF ADVANCE Programs." NSF ADVANCE. Co-PI (with PI A. Austin, Michigan State), 2009-12.

Co-PI and executive committee member for ChemLinks Coalition, 1993-2002, NSF-DUE Systemic Changes in the Undergraduate Chemistry Curriculum (CCD-CHEM) (PI B. Spencer).

Planning group member and workshop leader for "Multi-Initiative Dissemination (MID): Strategies to Promote Active Learning in Chemistry Courses," NSF-DUE grant for joint dissemination of the five NSF chemistry systemic initiatives (PI E. Lewis, U. C. Berkeley), 2000-04.

### Collaborators and Other Affiliations

At Colorado: L. Avallone, S. Buhr, C. Coates, T. DeAntoni, R. Donohue, J. Graf, M.-L. Hassi, A.-B. Hunter, A. Lester, C. Liston, G. Melton, K. Mueller, J. Nielsen, L. Pedersen-Gallegos, K. Perkins, P. Rankin, L. Romero de Mendoza, C. Schott, E. Seymour, L. K. Smith, H. Thiry, T. Weston, C. Wieman.

Elsewhere: A. Austin, Michigan State U.; K. De Welde, Florida Gulf Coast U.; T. Ferrett, Carleton C.; E. Lewis, NSF-DUE; R. Marschke, U. Colorado-Colorado Springs; H. Mernitz, Alverno C.; W. Rocque, Redlands U.; B. Spencer, Beloit C.; J. Stewart, Hope C.

Advisors: G. C. Pimentel, U. C. Berkeley (graduate); D. H. Levy, U. Chicago (postdoctoral).

# Biographical Sketch: Jason Grout

## Jason Grout

- Email: [jason.grout@drake.edu](mailto:jason.grout@drake.edu)
- Web: <http://www.drake.edu/artsci/mathcs/people/grout.html>
- Phone: 515-271-3113

## Professional Preparation

Missouri State University	Math/Computer Science (double major)	B.S. 2001
Brigham Young University	Mathematics	M.S. 2003
Brigham Young University	Mathematics	Ph.D. 2007
Iowa State University	Postdoc, Mathematics	2007–2009

## Appointments

- Assistant Professor of Mathematics, Drake University, August 2009–present.
- Postdoctoral Associate, Iowa State University, August 2007–July 2009.

## Most Relevant Publications

- [1] Wayne Barrett, Jason Grout, and Raphael Loewy, *The minimum rank problem over the finite field of order 2: minimum rank 3*, Linear Algebra Appl. **430** (2009), no. 4, 890–923, DOI 10.1016/j.laa.2008.08.025, available at <http://lanl.arxiv.org/abs/math/0612331>. Preprint includes relevant Sage code.
- [2] D. Cvetković and J. Grout, *Graphs with extremal energy should have a small number of distinct eigenvalues*, Bull. Cl. Sci. Math. Nat. Sci. Math. (2007), no. 32, 43–57, available at <http://lanl.arxiv.org/abs/0710.5669>. Uses Mathematica and Sage.
- [3] Laura DeLoss, Jason Grout, Leslie Hogben, Tracy McKay, Jason Smith, and Geoff Tims, *Techniques for determining the minimum rank of a small graph*, Linear Algebra Appl., 7 pages. Accepted (likely published 2010). Uses Sage.
- [4] Jason Grout, *The minimum rank problem over finite fields*, 23 pp., available at <http://lanl.arxiv.org/abs/0801.2987>. Submitted (likely published 2010). Uses Sage.
- [5] W.A. Stein and others, *Sage Mathematics Software*, The Sage Development Team. <http://www.sagemath.org>. (Sage developer).

## Other Publications

- [1] Luz M. DeAlba, Jason Grout, Leslie Hogben, Rana Mikkelsen, and Kaela Rasmussen, *Universally optimal matrices and field independence of the minimum rank of a graph*, Electron. J. Linear Algebra **18** (2009), 403–419.



## Synergistic Activities

- **Outside Service:** Consultant, Institute for Defense Analysis—Center for Communications Research.
- **Research Tools:** Designed, contributed, and reviewed code for Sage in the areas of linear algebra, graph theory, graphics, and user interface. Sage is a comprehensive open source program for mathematics.
- **Databases:** Created the Small Graph database, providing information about graphs with 8 or fewer vertices: [http://orion.math.iastate.edu/grout/graph\\_database](http://orion.math.iastate.edu/grout/graph_database).
- **Outreach:** Helped organize and lead elementary school and secondary school math circles.
- **Training:** Co-organized and will help teach an online MAA Professional Enhancement Program (PREP) workshop on using Sage in the classroom in Summer 2010 to several dozen faculty from around the country.

## Collaborators and Other Affiliations

- **Coauthors/Collaborators:** M. Allison (Wyoming), W. Barrett (BYU), E. Bodine (Washington State), R. Brualdi (Wisconsin), S. Butler (UCLA), D. Cvetković (Belgrade), L. DeAlba (Drake), L. DeLoss, L. Deaett (Victoria), J. Debnath (Winona State), P. van den Driessche (Victoria), W. Florero (San Jose State), C. Garnett (Wyoming), T. Hall (Utah Valley), L. Hogben (Iowa State), B. Im (Chonnam National University), I. Kim (Minnesota-Mankato), H. Kim (Sungkyunkwan), S. Kirkland (Regina), R. Loewy (Technion), J. McDonald (Washington State), T. McKay (Iowa State), R. Mikkelsen (Iowa State), R. Nair (Wyoming), O. Pryporova (Iowa State), K. Rasmussen (Iowa State), K. Savage (Mississippi), B. Shader (Wyoming), J. Smith (Iowa State), G. Tims (Iowa State), A. Wangsness Wehe (Fitchburg State), B. Woodruff (BYU-Idaho), and A. Yielding (Washington State).
- **M.S. and Ph.D. advisor:** Wayne Barrett, Brigham Young University.
- **Postdoctoral advisor:** Leslie Hogben, Iowa State University.
- **Students advised:** None.

# SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION <b>American Institute of Mathematics</b>				FOR NSF USE ONLY				
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Robert Beezer</b>				PROPOSAL NO.		DURATION (months)		
				Proposed		Granted		
AWARD NO.								
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months			Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR		
1. <b>Robert Beezer - PI</b>				2.00	0.00	0.00	\$ 21,896	\$
2.								
3.								
4.								
5.								
6. ( 0 ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0	
7. ( 1 ) TOTAL SENIOR PERSONNEL (1 - 6)				2.00	0.00	0.00	21,896	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)								
1. ( 0 ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	0	
2. ( 2 ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	20,000	
3. ( 0 ) GRADUATE STUDENTS							0	
4. ( 0 ) UNDERGRADUATE STUDENTS							0	
5. ( 0 ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0	
6. ( 0 ) OTHER							0	
TOTAL SALARIES AND WAGES (A + B)							41,896	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							41,896	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)								
TOTAL EQUIPMENT							0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							10,000	
2. FOREIGN							0	
F. PARTICIPANT SUPPORT COSTS								
1. STIPENDS \$ 0								
2. TRAVEL 9,000								
3. SUBSISTENCE 0								
4. OTHER 0								
TOTAL NUMBER OF PARTICIPANTS ( 0 ) TOTAL PARTICIPANT COSTS							9,000	
G. OTHER DIRECT COSTS								
1. MATERIALS AND SUPPLIES							4,000	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							10,000	
3. CONSULTANT SERVICES							0	
4. COMPUTER SERVICES							0	
5. SUBAWARDS							0	
6. OTHER							0	
TOTAL OTHER DIRECT COSTS							14,000	
H. TOTAL DIRECT COSTS (A THROUGH G)							74,896	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)								
<b>Total Direct Costs (Rate: 26.0000, Base: 74896)</b>								
TOTAL INDIRECT COSTS (F&A)							19,473	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							94,369	
K. RESIDUAL FUNDS							0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 94,369	\$
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$				
PI/PD NAME <b>Robert Beezer</b>				FOR NSF USE ONLY				
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION				
				Date Checked	Date Of Rate Sheet	Initials - ORG		

1 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

# SUMMARY PROPOSAL BUDGET

YEAR **2**

ORGANIZATION				FOR NSF USE ONLY		
<b>American Institute of Mathematics</b>				PROPOSAL NO.		DURATION (months)
						Proposed      Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Robert Beezer</b>				AWARD NO.		
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer
				CAL	ACAD	SUMR
1. <b>Robert Beezer - PI</b>				2.00	0.00	0.00
2.						
3.						
4.						
5.						
6. ( <b>0</b> ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00
7. ( <b>1</b> ) TOTAL SENIOR PERSONNEL (1 - 6)				2.00	0.00	0.00
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. ( <b>0</b> ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00
2. ( <b>2</b> ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00
3. ( <b>0</b> ) GRADUATE STUDENTS						
4. ( <b>0</b> ) UNDERGRADUATE STUDENTS						
5. ( <b>0</b> ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						
6. ( <b>0</b> ) OTHER						
TOTAL SALARIES AND WAGES (A + B)						<b>43,090</b>
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)						<b>0</b>
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)						<b>43,090</b>
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)						
TOTAL EQUIPMENT						<b>0</b>
E. TRAVEL            1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)						<b>10,000</b>
2. FOREIGN						<b>0</b>
F. PARTICIPANT SUPPORT COSTS						
1. STIPENDS        \$ <b>20,000</b>						
2. TRAVEL <b>9,000</b>						
3. SUBSISTENCE <b>0</b>						
4. OTHER <b>0</b>						
TOTAL NUMBER OF PARTICIPANTS    ( <b>0</b> )                      TOTAL PARTICIPANT COSTS						<b>29,000</b>
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES						<b>1,500</b>
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION						<b>10,000</b>
3. CONSULTANT SERVICES						<b>0</b>
4. COMPUTER SERVICES						<b>0</b>
5. SUBAWARDS						<b>0</b>
6. OTHER						<b>0</b>
TOTAL OTHER DIRECT COSTS						<b>11,500</b>
H. TOTAL DIRECT COSTS (A THROUGH G)						<b>93,590</b>
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)						
<b>Total Direct Costs (Rate: 26.0000, Base: 93590)</b>						
TOTAL INDIRECT COSTS (F&A)						<b>24,333</b>
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)						<b>117,923</b>
K. RESIDUAL FUNDS						<b>0</b>
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)						\$ <b>117,923</b> \$
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$		
PI/PD NAME <b>Robert Beezer</b>				FOR NSF USE ONLY		
				INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*				Date Checked	Date Of Rate Sheet	Initials - ORG

