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April 11, 2008

Dr. Janine E. Janosky
Vice Provost for Research
Central Michigan University
251 Foust Hall
Mt. Pleasant, MI 48859

Re: Azita Manouchehri

Dear Dr. Janosky:

The included document serves as Dr. Manouchehri's official response to the investigation committee's report concerning NSF Award No. 0455797, *Concept: Connecting Content and Pedagogical Education of Pre-Service Teachers*. Pursuant to Central Michigan University's policy on research integrity, an individual against whom an allegation has been made has the opportunity to respond in writing to any part of the investigation and a subsequent report. Also, pursuant with this policy, please include Dr. Manouchehri's response in the final report.

Sincerely,

WHITE, SCHNEIDER, YOUNG
& CHIODINI, P.C.

James T. Feeny
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nmp
Enclosure
(Via Hand Delivery)
cc w/enc: Azita Manouchehri

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DR. AZITA MANOUCHEHRI'S RESPONSE

Section 0: Preamble - Introduction

To begin, it is important to understand the process in which Dr. Manouchehri was testing materials being used in the pilot MTH 362 course. Dr. Manouchehri's goal was to utilize the teaching experiment by presenting students with materials and seeing how the students reacted to the materials. To that extent, Dr. Manouchehri's course packet was not a cohesive set of documents, but a "living document" that changed almost daily. Dr. Manouchehri would use the comments made by the graduate student observing class, comments made by Dr. DeMeyer after her observation of a class, and Dr. Manouchehri's own observation, to change to class materials. Due to the time constraints and ever-evolving process of the class, Dr. Manouchehri was continuously updating the course packet and attempting to supply materials that would maximize the goals of the project. Dr. Manouchehri believes that because the MTH 362 class was a pilot project and was intended in the grant to be a development phase of the project, that she was not releasing materials for publication, but only testing to see the effect certain materials had on students.[1]

On or about July 11, 2007, a meeting was held between Dean Robert Kohrman, Dr. Doug Lapp, and Dr. Wayne Osborn, Interim Vice Provost of the Office of Research and Sponsored Programs. During the course of the meeting, allegations were levied against Dr. Manouchehri for plagiarism of materials in respect to the NSF Award #0455797, *Concept: Connecting Content and Pedagogical Education of Pre-Service Teachers* ("Concept"). Although Dr. Manouchehri believes the allegation of plagiarism was made in bad faith, she recognizes the importance and severity of such an allegation and Central Michigan University's (CMU) desire to dutifully and diligently respond to all such serious allegations.

Regrettably, CMU's conduct both before and after the July 11, 2007 meeting has been woefully without due process, has violated several of CMU's own policies contained in its "Policy on Research Integrity," and its investigation committee ("Committee") has rendered a decision which fails to support any finding of research misconduct or plagiarism by a preponderance of evidence.

Initially, the issue of possible plagiarism was never properly dealt with by CMU administrators. As the Committee stated in its report, "the most compelling indication of the lack of functionality" began in March of 2007. The Committee then describes how allegations of plagiarism were dealt with without ever seeking Dr. Manouchehri's input or assistance. In fact, Dr. Manouchehri's only notice of any potential issue of plagiarism

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[1] For a deeper understanding of Dr. Manouchehri's process, please review *Design Experiments in Educational Research*, Cobb, Confrey, diSessa, Lehrer, and Schauble. (Exhibit E.)

came from Dr. Angelos in March/April of 2007. Dr. Manouchehri's interactions with Dr. Angelos left her with the impression the issue had been resolved. In fact, the Committee acknowledges there was a "common understanding that the issue of possible plagiarism had been resolved. . . ."

Dr. Manouchehri continues to argue her due process rights were violated because she was unaware of the true nature of the alleged plagiarism until she met with the Committee on November 13, 2007. The failure to directly address the issue of possible plagiarism with the accused in March/April of 2007, while developing a "strategy for resolving the issue," appears extremely suspicious and undermines the genuine nature of the first allegation. Even more alarming is the fact that CMU administrators and faculty decided to conduct a raid on Dr. Manouchehri's class to collect the course materials and replace them with new materials while Dr. Manouchehri was attending a conference. Although the plan was to replace the confiscated documents, the students' documents were never replaced, leaving the entire class severely disadvantaged only two weeks prior to the final exam. Such a tactic clearly disadvantaged the students who trusted CMU to provide them with a fair opportunity to succeed in their class.

At the very least, it appears CMU was initially conducting an informal investigation not based on a formal complaint, and secretly developing plans to address the alleged plagiarism while simultaneously leading Dr. Manouchehri to share in the "common understanding that the issue of alleged plagiarism had been resolved" and allowing Dr. Manouchehri to continue working 80-90 hours a week on the Concept grant.

The aforementioned notwithstanding, CMU continued to violate Dr. Manouchehri's due process rights and its own policies once the investigation began.

CMU's Policy on Research Integrity, subsection 2, titled *Procedures for Handling Allegations of Misconduct*, subsection A(2): *The Inquiry Stage*, indicates an individual alleging misconduct is encouraged to discuss the matter with the Assistant Vice President for Research before making a written allegation. Although this step is not mandatory, clearly CMU believes such a policy is sufficiently important enough to include it within its *Procedures for Handling Allegations*. There is no evidence in the Committee's report that such a step was initiated. Dr. Manouchehri believes a discussion with the Assistant Vice President for Research and the Concept team members would have enabled this matter to be resolved immediately, and she suggested this option in an e-mail to Provost Shapiro. However, Dr. Manouchehri's request was ignored.