2 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

# SUMMARY PROPOSAL BUDGET

YEAR 3

ORGANIZATION <b>American Institute of Mathematics</b>				FOR NSF USE ONLY			
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Robert Beezer</b>				PROPOSAL NO.	DURATION (months)		
				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. <b>Robert Beezer - PI</b>				2.00	0.00	0.00	\$ 23,746
2.							
3.							
4.							
5.							
6. ( 0 ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. ( 1 ) TOTAL SENIOR PERSONNEL (1 - 6)				2.00	0.00	0.00	23,746
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( 0 ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	0
2. ( 2 ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	20,410
3. ( 0 ) GRADUATE STUDENTS							0
4. ( 0 ) UNDERGRADUATE STUDENTS							0
5. ( 0 ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0
6. ( 0 ) OTHER							0
TOTAL SALARIES AND WAGES (A + B)							44,156
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							44,156
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							10,000
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ 30,000							
2. TRAVEL 0							
3. SUBSISTENCE 0							
4. OTHER 0							
TOTAL NUMBER OF PARTICIPANTS ( 0 ) TOTAL PARTICIPANT COSTS							30,000
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							1,500
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							10,000
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							11,500
H. TOTAL DIRECT COSTS (A THROUGH G)							95,656
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)							
<b>Total Direct Cost (Rate: 26.0000, Base: 95656)</b>							
TOTAL INDIRECT COSTS (F&A)							24,871
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							120,527
K. RESIDUAL FUNDS							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 120,527 \$
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME <b>Robert Beezer</b>				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

3 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

# SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION <b>American Institute of Mathematics</b>				FOR NSF USE ONLY			
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Robert Beezer</b>				PROPOSAL NO.	DURATION (months)		
				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. <b>Robert Beezer - PI</b>				6.00	0.00	0.00	\$ <b>67,757</b>
2.							
3.							
4.							
5.							
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	<b>0</b>
7. ( <b>1</b> ) TOTAL SENIOR PERSONNEL (1 - 6)				6.00	0.00	0.00	<b>67,757</b>
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( <b>0</b> ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	<b>0</b>
2. ( <b>6</b> ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	<b>61,385</b>
3. ( <b>0</b> ) GRADUATE STUDENTS							<b>0</b>
4. ( <b>0</b> ) UNDERGRADUATE STUDENTS							<b>0</b>
5. ( <b>0</b> ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							<b>0</b>
6. ( <b>0</b> ) OTHER							<b>0</b>
TOTAL SALARIES AND WAGES (A + B)							<b>129,142</b>
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							<b>0</b>
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							<b>129,142</b>
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							<b>0</b>
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							<b>30,000</b>
2. FOREIGN							<b>0</b>
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ <b>50,000</b>							
2. TRAVEL <b>18,000</b>							
3. SUBSISTENCE <b>0</b>							
4. OTHER <b>0</b>							
TOTAL NUMBER OF PARTICIPANTS ( <b>0</b> ) TOTAL PARTICIPANT COSTS							<b>68,000</b>
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							<b>7,000</b>
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							<b>30,000</b>
3. CONSULTANT SERVICES							<b>0</b>
4. COMPUTER SERVICES							<b>0</b>
5. SUBAWARDS							<b>0</b>
6. OTHER							<b>0</b>
TOTAL OTHER DIRECT COSTS							<b>37,000</b>
H. TOTAL DIRECT COSTS (A THROUGH G)							<b>264,142</b>
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)							
TOTAL INDIRECT COSTS (F&A)							<b>68,677</b>
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							<b>332,819</b>
K. RESIDUAL FUNDS							<b>0</b>
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ <b>332,819</b> \$
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME <b>Robert Beezer</b>				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

C \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

## UTMOST Budget Justification

**Sage Days Workshops** (\$18,000) The Sage project has successfully held nineteen week-long workshops. UTMOST will organize two workshops, in the Summers of 2011 and 2012, allowing faculty from the test sites and members of the project team to collaborate. Sage Days workshops typically cost \$12,000, with most of the expense for travel costs of the participants. Since members of the project team will have separate travel funding through this grant, the cost of each workshop is estimated to be \$9,000.

**Test Site Stipends** (\$50,000) Faculty involved at test sites will be given stipends to support their participation. This participation will involve advance preparation in the summer to learn Sage and prepare to teach courses with a new style of textbook. Other activities supported by these stipends will include their participation in evaluation instruments, organizing students to participate in evaluations, and authoring new Sage-enhanced materials. The five sites beginning in Summer 2011 with a two-year commitment will receive \$4,000 the first year and \$2,000 the second year. The five sites beginning Summer 2012 with a one-year commitment will receive \$4,000.

**Supplies** (\$7,000) \$3,000 is allocated for the purchase of two departmental servers for test sites, one in each of Years 2 and 3. As part of the project's goal to make it easier for institutions to use open mathematics software, the experience of helping two departments to setup and maintain a departmental Sage server is an important activity for the project.

\$4,000 is allocated for two laptops and one desktop machine for project members to complement hardware provided by their institutions. With each project member traveling to test sites for intensive work with Sage, it is important they have a mobile computer.

**Other Personnel** (\$61,385) \$4,000 is allocated for a system administrator of a central Sage server, hosted at the University of Washington, during Years 2 and 3. This server will exclusively support the ten test sites. This system administrator will also assist with the two servers supplied to test sites.

\$57,385 is allocated for programming projects designed to improve the Sage notebook interface and Sage server configuration, directly in support of the project's activities and goals. Programmers will include undergraduate students, graduate students, faculty, and consultants, paid hourly or on a project-completion basis.

**AIM Textbook Site** (\$30,000) Funds in the amount of \$10,000 per year will allow the American Institute of Mathematics to undertake a pilot project as a sponsor and supporter of open textbooks in mathematics.

**Travel** (\$30,000) Five faculty on the project team will mentor and advise test sites, attend Sage Days workshops, collaborate on textbook conversions, collaborate on improvements to Sage, present project results at regional and national meetings, and present workshops and minicourses to disseminate the project's methods. Travel for these activities will be supported with \$2,000 per year per person.

**Summer Salary** (\$67,757) Summer salary for Dr. Robert Beezer is for six months (two months each of three Summers) with a 1% increase each year, and an expected step-increase effective in Year 3. Dr. Kiran Kedlaya has not requested a salary for his participation. Salaries for other senior personnel are contained in their collaborative proposals.

# SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION <b>Stephen F. Austin State University</b>				<b>FOR NSF USE ONLY</b>	
				PROPOSAL NO.	DURATION (months) Proposed      Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Thomas W Judson</b>				AWARD NO.	
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)		NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
		CAL	ACAD		
1. <b>Thomas W Judson - Co-PI</b>		0.00	0.00	1.25	\$ <b>8,583</b>
2.					
3.					
4.					
5.					
6. ( 0 ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)		0.00	0.00	0.00	<b>0</b>
7. ( 1 ) TOTAL SENIOR PERSONNEL (1 - 6)		0.00	0.00	1.25	<b>8,583</b>
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. ( 0 ) POST DOCTORAL SCHOLARS		0.00	0.00	0.00	<b>0</b>
2. ( 0 ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)		0.00	0.00	0.00	<b>0</b>
3. ( 0 ) GRADUATE STUDENTS					<b>0</b>
4. ( 0 ) UNDERGRADUATE STUDENTS					<b>0</b>
5. ( 0 ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					<b>0</b>
6. ( 0 ) OTHER					<b>0</b>
TOTAL SALARIES AND WAGES (A + B)					<b>8,583</b>
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					<b>1,859</b>
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					<b>10,442</b>
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)					
TOTAL EQUIPMENT					<b>0</b>
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)					<b>0</b>
2. FOREIGN					<b>0</b>
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS \$ <b>0</b>					
2. TRAVEL <b>0</b>					
3. SUBSISTENCE <b>0</b>					
4. OTHER <b>0</b>					
TOTAL NUMBER OF PARTICIPANTS ( 0 ) TOTAL PARTICIPANT COSTS					<b>0</b>
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES					<b>0</b>
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					<b>0</b>
3. CONSULTANT SERVICES					<b>0</b>
4. COMPUTER SERVICES					<b>0</b>
5. SUBAWARDS					<b>0</b>
6. OTHER					<b>0</b>
TOTAL OTHER DIRECT COSTS					<b>0</b>
H. TOTAL DIRECT COSTS (A THROUGH G)					<b>10,442</b>
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) <b>Salaries/wages (Rate: 50.0000, Base: 8583)</b>					
TOTAL INDIRECT COSTS (F&A)					<b>4,292</b>
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					<b>14,734</b>
K. RESIDUAL FUNDS					<b>0</b>
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)					\$ <b>14,734</b> \$
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>		AGREED LEVEL IF DIFFERENT \$			
PI/PI NAME <b>Thomas W Judson</b>		<b>FOR NSF USE ONLY</b>			
ORG. REP. NAME* <b>Baker PATTILLO</b>		INDIRECT COST RATE VERIFICATION			
		Date Checked	Date Of Rate Sheet	Initials - ORG	

1 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

# SUMMARY PROPOSAL BUDGET

YEAR **2**

ORGANIZATION <b>Stephen F. Austin State University</b>				FOR NSF USE ONLY			
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Thomas W Judson</b>				PROPOSAL NO.	DURATION (months)		
				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. <b>Thomas W Judson - Co-PI</b>				0.00	0.00	2.00	\$ <b>14,420</b>
2.							
3.							
4.							
5.							
6. ( <b>0</b> ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	<b>0</b>
7. ( <b>1</b> ) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	2.00	<b>14,420</b>
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( <b>0</b> ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	<b>0</b>
2. ( <b>0</b> ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	<b>0</b>
3. ( <b>0</b> ) GRADUATE STUDENTS							<b>0</b>
4. ( <b>0</b> ) UNDERGRADUATE STUDENTS							<b>0</b>
5. ( <b>0</b> ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							<b>0</b>
6. ( <b>0</b> ) OTHER							<b>0</b>
TOTAL SALARIES AND WAGES (A + B)							<b>14,420</b>
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							<b>3,124</b>
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							<b>17,544</b>
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							<b>0</b>
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							<b>0</b>
2. FOREIGN							<b>0</b>
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ <b>0</b>							
2. TRAVEL <b>0</b>							
3. SUBSISTENCE <b>0</b>							
4. OTHER <b>0</b>							
TOTAL NUMBER OF PARTICIPANTS ( <b>0</b> ) TOTAL PARTICIPANT COSTS							<b>0</b>
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							<b>0</b>
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							<b>0</b>
3. CONSULTANT SERVICES							<b>0</b>
4. COMPUTER SERVICES							<b>0</b>
5. SUBAWARDS							<b>0</b>
6. OTHER							<b>0</b>
TOTAL OTHER DIRECT COSTS							<b>0</b>
H. TOTAL DIRECT COSTS (A THROUGH G)							<b>17,544</b>
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) <b>Salaries/wages (Rate: 50.0000, Base: 14420)</b>							
TOTAL INDIRECT COSTS (F&A)							<b>7,210</b>
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							<b>24,754</b>
K. RESIDUAL FUNDS							<b>0</b>
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ <b>24,754</b> \$
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME <b>Thomas W Judson</b>				FOR NSF USE ONLY			
ORG. REP. NAME* <b>Baker PATTILLO</b>				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

2 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET



# SUMMARY PROPOSAL BUDGET

YEAR 3

ORGANIZATION <b>Stephen F. Austin State University</b>				<b>FOR NSF USE ONLY</b>	
				PROPOSAL NO.	DURATION (months) Proposed      Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Thomas W Judson</b>				AWARD NO.	
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)		NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
		CAL	ACAD		
1. <b>Thomas W Judson - Co-PI</b>		0.00	0.00	0.50	\$ 3,785
2.					
3.					
4.					
5.					
6. ( 0 ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)		0.00	0.00	0.00	0
7. ( 1 ) TOTAL SENIOR PERSONNEL (1 - 6)		0.00	0.00	0.50	3,785
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. ( 0 ) POST DOCTORAL SCHOLARS		0.00	0.00	0.00	0
2. ( 0 ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)		0.00	0.00	0.00	0
3. ( 0 ) GRADUATE STUDENTS					0
4. ( 0 ) UNDERGRADUATE STUDENTS					0
5. ( 0 ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					0
6. ( 0 ) OTHER					0
TOTAL SALARIES AND WAGES (A + B)					3,785
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					820
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					4,605
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)					
TOTAL EQUIPMENT					0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)					0
2. FOREIGN					0
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS \$ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS ( 0 ) TOTAL PARTICIPANT COSTS					0
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES					0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					0
3. CONSULTANT SERVICES					0
4. COMPUTER SERVICES					0
5. SUBAWARDS					0
6. OTHER					0
TOTAL OTHER DIRECT COSTS					0
H. TOTAL DIRECT COSTS (A THROUGH G)					4,605
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) <b>Salaries/wages (Rate: 50.0000, Base: 3785)</b>					
TOTAL INDIRECT COSTS (F&A)					1,893
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					6,498
K. RESIDUAL FUNDS					0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)					\$ 6,498
M. COST SHARING PROPOSED LEVEL \$ 0		AGREED LEVEL IF DIFFERENT \$			
PI/PI NAME <b>Thomas W Judson</b>		<b>FOR NSF USE ONLY</b>			
ORG. REP. NAME* <b>Baker PATTILLO</b>		INDIRECT COST RATE VERIFICATION			
		Date Checked	Date Of Rate Sheet	Initials - ORG	

3 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

# SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION <b>Stephen F. Austin State University</b>				FOR NSF USE ONLY					
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Thomas W Judson</b>				PROPOSAL NO.		DURATION (months)			
				Proposed		Granted			
AWARD NO.									
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer		Funds granted by NSF (if different)	
				CAL	ACAD	SUMR			
1. <b>Thomas W Judson - Co-PI</b>				0.00	0.00	3.75	\$ <b>26,788</b>		\$
2.									
3.									
4.									
5.									
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	<b>0</b>		
7. ( <b>1</b> ) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	3.75	<b>26,788</b>		
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)									
1. ( <b>0</b> ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	<b>0</b>		
2. ( <b>0</b> ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	<b>0</b>		
3. ( <b>0</b> ) GRADUATE STUDENTS							<b>0</b>		
4. ( <b>0</b> ) UNDERGRADUATE STUDENTS							<b>0</b>		
5. ( <b>0</b> ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							<b>0</b>		
6. ( <b>0</b> ) OTHER							<b>0</b>		
TOTAL SALARIES AND WAGES (A + B)							<b>26,788</b>		
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							<b>5,803</b>		
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							<b>32,591</b>		
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)									
TOTAL EQUIPMENT							<b>0</b>		
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							<b>0</b>		
2. FOREIGN							<b>0</b>		
F. PARTICIPANT SUPPORT COSTS									
1. STIPENDS \$ <b>0</b>									
2. TRAVEL <b>0</b>									
3. SUBSISTENCE <b>0</b>									
4. OTHER <b>0</b>									
TOTAL NUMBER OF PARTICIPANTS ( <b>0</b> ) TOTAL PARTICIPANT COSTS							<b>0</b>		
G. OTHER DIRECT COSTS									
1. MATERIALS AND SUPPLIES							<b>0</b>		
2. PUBLICATION COSTS/DOCUMENTATION/DISEMINATION							<b>0</b>		
3. CONSULTANT SERVICES							<b>0</b>		
4. COMPUTER SERVICES							<b>0</b>		
5. SUBAWARDS							<b>0</b>		
6. OTHER							<b>0</b>		
TOTAL OTHER DIRECT COSTS							<b>0</b>		
H. TOTAL DIRECT COSTS (A THROUGH G)							<b>32,591</b>		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)									
TOTAL INDIRECT COSTS (F&A)							<b>13,395</b>		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							<b>45,986</b>		
K. RESIDUAL FUNDS							<b>0</b>		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ <b>45,986</b>		\$
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$					
PI/PI NAME <b>Thomas W Judson</b>				FOR NSF USE ONLY					
ORG. REP. NAME* <b>Baker PATTILLO</b>				INDIRECT COST RATE VERIFICATION					
				Date Checked		Date Of Rate Sheet		Initials - ORG	

C \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

**Stephen F. Austin State University  
Budget Justification**

**Personnel**

In accordance with university estimates, cost-of-living raises have been calculated at 5% annually.

*Co-Principal Investigator.* As Co-PI, Dr. Thomas Judson will be responsible for the following:

- Year 1 (2010-2011). Work with Dr. Robert Beezer to create integrated curricular materials for linear algebra and abstract algebra. Work with the other members of the project to select test sites and assist in training faculty at these test sites. Assist Drs. Marja-Liisa Hassi and Sandra Laursen with the evaluation of the project.
- Year 2 (2011-2012). Work with Dr. Robert Beezer to create integrated curricular materials for linear algebra and abstract algebra. Work with the other members of the project to select test sites and assist in training faculty at these test sites. Assist Drs. Marja-Liisa Hassi and Sandra Laursen with the evaluation of the project.
- Year 3 (2012-2013). Work with the other members of the project to train faculty at the test sites. Assist Drs. Marja-Liisa Hassi and Sandra Laursen with the evaluation of the project.

Funds are requested during the summer months only, although Dr. Judson will be involved in the project during the academic year as well. Specifically, summer salary is requested at \$8,583 for 1.25 months in Year 1; \$14,420 for 2 months in Year 2; and \$3,785 for .5 months in Year 3. (The requested amounts for this project have been calculated to ensure that Dr. Judson's NSF-funded salary across all projects will not exceed a total of 2 months per year.)

**Fringe Benefits**

The university's fringe benefits for full-time faculty include FICA/Medicare, retirement matching, worker's compensation, and unemployment compensation calculated at 16.05% of salary plus health insurance. Dr. Judson's fringe benefits are requested in proportion to his requested summer salary, with \$1,859 in Year 1; \$3,124 in Year 2; and \$820 in Year 3.

**Indirect Costs**

Stephen F. Austin State University's DHHS-negotiated indirect cost rate is 50% salaries and wages (excluding fringe benefits). Accordingly, \$4,292 is requested in Year 1; \$7,210 is requested in Year 2; and \$1,893 is requested in Year 3.

**TOTAL ANNUAL REQUEST**

Year 1 = \$14,734

Year 2 = \$24,754

Year 3 = \$6,498

# SUMMARY PROPOSAL BUDGET

YEAR **2**

ORGANIZATION <b>University of Washington</b>				FOR NSF USE ONLY			
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>William A Stein</b>				PROPOSAL NO.	DURATION (months)		
				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. <b>William A Stein - none</b>				0.00	0.00	2.00	\$ <b>21,395</b>
2.							
3.							
4.							
5.							
6. ( <b>0</b> ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	<b>0</b>
7. ( <b>1</b> ) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	2.00	<b>21,395</b>
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( <b>0</b> ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	<b>0</b>
2. ( <b>0</b> ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	<b>0</b>
3. ( <b>0</b> ) GRADUATE STUDENTS							<b>0</b>
4. ( <b>0</b> ) UNDERGRADUATE STUDENTS							<b>0</b>
5. ( <b>0</b> ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							<b>0</b>
6. ( <b>0</b> ) OTHER							<b>0</b>
TOTAL SALARIES AND WAGES (A + B)							<b>21,395</b>
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							<b>5,049</b>
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							<b>26,444</b>
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							<b>0</b>
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							<b>0</b>
2. FOREIGN							<b>0</b>
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ <b>0</b>							
2. TRAVEL <b>0</b>							
3. SUBSISTENCE <b>0</b>							
4. OTHER <b>0</b>							
TOTAL NUMBER OF PARTICIPANTS ( <b>0</b> ) TOTAL PARTICIPANT COSTS							<b>0</b>
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							<b>0</b>
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							<b>0</b>
3. CONSULTANT SERVICES							<b>0</b>
4. COMPUTER SERVICES							<b>0</b>
5. SUBAWARDS							<b>0</b>
6. OTHER							<b>0</b>
TOTAL OTHER DIRECT COSTS							<b>0</b>
H. TOTAL DIRECT COSTS (A THROUGH G)							<b>26,444</b>
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) <b>A. Senior Personnel, C. Fringe Benefits (Rate: 56.0000, Base: 26444)</b>							
TOTAL INDIRECT COSTS (F&A)							<b>14,809</b>
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							<b>41,253</b>
K. RESIDUAL FUNDS							<b>0</b>
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ <b>41,253</b>
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME <b>William A Stein</b>				FOR NSF USE ONLY			
ORG. REP. NAME* <b>Laurie Salehi</b>				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

2 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

1020378

# SUMMARY PROPOSAL BUDGET

YEAR 3

ORGANIZATION <b>University of Washington</b>				FOR NSF USE ONLY			
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>William A Stein</b>				PROPOSAL NO.	DURATION (months)		
				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. <b>William A Stein - none</b>				0.00	0.00	2.00	\$ 22,251
2.							
3.							
4.							
5.							
6. ( 0 ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. ( 1 ) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	2.00	22,251
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( 0 ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	0
2. ( 0 ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	0
3. ( 0 ) GRADUATE STUDENTS							0
4. ( 0 ) UNDERGRADUATE STUDENTS							0
5. ( 0 ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0
6. ( 0 ) OTHER							0
TOTAL SALARIES AND WAGES (A + B)							22,251
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							5,251
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							27,502
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ 0							
2. TRAVEL 0							
3. SUBSISTENCE 0							
4. OTHER 0							
TOTAL NUMBER OF PARTICIPANTS ( 0 ) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							27,502
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) <b>A., C. (Rate: 56.0000, Base: 27502)</b>							
TOTAL INDIRECT COSTS (F&A)							15,401
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							42,903
K. RESIDUAL FUNDS							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 42,903
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME <b>William A Stein</b>				FOR NSF USE ONLY			
ORG. REP. NAME* <b>Laurie Salehi</b>				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

3 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

1020378

# SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION <b>University of Washington</b>				FOR NSF USE ONLY			
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>William A Stein</b>				PROPOSAL NO.	DURATION (months)		
				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. <b>William A Stein - none</b>				0.00	0.00	4.00	\$ <b>43,646</b>
2.							
3.							
4.							
5.							
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	<b>0</b>
7. ( <b>1</b> ) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	4.00	<b>43,646</b>
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( <b>0</b> ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	<b>0</b>
2. ( <b>0</b> ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	<b>0</b>
3. ( <b>0</b> ) GRADUATE STUDENTS							<b>0</b>
4. ( <b>0</b> ) UNDERGRADUATE STUDENTS							<b>0</b>
5. ( <b>0</b> ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							<b>0</b>
6. ( <b>0</b> ) OTHER							<b>0</b>
TOTAL SALARIES AND WAGES (A + B)							<b>43,646</b>
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							<b>10,300</b>
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							<b>53,946</b>
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							<b>0</b>
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							<b>0</b>
2. FOREIGN							<b>0</b>
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ <b>0</b>							
2. TRAVEL <b>0</b>							
3. SUBSISTENCE <b>0</b>							
4. OTHER <b>0</b>							
TOTAL NUMBER OF PARTICIPANTS ( <b>0</b> ) TOTAL PARTICIPANT COSTS							<b>0</b>
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							<b>0</b>
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							<b>0</b>
3. CONSULTANT SERVICES							<b>0</b>
4. COMPUTER SERVICES							<b>0</b>
5. SUBAWARDS							<b>0</b>
6. OTHER							<b>0</b>
TOTAL OTHER DIRECT COSTS							<b>0</b>
H. TOTAL DIRECT COSTS (A THROUGH G)							<b>53,946</b>
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)							
TOTAL INDIRECT COSTS (F&A)							<b>30,210</b>
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							<b>84,156</b>
K. RESIDUAL FUNDS							<b>0</b>
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ <b>84,156</b>
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME <b>William A Stein</b>				FOR NSF USE ONLY			
ORG. REP. NAME* <b>Laurie Salehi</b>				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

C \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

## **Budget Justification**

### **A. Salary**

PI is requesting salary for two months each summer starting in year 2 and 3 to participate in this collaborative research with AIMath.org. PI is not planning to work on the project during the summer of year 1. He will be working on another NSF funded project providing support for 2 months of summer salary year 1 which is the FRG L-functions grant through AIM.

In accordance with university estimates, cost-of-living increases have been calculated at 4% annually.

### **C. Benefits**

Benefits are calculated in PI salary at 23.6% according to a negotiated rate established by the university every two years or biennium.

### **I. Indirect Cost**

The Indirect Cost Rate for on-campus research of 56% is the negotiated by the university with the cognizant institution, DHHS, in the agreement of October 13, 2009 .

# SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION				FOR NSF USE ONLY			
<b>University of Colorado at Boulder</b>				PROPOSAL NO.		DURATION (months)	
						Proposed      Granted	
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Marja-Liisa Hassi</b>				AWARD NO.			
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	
				CAL	ACAD	SUMR	Funds granted by NSF (if different)
1. <b>Marja-Liisa Hassi - P.I.</b>				0.60	0.00	0.00	\$ <b>2,871</b>
2. <b>Sandra L Laursen - Research Associate</b>				0.20	0.00	0.00	\$ <b>1,162</b>
3.							
4.							
5.							
6. ( 0 ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	<b>0</b>
7. ( 2 ) TOTAL SENIOR PERSONNEL (1 - 6)				0.80	0.00	0.00	<b>4,033</b>
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( 0 ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	<b>0</b>
2. ( 0 ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	<b>0</b>
3. ( 0 ) GRADUATE STUDENTS							<b>0</b>
4. ( 0 ) UNDERGRADUATE STUDENTS							<b>0</b>
5. ( 0 ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							<b>0</b>
6. ( 0 ) OTHER							<b>0</b>
TOTAL SALARIES AND WAGES (A + B)							<b>4,033</b>
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							<b>1,117</b>
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							<b>5,150</b>
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							<b>0</b>
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							<b>0</b>
2. FOREIGN							<b>0</b>
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____ <b>0</b>							
2. TRAVEL _____ <b>0</b>							
3. SUBSISTENCE _____ <b>0</b>							
4. OTHER _____ <b>0</b>							
TOTAL NUMBER OF PARTICIPANTS ( 0 ) TOTAL PARTICIPANT COSTS							<b>0</b>
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							<b>375</b>
2. PUBLICATION COSTS/DOCUMENTATION/DISEMINATION							<b>45</b>
3. CONSULTANT SERVICES							<b>0</b>
4. COMPUTER SERVICES							<b>0</b>
5. SUBAWARDS							<b>0</b>
6. OTHER							<b>30</b>
TOTAL OTHER DIRECT COSTS							<b>450</b>
H. TOTAL DIRECT COSTS (A THROUGH G)							<b>5,600</b>
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) <b>51.5% MTDC (Rate: 51.5000, Base: 5600)</b>							
TOTAL INDIRECT COSTS (F&A)							<b>2,884</b>
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							<b>8,484</b>
K. RESIDUAL FUNDS							<b>0</b>
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ <b>8,484</b> \$
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$			
PI/PI NAME <b>Marja-Liisa Hassi</b>				FOR NSF USE ONLY			
ORG. REP. NAME* <b>Stefan Reiss</b>				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

1 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

1020687



# SUMMARY PROPOSAL BUDGET

YEAR 2

ORGANIZATION				FOR NSF USE ONLY			
<b>University of Colorado at Boulder</b>				PROPOSAL NO.		DURATION (months)	
						<div style="display: flex; justify-content: space-between;"> <span>Proposed</span> <span>Granted</span> </div>	
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Marja-Liisa Hassi</b>				AWARD NO.			
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	
				CAL	ACAD	SUMR	Funds granted by NSF (if different)
1. <b>Marja-Liisa Hassi - P.I.</b>				2.40	0.00	0.00	\$ <b>11,668</b>
2. <b>Sandra L Laursen - Research Associate</b>				0.20	0.00	0.00	<b>1,181</b>
3.							
4.							
5.							
6. ( 0 ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	<b>0</b>
7. ( 2 ) TOTAL SENIOR PERSONNEL (1 - 6)				2.60	0.00	0.00	<b>12,849</b>
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( 0 ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	<b>0</b>
2. ( 0 ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	<b>0</b>
3. ( 0 ) GRADUATE STUDENTS							<b>0</b>
4. ( 1 ) UNDERGRADUATE STUDENTS							<b>615</b>
5. ( 0 ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							<b>0</b>
6. ( 0 ) OTHER							<b>0</b>
TOTAL SALARIES AND WAGES (A + B)							<b>13,464</b>
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							<b>3,568</b>
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							<b>17,032</b>
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							<b>0</b>
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							<b>2,200</b>
2. FOREIGN							<b>0</b>
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____ <b>0</b>							
2. TRAVEL _____ <b>0</b>							
3. SUBSISTENCE _____ <b>0</b>							
4. OTHER _____ <b>0</b>							
TOTAL NUMBER OF PARTICIPANTS ( 0 ) TOTAL PARTICIPANT COSTS							<b>0</b>
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							<b>252</b>
2. PUBLICATION COSTS/DOCUMENTATION/DISEMINATION							<b>70</b>
3. CONSULTANT SERVICES							<b>0</b>
4. COMPUTER SERVICES							<b>0</b>
5. SUBAWARDS							<b>0</b>
6. OTHER							<b>70</b>
TOTAL OTHER DIRECT COSTS							<b>392</b>
H. TOTAL DIRECT COSTS (A THROUGH G)							<b>19,624</b>
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)							
<b>51.5% MTDC (Rate: 51.5000, Base: 19624)</b>							
TOTAL INDIRECT COSTS (F&A)							<b>10,106</b>
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							<b>29,730</b>
K. RESIDUAL FUNDS							<b>0</b>
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ <b>29,730</b> \$
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$			
PI/PI NAME				FOR NSF USE ONLY			
<b>Marja-Liisa Hassi</b>				INDIRECT COST RATE VERIFICATION			
ORG. REP. NAME*				Date Checked	Date Of Rate Sheet	Initials - ORG	
<b>Stefan Reiss</b>							

2 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

1020687

# SUMMARY PROPOSAL BUDGET

YEAR 3

ORGANIZATION				FOR NSF USE ONLY			
<b>University of Colorado at Boulder</b>				PROPOSAL NO.		DURATION (months)	
						Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Marja-Liisa Hassi</b>				AWARD NO.			
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. <b>Marja-Liisa Hassi - P.I.</b>				3.60	0.00	0.00	\$ 17,782
2. <b>Sandra L Laursen - Research Associate</b>				0.20	0.00	0.00	1,200
3.							
4.							
5.							
6. ( 0 ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. ( 2 ) TOTAL SENIOR PERSONNEL (1 - 6)				3.80	0.00	0.00	18,982
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( 0 ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	0
2. ( 0 ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	0
3. ( 0 ) GRADUATE STUDENTS							0
4. ( 1 ) UNDERGRADUATE STUDENTS							840
5. ( 0 ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0
6. ( 0 ) OTHER							0
TOTAL SALARIES AND WAGES (A + B)							19,822
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							5,270
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							25,092
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							2,800
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ 0							
2. TRAVEL 0							
3. SUBSISTENCE 0							
4. OTHER 0							
TOTAL NUMBER OF PARTICIPANTS ( 0 ) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							255
2. PUBLICATION COSTS/DOCUMENTATION/DISEMINATION							671
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							71
TOTAL OTHER DIRECT COSTS							997
H. TOTAL DIRECT COSTS (A THROUGH G)							28,889
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)							
<b>51.5% MTDC (Rate: 51.5000, Base: 28889)</b>							
TOTAL INDIRECT COSTS (F&A)							14,878
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							43,767
K. RESIDUAL FUNDS							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 43,767
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PI NAME				FOR NSF USE ONLY			
<b>Marja-Liisa Hassi</b>				INDIRECT COST RATE VERIFICATION			
ORG. REP. NAME*				Date Checked	Date Of Rate Sheet	Initials - ORG	
<b>Stefan Reiss</b>							

3 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

1020687

# SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION <b>University of Colorado at Boulder</b>				FOR NSF USE ONLY			
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Marja-Liisa Hassi</b>				PROPOSAL NO.	DURATION (months)		
				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. <b>Marja-Liisa Hassi - P.I.</b>				6.60	0.00	0.00	\$ <b>32,321</b>
2. <b>Sandra L Laursen - Research Associate</b>				0.60	0.00	0.00	<b>3,543</b>
3.							
4.							
5.							
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	<b>0</b>
7. ( <b>2</b> ) TOTAL SENIOR PERSONNEL (1 - 6)				7.20	0.00	0.00	<b>35,864</b>
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( <b>0</b> ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	<b>0</b>
2. ( <b>0</b> ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	<b>0</b>
3. ( <b>0</b> ) GRADUATE STUDENTS							<b>0</b>
4. ( <b>2</b> ) UNDERGRADUATE STUDENTS							<b>1,455</b>
5. ( <b>0</b> ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							<b>0</b>
6. ( <b>0</b> ) OTHER							<b>0</b>
TOTAL SALARIES AND WAGES (A + B)							<b>37,319</b>
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							<b>9,955</b>
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							<b>47,274</b>
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							<b>0</b>
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							<b>5,000</b>
2. FOREIGN							<b>0</b>
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ <b>0</b>							
2. TRAVEL <b>0</b>							
3. SUBSISTENCE <b>0</b>							
4. OTHER <b>0</b>							
TOTAL NUMBER OF PARTICIPANTS ( <b>0</b> ) TOTAL PARTICIPANT COSTS							<b>0</b>
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							<b>882</b>
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							<b>786</b>
3. CONSULTANT SERVICES							<b>0</b>
4. COMPUTER SERVICES							<b>0</b>
5. SUBAWARDS							<b>0</b>
6. OTHER							<b>171</b>
TOTAL OTHER DIRECT COSTS							<b>1,839</b>
H. TOTAL DIRECT COSTS (A THROUGH G)							<b>54,113</b>
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)							
TOTAL INDIRECT COSTS (F&A)							<b>27,868</b>
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							<b>81,981</b>
K. RESIDUAL FUNDS							<b>0</b>
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ <b>81,981</b>
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME <b>Marja-Liisa Hassi</b>				FOR NSF USE ONLY			
ORG. REP. NAME* <b>Stefan Reiss</b>				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

C \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

## **Budget Justification: University of Colorado at Boulder**

### **Collaborative Research: UTMOST: Undergraduate Teaching in Mathematics with Open Software and Textbooks**

A three-year budget is requested for the period September 1, 2010, through August 31, 2013.

Funds are requested to cover salaries for PI Marja-Liisa Hassi and research associate Sandra Laursen. Benefits are budgeted at the current campus rate of 27.7% for all research faculty. Salaries and other costs are budgeted with 1.6% annual inflation.

Hassi will design research protocols, conduct telephone and in-person interviews, focus groups, and workshop observations, and will analyze and interpret data and write up findings. Laursen will assist with study design and with financial monitoring and reporting to NSF.

We also budget 140 hours (total) of hourly wages for undergraduate student workers to transcribe recorded interviews and complete other data entry tasks, with an annual increase of \$0.25/hr and benefits at 1.4%.

The travel budget includes field work, project meetings and conference presentations, as follows:

- 1 trip each in Years 2 and 3 to observe workshops and conduct focus groups with participants. Each is budgeted at \$1200 to cover airfare, local travel, lodging, and per diem for 3 nights for 1 researcher each.
- 1 site visit in Year 2 to visit a campus where the UTMOST methods are being adopted, budgeted at \$1000 to cover airfare, local travel, lodging and per diem for 2 nights for 1 researcher.
- 1 professional meeting in Year 3 to disseminate findings. Each is budgeted at \$1600 to cover registration, airfare, local travel, lodging and per diem for 3 nights for 1 researcher each.

Materials and equipment include printing costs for reports, digital media storage for recorded interviews, digital recording equipment, and cables and replacement parts. Research materials include copies of curriculum and other instructional materials used by the study sites, and essential reference publications on computer-aided. Software and licensing fees include N'vivo for qualitative data analysis and SPSS for quantitative data analysis. We budget for copying and shipping of hard-copy informed consent forms and final reports to workshop and study sites, and for long-distance communications for project planning and telephone interviews with study participants. Publication costs are budgeted at \$600 in Year 3 to cover journal costs of publishing an article resulting from the project.

# SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION <b>Drake University</b>				FOR NSF USE ONLY			
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Jason N Grout</b>				PROPOSAL NO.	DURATION (months)		
				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. <b>Jason N Grout - Assistant Professor</b>				0.00	0.00	2.00	\$ 12,480
2.							
3.							
4.							
5.							
6. ( 0 ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. ( 1 ) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	2.00	12,480
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( 0 ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	0
2. ( 0 ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	0
3. ( 0 ) GRADUATE STUDENTS							0
4. ( 0 ) UNDERGRADUATE STUDENTS							0
5. ( 0 ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0
6. ( 0 ) OTHER							0
TOTAL SALARIES AND WAGES (A + B)							12,480
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							1,086
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							13,566
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ 0							
2. TRAVEL 0							
3. SUBSISTENCE 0							
4. OTHER 0							
TOTAL NUMBER OF PARTICIPANTS ( 0 ) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							13,566
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)							
<b>Drake University indirect costs (Rate: 30.0000, Base: 13566)</b>							
TOTAL INDIRECT COSTS (F&A)							4,070
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							17,636
K. RESIDUAL FUNDS							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 17,636
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME <b>Jason N Grout</b>				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

1 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

# SUMMARY PROPOSAL BUDGET

YEAR **2**

ORGANIZATION <b>Drake University</b>				FOR NSF USE ONLY			
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Jason N Grout</b>				PROPOSAL NO.	DURATION (months)		
				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. <b>Jason N Grout - Assistant Professor</b>				0.00	0.00	2.00	\$ <b>12,979</b>
2.							
3.							
4.							
5.							
6. ( <b>0</b> ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	<b>0</b>
7. ( <b>1</b> ) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	2.00	<b>12,979</b>
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( <b>0</b> ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	<b>0</b>
2. ( <b>0</b> ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	<b>0</b>
3. ( <b>0</b> ) GRADUATE STUDENTS							<b>0</b>
4. ( <b>0</b> ) UNDERGRADUATE STUDENTS							<b>0</b>
5. ( <b>0</b> ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							<b>0</b>
6. ( <b>0</b> ) OTHER							<b>0</b>
TOTAL SALARIES AND WAGES (A + B)							<b>12,979</b>
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							<b>1,129</b>
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							<b>14,108</b>
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							<b>0</b>
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							<b>0</b>
2. FOREIGN							<b>0</b>
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ <b>0</b>							
2. TRAVEL <b>0</b>							
3. SUBSISTENCE <b>0</b>							
4. OTHER <b>0</b>							
TOTAL NUMBER OF PARTICIPANTS ( <b>0</b> ) TOTAL PARTICIPANT COSTS							<b>0</b>
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							<b>0</b>
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							<b>0</b>
3. CONSULTANT SERVICES							<b>0</b>
4. COMPUTER SERVICES							<b>0</b>
5. SUBAWARDS							<b>0</b>
6. OTHER							<b>0</b>
TOTAL OTHER DIRECT COSTS							<b>0</b>
H. TOTAL DIRECT COSTS (A THROUGH G)							<b>14,108</b>
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) <b>Drake University indirect costs (Rate: 30.0000, Base: 14108)</b>							
TOTAL INDIRECT COSTS (F&A)							<b>4,232</b>
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							<b>18,340</b>
K. RESIDUAL FUNDS							<b>0</b>
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ <b>18,340</b> \$
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME <b>Jason N Grout</b>				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

2 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

# SUMMARY PROPOSAL BUDGET

YEAR 3

ORGANIZATION <b>Drake University</b>				FOR NSF USE ONLY			
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Jason N Grout</b>				PROPOSAL NO.	DURATION (months)		
				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. <b>Jason N Grout - Assistant Professor</b>				0.00	0.00	2.00	\$ 13,498
2.							
3.							
4.							
5.							
6. ( 0 ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. ( 1 ) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	2.00	13,498
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( 0 ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	0
2. ( 0 ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	0
3. ( 0 ) GRADUATE STUDENTS							0
4. ( 0 ) UNDERGRADUATE STUDENTS							0
5. ( 0 ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0
6. ( 0 ) OTHER							0
TOTAL SALARIES AND WAGES (A + B)							13,498
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							1,174
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							14,672
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ 0							
2. TRAVEL 0							
3. SUBSISTENCE 0							
4. OTHER 0							
TOTAL NUMBER OF PARTICIPANTS ( 0 ) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							14,672
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)							
<b>Drake University indirect costs (Rate: 30.0000, Base: 14672)</b>							
TOTAL INDIRECT COSTS (F&A)							4,402
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							19,074
K. RESIDUAL FUNDS							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 19,074
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME <b>Jason N Grout</b>				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

3 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

# SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION <b>Drake University</b>				FOR NSF USE ONLY			
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Jason N Grout</b>				PROPOSAL NO.	DURATION (months)		
				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. <b>Jason N Grout - Assistant Professor</b>				0.00	0.00	6.00	\$ <b>38,957</b>
2.							
3.							
4.							
5.							
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	<b>0</b>
7. ( <b>1</b> ) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	6.00	<b>38,957</b>
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( <b>0</b> ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	<b>0</b>
2. ( <b>0</b> ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	<b>0</b>
3. ( <b>0</b> ) GRADUATE STUDENTS							<b>0</b>
4. ( <b>0</b> ) UNDERGRADUATE STUDENTS							<b>0</b>
5. ( <b>0</b> ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							<b>0</b>
6. ( <b>0</b> ) OTHER							<b>0</b>
TOTAL SALARIES AND WAGES (A + B)							<b>38,957</b>
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							<b>3,389</b>
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							<b>42,346</b>
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							<b>0</b>
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							<b>0</b>
2. FOREIGN							<b>0</b>
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ <b>0</b>							
2. TRAVEL <b>0</b>							
3. SUBSISTENCE <b>0</b>							
4. OTHER <b>0</b>							
TOTAL NUMBER OF PARTICIPANTS ( <b>0</b> ) TOTAL PARTICIPANT COSTS							<b>0</b>
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							<b>0</b>
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							<b>0</b>
3. CONSULTANT SERVICES							<b>0</b>
4. COMPUTER SERVICES							<b>0</b>
5. SUBAWARDS							<b>0</b>
6. OTHER							<b>0</b>
TOTAL OTHER DIRECT COSTS							<b>0</b>
H. TOTAL DIRECT COSTS (A THROUGH G)							<b>42,346</b>
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)							
TOTAL INDIRECT COSTS (F&A)							<b>12,704</b>
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							<b>55,050</b>
K. RESIDUAL FUNDS							<b>0</b>
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ <b>55,050</b> \$
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME <b>Jason N Grout</b>				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

C \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET



## Budget Justification Page

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Summer salary for Jason Grout is for six months (two months each of three summers) with a 4% increase each year.

(See GPG Section II.C.2.h for guidance on information to include on this form.)

Investigator: Robert Beezer

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ \*Transfer of Support  
Project/Proposal Title: UTMOST: Undergraduate Teaching in Mathematics with Open Software and Textbooks

Person-Months Per Year Committed to the Project.    Cal:0.00    Acad: 0.00    Sumr: 2.00

Person-Months Per Year Committed to the Project.	Cal:0.00	Acad: 9.00	Sumr: 0.00
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Person-Months Per Year Committed to the Project.	Cal:0.00	Acad: 0.00	Sumr: 0.50
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Person-Months Per Year Committed to the Project.      Cal:              Acad:              Sumr:

Person-Months Per Year Committed to the Project.	Cal:	Acad:	Summ:
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(See GPG Section II.C.2.h for guidance on information to include on this form.)

Investigator: Kiran Kedlaya

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ \*Transfer of Support

Project/Proposal Title: Cohomological methods in algebraic geometry and number theory

Person-Months Per Year Committed to the Project.    Cal:0.00    Acad: 0.00    Sumr: 2.00

Person-Months Per Year Committed to the Project.      Cal:              Acad:              Sumr:

Person-Months Per Year Committed to the Project.      Cal:              Acad:              Sumr:

Person-Months Per Year Committed to the Project.      Cal:              Acad:              Sumr:

Person-Months Per Year Committed to the Project.	Cal:	Acad:	Summ:
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## Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.			
Investigator: Thomas Judson	Other agencies (including NSF) to which this proposal has been/will be submitted.		
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:    UTMOST: Undergraduate Teaching in Mathematics with Open Software and Textbooks  Source of Support:    National Science Foundation Total Award Amount: \$    45,986 Total Award Period Covered:    09/01/10 - 08/31/13 Location of Project:    Stephen F. Austin State University Person-Months Per Year Committed to the Project.    Cal:0.00    Acad: 0.00    Sumr: 1.25			
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:    Texas Leadership Initiative: Mathematics Instruction Transformed (Texas LIMIT)  Source of Support:    National Science Foundation Total Award Amount: \$    1,494,187 Total Award Period Covered:    06/01/09 - 05/31/15 Location of Project:    Stephen F. Austin State University Person-Months Per Year Committed to the Project.    Cal:0.00    Acad: 1.35    Sumr: 0.50			
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:    Texas Middle and Secondary Mathematics Project - Supplemental Funds  Source of Support:    National Science Foundation Total Award Amount: \$    581,821 Total Award Period Covered:    09/11/08 - 09/30/12 Location of Project:    Stephen F. Austin State University Person-Months Per Year Committed to the Project.    Cal:0.00    Acad: 1.13    Sumr: 0.75			
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:  Source of Support: Total Award Amount: \$    Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project.    Cal:    Acad:    Sumr:			
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:  Source of Support: Total Award Amount: \$    Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project.    Cal:    Acad:    Summ:			

\*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

## Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: William Stein	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:    SAGE Software for Algebra and Geometry Experimentation
Source of Support:    NSF Total Award Amount: \$    144,543 Total Award Period Covered:    07/15/07 - 06/30/10 Location of Project:    University of Washington Person-Months Per Year Committed to the Project.    Cal:0.00    Acad: 0.00    Sumr: 0.00

Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:    Explicit Approaches to the Birch and Swinnerton-Dyer Conjecture
Source of Support:    NSF Total Award Amount: \$    129,994 Total Award Period Covered:    09/01/07 - 08/31/10 Location of Project:    University of Washington Person-Months Per Year Committed to the Project.    Cal:0.00    Acad: 0.00    Sumr: 2.00

Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:    SCREMS: The Computational Frontiers of Number Theory, Representation Theory and Mathematical Physics
Source of Support:    NSF Total Award Amount: \$    106,869 Total Award Period Covered:    09/01/08 - 08/31/11 Location of Project:    University of Washington Person-Months Per Year Committed to the Project.    Cal:0.00    Acad: 0.00    Sumr: 0.00

Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:    SAGE: Unifying Mathematical Software for Scientists, Engineers and Mathematicians
Source of Support:    NSF Total Award Amount: \$    239,358 Total Award Period Covered:    07/01/10 - 06/30/13 Location of Project:    University of Washington Person-Months Per Year Committed to the Project.    Cal:0.00    Acad: 0.00    Sumr: 0.50

Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:    UTMOST: Undergraduate Teaching in Mathematics with Open Software and Textbooks
Source of Support:    NSF via AIMath.org (collaborative research) Total Award Amount: \$    84,155 Total Award Period Covered:    09/01/10 - 08/31/13 Location of Project:    University of Washington Person-Months Per Year Committed to the Project.    Cal:0.00    Acad: 0.00    Summ: 2.00

\*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

## Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Marja-Liisa Hassi	Other agencies (including NSF) to which this proposal has been/will be submitted.
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Support:	<input checked="" type="checkbox"/> Current	<input type="checkbox"/> Pending	<input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support
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Project/Proposal Title:      Assessment and Evaluation Center for Transforming American Mathematics Education through the Inquiry-Based Learning in Mathematics Project

Source of Support:      Educational Advancement Foundation

Total Award Amount: \$      520,000      Total Award Period Covered:      10/01/07 - 12/31/10

Location of Project:      The University of Colorado at Boulder

Person-Months Per Year Committed to the Project.      Cal:      8.0      Acad:      Sumr:

Support:	<input type="checkbox"/> Current	<input checked="" type="checkbox"/> Pending	<input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support
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Project/Proposal Title:      The Challenge of Change: Studying a Model for Transforming Courses, Instructors and Departments at a Research-extensive University

Source of Support:      NSF-CCLI Phase 1

Total Award Amount:      \$199,986      Total Award Period Covered:      2/1/10-4/30/11

Location of Project:      University of Colorado at Boulder

Person-Months Per Year Committed to the Project.      Cal:      2.0      Acad:      Sumr:

Support:	<input type="checkbox"/> Current	<input checked="" type="checkbox"/> Pending	<input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support
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Project/Proposal Title:      Collaborative Research: UTMOST: Undergraduate Teaching in Mathematics with Open Software and Textbooks (this proposal). Note: Budget figure is for CU portion (for evaluation work only).

Source of Support:      NSF CCLI Phase 2

Total Award Amount: \$      81,981      Total Award Period Covered:      09/01/2010-08/31/2013

Location of Project:      The University of Colorado at Boulder

Person-Months Per Year Committed to the Project.      Cal:      2.2      Acad:      Sumr:

Support:	<input type="checkbox"/> Current	<input type="checkbox"/> Pending	<input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support
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Project/Proposal Title:

Source of Support:

Total Award Amount: \$      Total Award Period Covered:

Location of Project:      The University of Colorado at Boulder

Person-Months Per Year Committed to the Project.      Cal:      Acad:      Sumr:

Support:	<input type="checkbox"/> Current	<input type="checkbox"/> Pending	<input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support
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Project/Proposal Title:

Source of Support:

Total Award Amount: \$      Total Award Period Covered:

Location of Project:      The University of Colorado at Boulder

Person-Months Per Year Committed to the Project.      Cal:      Acad:      Sumr:

\*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

## Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.			
Investigator: Sandra Laursen	Other agencies (including NSF) to which this proposal has been/will be submitted.		
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support			
Project/Proposal Title:    Collaborative Research: Research, Dissemination, and Faculty Development of Inquiry-Based Learning (IBL) Methods in the Teaching and Learning of Mathematics.			
Source of Support:    NSF CCLI Phase 2			
Total Award Amount: \$    89,715    Total Award Period Covered:    12/01/2009-11/30/2012			
Location of Project:    The University of Colorado at Boulder			
Person-Months Per Year Committed to the Project.    Cal:    1.0    Acad:    Sumr:			
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support			
Project/Proposal Title:    Undergraduate Biological Sciences Education Initiative (evaluation for this project). Note: Figure listed is for the evaluation component only.			
Source of Support:    Howard Hughes Medical Institute			
Total Award Amount: \$    200,497    Total Award Period Covered:    10/01/06 – 9/30/10			
Location of Project:    The University of Colorado at Boulder			
Person-Months Per Year Committed to the Project.    Cal:    1.3    Acad:    Sumr:			
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support			
Project/Proposal Title:    Assessment and Evaluation Center for Transforming American Mathematics Education through the Inquiry-Based Learning in Mathematics Project			
Source of Support:    Educational Advancement Foundation			
Total Award Amount: \$    520,000    Total Award Period Covered:    10/01/2007 - 12/31/2010			
Location of Project:    The University of Colorado at Boulder			
Person-Months Per Year Committed to the Project.    Cal:    4.2    Acad:    Sumr:			
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support			
Project/Proposal Title:    Mapping the Extent and Character of the Undergraduate Research Experience at Public Research Universities: An Exploratory Study (supplemental award)			
Source of Support:    NSF			
Total Award Amount: \$    49,772    Total Award Period Covered:    9/01/2009-8/31/2010			
Location of Project:    The University of Colorado at Boulder			
Person-Months Per Year Committed to the Project.    Cal:    0.45    Acad:    Sumr:			
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support			
Project/Proposal Title:    REESE: Professional Socialization and Career Selection in Ph.D. Science Education: An Empirical Research Study			
Source of Support:    NSF-DRL			
Total Award Amount: \$    554,792    Total Award Period Covered:    9/1/2007-8/31/2010			
Location of Project:    The University of Colorado at Boulder			
Person-Months Per Year Committed to the Project.    Cal:    2.4    Acad:    Sumr:			

## Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

Investigator: Sandra Laursen	Other agencies (including NSF) to which this proposal has been/will be submitted.
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Support:	<input checked="" type="checkbox"/> Current	<input type="checkbox"/> Pending	<input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support
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Project/Proposal Title: Collaborative Research: Atmospheric Science Collaborations and Enriching NeTworks (ASCENT). Figure shown is for evaluation portion of this project.

Source of Support: NSF ADVANCE PAID

Total Award Amount: \$ 52,000      Total Award Period Covered: 09/01/2008-8/31/0211

Location of Project: The University of Colorado at Boulder

Person-Months Per Year Committed to the Project.      Cal: 0.5      Acad:      Sumr:

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Support:	<input type="checkbox"/> Current	<input checked="" type="checkbox"/> Pending	<input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support
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Project/Proposal Title: Collaborative Research: UTMOST: Undergraduate Teaching in Mathematics with Open Software and Textbooks (this proposal). Note: budget figure is for CU portion of collaborative (for evaluation work only).

Source of Support: NSF CCLI Phase 2

Total Award Amount: \$ 81,981      Total Award Period Covered: 09/01/2010-08/31/2013

Location of Project: The University of Colorado at Boulder

Person-Months Per Year Committed to the Project.      Cal: 0.2      Acad:      Sumr:

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Support:	<input checked="" type="checkbox"/> Current	<input type="checkbox"/> Pending	<input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support
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Project/Proposal Title: Collaborative Research: Facilitating career advancement for women in the geosciences through the Earth Science Women's Network (ESWN). Note: Figure is for CU Boulder portion of collaborative (for evaluation of the network).

Source of Support: NSF ADVANCE PAID

Total Award Amount: \$ 173,196      Total Award Period Covered: 09/01/2009-08/31/2013

Location of Project: The University of Colorado at Boulder

Person-Months Per Year Committed to the Project.      Cal: 1.0      Acad:      Sumr:

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Support:	<input checked="" type="checkbox"/> Current	<input type="checkbox"/> Pending	<input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support
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Project/Proposal Title: PAID: How Do Organizational Change Strategies Support the Success of Women Scholars in STEM Fields? An Analysis of NSF ADVANCE Programs.

Source of Support: NSF ADVANCE PAID

Total Award Amount: \$ 775,291      Total Award Period Covered: 1/01/2010-12/31/2012

Location of Project: Michigan State University

Person-Months Per Year Committed to the Project.      Cal: 1.5      Acad:      Sumr:

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Support:	<input type="checkbox"/> Current	<input checked="" type="checkbox"/> Pending	<input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support
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Project/Proposal Title: The Challenge of Change: Studying a Model for Transforming Courses, Instructors and Departments at a Research-extensive University

Source of Support: NSF-CCLI Phase 1

Total Award Amount: \$199,986      Total Award Period Covered: 2/1/2010-4/30/2011

Location of Project: University of Colorado at Boulder

Person-Months Per Year Committed to the Project.      Cal: 0.6      Acad:      Sumr:

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\*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.



**(See GPG Section II.D.8 for guidance on information to include on this form.)**

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Sandra Laursen	Other agencies (including NSF) to which this proposal has been/will be submitted.
<div>Support:    <input type="checkbox"/> Current    <input checked="" type="checkbox"/> Pending    <input type="checkbox"/> Submission Planned in Near Future    <input type="checkbox"/> *Transfer of Support</div> <div>Project/Proposal Title:    Development of a Research-Based Student-Centered Nature of Science Assessment</div> <div>Source of Support:    NSF CCLI Phase 1</div> <div>Total Award Amount: \$    198,441    Total Award Period Covered:    10/1/2009 - 9/30/2012</div> <div>Location of Project:    The University of Colorado at Boulder</div> <div>Person-Months Per Year Committed to the Project.    Cal:    1.35    Acad:    Sumr:</div>	
<div>Support:    <input type="checkbox"/> Current    <input checked="" type="checkbox"/> Pending    <input type="checkbox"/> Submission Planned in Near Future    <input type="checkbox"/> *Transfer of Support</div> <div>Project/Proposal Title:    Facilitating Change in Undergraduate STEM: An International Interdisciplinary Collaboration to Improve Change Strategies and Theories</div> <div>Source of Support:    NSF PIRE</div> <div>Total Award Amount: \$    401,129    Total Award Period Covered:    7/1/2010 - 6/30/2015</div> <div>Location of Project:    Western Michigan University</div> <div>Person-Months Per Year Committed to the Project.    Cal:    1.0    Acad:    Sumr:</div>	
<div>Support:    <input type="checkbox"/> Current    <input checked="" type="checkbox"/> Pending    <input type="checkbox"/> Submission Planned in Near Future    <input type="checkbox"/> *Transfer of Support</div> <div>Project/Proposal Title:    Collaborative Research on Out-of-School-Time Science Programs for Youth: Qualitative Research and Longitudinal Survey Design</div> <div>Source of Support:    NSF Informal Science Education</div> <div>Total Award Amount: \$    1,031,355    Total Award Period Covered:    07/01/2010 - 06/30/2014</div> <div>Location of Project:    The University of Colorado at Boulder</div> <div>Person-Months Per Year Committed to the Project.    Cal:    3.0    Acad:    Sumr:</div>	
<div>Support:    <input type="checkbox"/> Current    <input type="checkbox"/> Pending    <input type="checkbox"/> Submission Planned in Near Future    <input type="checkbox"/> *Transfer of Support</div> <div>Project/Proposal Title:</div> <div>Source of Support:</div> <div>Total Award Amount: \$    Total Award Period Covered:</div> <div>Location of Project:    The University of Colorado at Boulder</div> <div>Person-Months Per Year Committed to the Project.    Cal:    Acad:    Sumr:</div>	
<div>Support:    <input type="checkbox"/> Current    <input type="checkbox"/> Pending    <input type="checkbox"/> Submission Planned in Near Future    <input type="checkbox"/> *Transfer of Support</div> <div>Project/Proposal Title:</div> <div>Source of Support:</div> <div>Total Award Amount: \$    Total Award Period Covered:</div> <div>Location of Project:    University of Colorado-Boulder</div> <div>Person-Months Per Year Committed to the Project.    Cal:    Acad:    Sumr:</div>	

\*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

## Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: Jason Grout	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Collaborative Research: UTMOST: Undergraduate Teaching in Mathematics with Open Software and Textbooks (this proposal). Note: budget figure is only for Drake portion of	Source of Support: NSF Total Award Amount: \$ 55,050 Total Award Period Covered: 09/01/10 - 08/31/13 Location of Project: Drake University Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 2.00
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Sage: Using Open-Source Mathematics Software with Undergraduates (PREP program)	Source of Support: Mathematical Association of America Total Award Amount: \$ 10,400 Total Award Period Covered: 05/01/10 - 08/31/10 Location of Project: Various Locations Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.50
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	Source of Support: Total Award Amount: \$                      Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal:                      Acad:                      Sumr:
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	Source of Support: Total Award Amount: \$                      Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal:                      Acad:                      Sumr:
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	Source of Support: Total Award Amount: \$                      Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal:                      Acad:                      Summ:

\*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

## FACILITIES, EQUIPMENT & OTHER RESOURCES

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**FACILITIES:** Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. USE additional pages as necessary.

**Laboratory:**

**Clinical:**

**Animal:**

**Computer:** The PI will have a new laptop computer provided by the University of Puget Sound. The Department of Mathematics and Computer Science has two student laboratory spaces with approximately 45 desktop computers and maintains several Windows and Linux servers.

**Office:** The PI has a private office at the University of Puget Sound (Thompson 303) with an older, insufficient, desktop computer.

**Other:**

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**MAJOR EQUIPMENT:** List the most important items available for this project and, as appropriate identifying the location and pertinent capabilities of each.

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**OTHER RESOURCES:** Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.

The American Institute of Mathematics will provide secretarial, clerical and budget support for grant administration.

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## **FACILITIES, EQUIPMENT & OTHER RESOURCES**

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**Continuation Page:**

COMPUTER FACILITIES (continued):

## FACILITIES, EQUIPMENT & OTHER RESOURCES

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**FACILITIES:** Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. USE additional pages as necessary.

**Laboratory:** Laboratory space will be in the teaching lab and research labs in the Department of Mathematics and Statistics within the SFA College of Science and Mathematics. The Department has dedicated laboratory classrooms for computer-based instruction.

**Clinical:** NA

**Animal:** NA

**Computer:** The Department of Mathematics and Statistics currently operates two computer laboratories for classroom use and maintains up-to-date statistics, computer algebra, and dynamic geometry software on computers in these labs.

**Office:** The proposed PI at SFA has his own offices and desktop computer which will be used during the project period.

**Other:** NA

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**MAJOR EQUIPMENT:** List the most important items available for this project and, as appropriate identifying the location and pertinent capabilities of each.

NA

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**OTHER RESOURCES:** Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.

NA

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## FACILITIES, EQUIPMENT & OTHER RESOURCES

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**FACILITIES:** Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. USE additional pages as necessary.

**Laboratory:**

**Clinical:**

**Animal:**

**Computer:** Mathematics Department facilities at the University of Washington for research/administrative computing: Windows 2003 R2 SP2 File/Print Server - 1.5TB disk storage, 4 Xeon Processors at 2GHz, 4GB RAM RHEL 3 Web Server - 36GB disk storage, 2 Pentium III Processors at 800MHz, 2GB RAM RHEL 3

**Office:** PI has a private office, Padelford C423.

**Other:**

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**MAJOR EQUIPMENT:** List the most important items available for this project and, as appropriate identifying the location and pertinent capabilities of each.

---

**OTHER RESOURCES:** Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.

Library Facilities are available both within the department an on the main campus.

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## FACILITIES, EQUIPMENT & OTHER RESOURCES

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Continuation Page:

### COMPUTER FACILITIES (continued):

Email Server - 36GB disk storage, 2 Pentium III Processors at 800MHz, 2GB  
RAM RHEL 3 Compute Servers (2) - 36GB disk storage, 2 Pentium III  
Processors at 800MHz, 2GB RAM.

## FACILITIES, EQUIPMENT & OTHER RESOURCES

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**FACILITIES:** Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. USE additional pages as necessary.

**Laboratory:**

**Clinical:**

**Animal:**

**Computer:** The proposed PI at Drake University has his own computer which will be used during the project period.

**Office:** The proposed PI at Drake University has his own office which will be used during the project period.

**Other:**

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**MAJOR EQUIPMENT:** List the most important items available for this project and, as appropriate identifying the location and pertinent capabilities of each.

---

**OTHER RESOURCES:** Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.

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January 7, 2010

Dear Rob Beezer,

The Reed College Mathematics Department would like to serve as a test-site for UTMOST. We are excited by the prospect of using your Abstract Algebra materials as a basis for our course on the subject during the 2011–12 academic year, and would devote at least one course the following year to your project.

Reed is a private residential college of liberal arts and sciences with an enrollment of approximately 1400 students, located in Portland, Oregon. Our academic program is highly structured, balancing broad distribution requirements with in-depth study in a particular field, including a year-long undergraduate thesis project, culminating in a written document and oral defense before faculty members. A high percentage of our students go on to graduate school. Our Department considers it a measure of our success to currently have four alumni pursuing PhDs in mathematics at the University of Chicago.

We believe that our experience will be of value to your project. Open source textbooks have long been an integral part of our local culture. A distinctive feature of our mathematics program is a rigorous first-year analysis course, Math 112, designed to teach the reading and writing of mathematics. For more than 20 years, many of us have based Math 112 on various notes created in-house. The following year-long sophomore multivariable class also typically uses in-house notes. Our beginning statistics course always uses notes developed by our statistician, Albyn Jones. See the links provided below for these and other examples.

We have also long-discussed the appropriate use of computers in the classroom and are aware of some of the pitfalls and the advantages. The prevailing attitude might be described as “a healthy skepticism.” We have experience using Mathematica, Maple, R, Sage and other software both in the classroom and as research tools.

The Department has agreed to have Rao Potluri teach Abstract Algebra using your materials in Spring 2012. Rao may be a perfect candidate: he has the most experience teaching our Abstract Algebra course; he is really good at teaching this course; he has almost no experience with Sage; and he is very enthusiastic about learning to use Sage. In the following academic year, 2012–13, we guarantee to again designate at least one course towards your project. Since you are planning on developing more material, it makes sense to not specify a particular course at this time.

The Reed College Mathematics Department is eager to explore the new possibilities for our curriculum promised by UTMOST.

Sincerely,



James D. Fix  
Chair, Department of Mathematics  
Reed College, Portland OR 97202

Examples of our course notes:

- Calculus (Math 111) and Introductory to Analysis (Math 112): [www.reed.edu/~mayer](http://www.reed.edu/~mayer).
- Multivariable Calculus: [www.reed.edu/~jerry/211/vcalc.html](http://www.reed.edu/~jerry/211/vcalc.html).
- Statistics: [www.reed.edu/~jones/141/Statistics.pdf](http://www.reed.edu/~jones/141/Statistics.pdf)
- Advanced Analysis: [www.reed.edu/~davidp/321notes.pdf](http://www.reed.edu/~davidp/321notes.pdf).
- Logic: [www.reed.edu/~wieting/essays/MathLogic.pdf](http://www.reed.edu/~wieting/essays/MathLogic.pdf).



# STEPHEN F. AUSTIN STATE UNIVERSITY

## Department of Mathematics and Statistics

P.O. Box 13040 - SFA Station Nacogdoches, Texas 75962-3040  
Phone: (936) 468-3805 FAX: (936) 468-1669

January 7, 2010

Dr. Robert A. Beezer  
Department of Mathematics and Computer Science  
University of Puget Sound  
1500 N. Warner  
Tacoma, WA 98416-1043

Dear Dr. Beezer:

The purpose of this letter is to communicate the support of Stephen F. Austin State University (SFA) for participation in the National Science Foundation project you are proposing under the Course, Curriculum, and Laboratory Improvement Initiative. We believe that this educational project offers great opportunities for leveraging the power of mathematics software through integration with open-source curriculum and textbooks.

SFA is a comprehensive, regional university with an annual enrollment of approximately 12,000 students and a rich history of commitment to outstanding teaching. This university offers undergraduates more than 80 majors and 120 areas of study from six colleges, and graduate students may choose from approximately 50 master's degrees and three doctoral degrees. In addition to the undergraduate major in mathematics, the Department of Mathematics and Statistics offers undergraduate minors in mathematics and applied statistics and graduate majors in mathematics, statistics, and mathematics teaching. Although SFA attracts a significant number of students from the Dallas and Houston metropolitan areas, the largest percentage of students are from rural East Texas. This student population faces significant financial obstacles to completing a college degree, so a project making sophisticated software and linked textbooks available at little or no cost to students is exciting for students and faculty alike.

Several faculty members in the Department of Mathematics and Statistics have expressed great enthusiasm about teaching courses using available open-source textbooks and the Sage software. We would welcome the opportunity to serve as a test site during project implementation and will commit to adjusting course schedules to accommodate such participation.

As a department chair, I am excited about the opportunity to support a project that holds such potential for transforming mathematics education.

Sincerely,

Deborah A. Pace  
Professor and Chair



December 23, 2009

Department of Mathematics  
CSU Dominguez Hills  
1000 E Victoria Street  
Carson, CA 90747

Robert A. Beezer  
Department of Mathematics and Computer Science  
University of Puget Sound  
1500 N Warner  
Tacoma, WA 98416-1043

Dear Professor Beezer,

Dr. Wai Yan Pong has brought to my attention of his involvement in the NSF grant that your group is applying. We are supportive for Dr. Pong's participation. If the grant application is successful, we will have one of our faculty members, most likely Dr. Pong at the beginning, to teach either a course in linear algebra, abstract algebra or number theory in the 2011-2012 academic year using SAGE related materials. We understand there will be evaluations of how this works for the faculty member as well as the students.

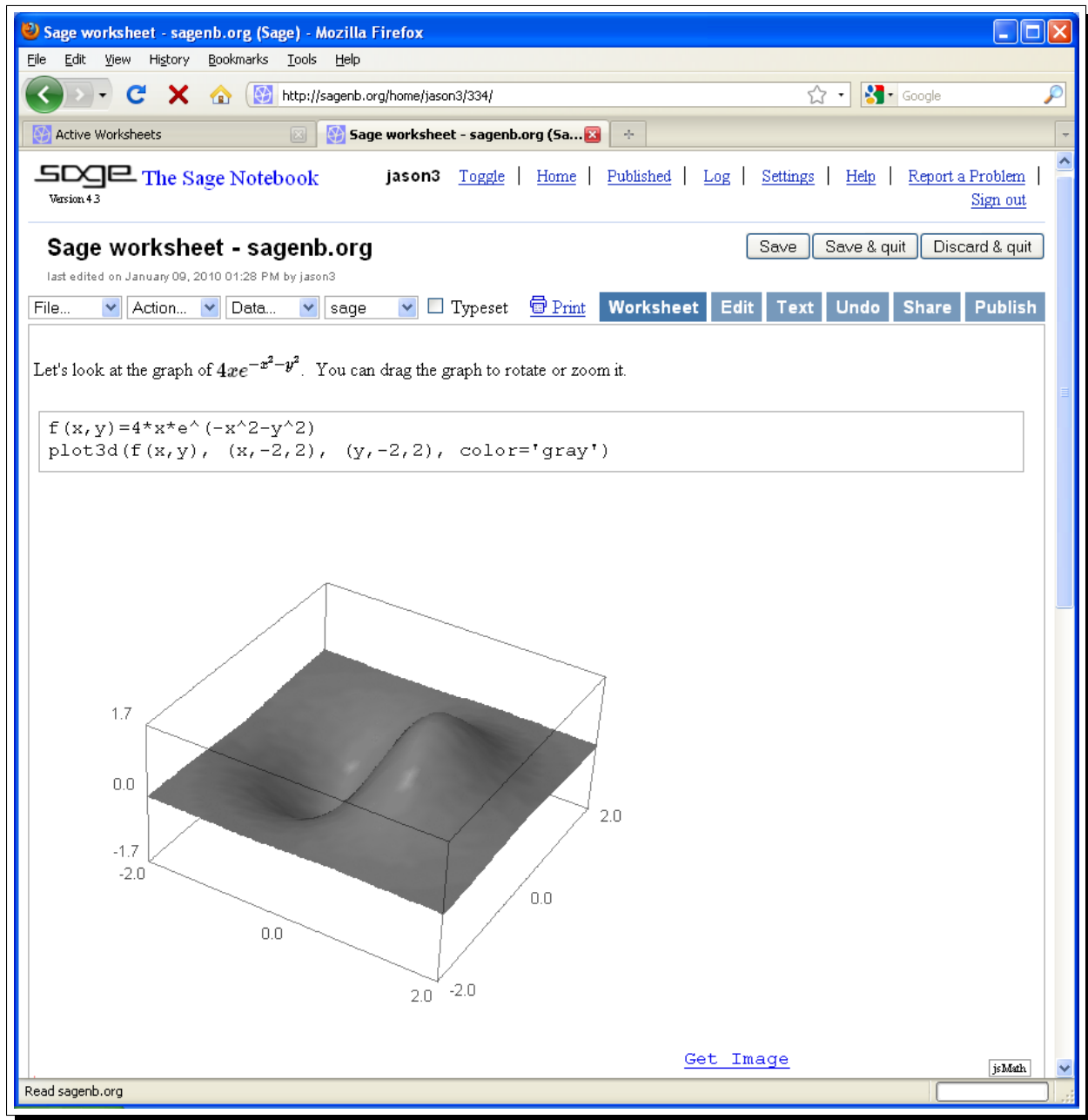
As a matter of fact, our department is exploring different ways of using SAGE. We have already set up our own SAGE server and are looking for different ways to incorporate it into our courses. Your invitation to Dr. Pong presents a perfect opportunity to help us achieve this goal.

Feel free to contact me if you need further information.

Sincerely yours,

John Wilkins  
Chair, Department of Mathematics  
CSU Dominguez Hills

## UTMOST Supplementary Documentation: Sage Notebook Screenshot



Screenshot of the current Sage notebook running in Firefox on Windows

## UTMOST Supplementary Documentation: Sage Textbook Screenshot

Section RREF Reduced Row-Echelon Form - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://linear.ups.edu/jsmath/latest/fcla-jsmath-latestli18.html#x19-340

To write the set of solution vectors in set notation, we have

$$S = \left\{ \begin{bmatrix} 3-x_3 \\ 2+x_3 \\ x_3 \end{bmatrix} \mid x_3 \in \mathbb{C} \right\}$$

We'll learn more in the next section about systems with infinitely many solutions and how to express their solution sets. Right now, you might look back at [Example IS](#). ☒

Generate new matrix

Operation: Automatic Swap A and B Multiply A Multiply A & Add to B

Row A: 2 Row B: 3 Multiple: 4

$$\begin{pmatrix} 1 & 2 & -1 & -3 \\ 0 & -1 & 2 & 1 \\ 0 & 4 & -8 & -4 \end{pmatrix} \xrightarrow{4R_2+R_3 \rightarrow R_3} \begin{pmatrix} 1 & 2 & -1 & -3 \\ 0 & -1 & 2 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

**Theorem RREFU**  
**Reduced Row-Echelon Form is Unique**  
 Suppose that  $A$  is an  $m \times n$  matrix and that  $B$  and  $C$  are  $m \times n$  matrices that are row-equivalent to  $A$  and in reduced row-echelon form. Then  $B = C$ . ☐

**Proof** We need to begin with no assumptions about any relationships between  $B$  and  $C$ , other than they are both in reduced row-echelon form, and they are both row-equivalent to  $A$ .

If  $B$  and  $C$  are both row-equivalent to  $A$ , then they are row-equivalent to each other. Repeated row operations on a matrix combine the rows with each other using operations that are linear, and are identical in each column. A key observation for this proof is that each individual row of  $B$  is linearly related to the rows of  $C$ . This relationship is different for each row of  $B$ , but once we fix a row, the relationship is the same across columns. More precisely, there are scalars  $\delta_{ik}$ ,  $1 \leq i, k \leq m$  such that for any  $1 \leq i \leq m$ ,  $1 \leq j \leq n$ ,

$$[B]_{ij} = \sum_{k=1}^m \delta_{ik} [C]_{kj}$$

You should read this as saying that an entry of row  $i$  of  $B$  (in column  $j$ ) is a linear function of the entries of all the rows of  $C$  that are also in column  $j$ , and the scalars ( $\delta_{ik}$ ) depend on which row of  $B$  we are considering (the  $i$  subscript on  $\delta_{ik}$ ), but are the same for every column (no dependence on  $j$  in  $\delta_{ik}$ ). This idea may be complicated now, but will feel more familiar once we discuss "linear combinations" ([Definition LCCV](#)) and jsMath

Find: Previous Next Highlight all Match case

Done

Screenshot of a Sage-enhanced mathematics open textbook prototype