CMU's due process failures with the investigation also included a failure to abide by proper timelines. In accordance with CMU's Policy on Research Integrity B(7), "If the report cannot be completed within 90 days, the Provost may request an interim report and an explanation for the delay. The Provost shall notify the individual against whom the allegation has been made of the delay and of the probable date of completion." Dr. Manouchehri has never received notification of why the entire investigation, started on

or about August 28, 2007, took until March 25, 2008 to release a report. Notwithstanding the fact that Dr. Manouchehri relocated from CMU's campus, there is nothing contained within the Committee's report indicating the Provost had requested an interim report, nor any explanation of delay, nor was Dr. Manouchehri notified of the reason for the delay and a probable date of completion.

CMU's procedural due process violations are not solely limited to its failure to notify of reasonable delays, but CMU also ran afoul of its own stated "responsibilities" related to research integrity, which held the mere allegation of plagiarism is potentially damaging to an individual's career, and therefore "no information about charges of alleged misconduct in research may be disclosed except to the appropriate **CMU** and **federal or state** authorities or as otherwise required by law." This policy was blatantly violated by Interim Executive Vice President/Provost E. Gary Shapiro when he sent a letter to Dr. Joseph A. Allutto of The Ohio State University, dated December 21, 2007. (Exhibit A.) This letter was also sent to Dr. Robert T. McGrath, Senior Vice President for Research at The Ohio State University. In his letter to Dr. Allutto, Provost Shapiro explicitly informed The Ohio State University that Dr. Manouchehri is being investigated. This letter clearly violates CMU's policy that "no information about charges of alleged misconduct in research may be disclosed except to the appropriate CMU and federal or state authorities." There is absolutely no explanation for the outrageous violation of CMU's own policies in submitting this letter to members of The Ohio State University.

CMU cannot plausibly claim Dr. Shapiro's letter was notifying federal or state authorities, nor did it cite any law which required CMU to report these allegations to The Ohio State University. The sheer fact that such a letter was sent to Dr. Manouchehri's new employer further evidences CMU's failure to properly comply with its own policies, and severely calls into question its ability to genuinely conduct an investigation into any alleged misconduct by Dr. Manouchehri. Even more disconcerting is the fact that the letter was sent by CMU's provost in charge of maintaining CMU's policies concerning alleged misconduct. Additionally, CMU's Policy on Research Integrity requires an affected individual "be afforded confidential treatment . . . and a prompt and thorough investigation." Dr. Manouchehri alleges CMU failed to afford confidential treatment when its Executive Vice President and Provost sent a letter to two members of The Ohio State University informing them of an ongoing investigation.

Dr. Manouchehri alleges she was not given a prompt and thorough investigation, seeing as a process that begun informally in March 2007, and formally on July 11, 2007, took approximately nine months to complete, and the Committee refused to investigate several concerns she raised. Dr. Manouchehri argues the Committee's refusal to fully consider all of CMU's procedural errors constitutes an abandonment of the Committee's purpose. Dr. Manouchehri further argues any attempt by the Committee to brush aside such difficult questions as "outside the scope" of the Committee's investigation is nothing short of a gross miscarriage of the Committee's duties.

ALLEGATION 1 -- Did Dr. Azita Manouchehri engage in research misconduct by improper assignment of authorship, claiming another person's work as her own?

NSF and CMU Definitions

Initially, the National Science Foundation (NSF) defines "research misconduct" as "fabrication, falsification, or plagiarism in proposing or performing research funded by NSF, reviewing research proposals submitted to NSF, reporting research results funded by NSF." 45 CFR 689.2(a). The NSF defines "plagiarism" as "the appropriation of another person's ideas, processes, results, or words without giving appropriate credit." 45 CFR 689.1(a)(3). The NSF specifically excludes from its definition of research misconduct "honest error or differences of opinion." 45 CFR 689.1(b).

Meanwhile, CMU's research integrity policy has adopted a broader definition, holding research misconduct includes:

> Improper assignment of authorship, such as excluding other contributors or claiming the work of another person as one's own, presenting substantially the same materials as an original article in more than one publication, including individuals as authors who have not made a definite contribution to the work published, and submitting multi-authored publications without the concurrence of all authors.
>
> Claiming another person's research as one's own, including plagiarism, appropriation of ideas as expressed in grant proposals or articles received for peer review, or in student papers, and violation of intellectual property laws.

The Committee's Findings for Allegation 1

Based exclusively on materials stolen from students enrolled in the Spring 2007 pilot MTH 362 class, the Committee determined research misconduct, as defined by the CMU policy, had taken place. The Committee then found research misconduct, as defined by the NSF, did not occur. Finally, the Committee determined that plagiarism, as defined by the NSF, had occurred.

Dr. Manouchehri has admitted throughout the entire course of this investigation that she supplied materials to the students enrolled in the pilot MTH 362 class. She acknowledged these materials were not always properly cited. However, Dr. Manouchehri has unwaveringly asserted, and the Committee has acknowledged, that the materials used in the pilot course were not for public release. The Committee also acknowledged Dr. Manouchehri's belief that materials used in the draft stage did not need citations because the citations would be added as the materials evolved. Finally, Dr. Manouchehri argues the Concept project was to utilize the "teaching experiment" methodology, where no such standards for citation of evolving materials was warranted.

Dr. Cobb, Dr. D'Ambrosio, and Dr. Smith all support this understanding. (Exhibit B.)

Despite Dr. Manouchehri's assertions, the Committee found by a preponderance of the evidence that Dr. Manouchehri negligently plagiarized materials she distributed in the pilot MTH 362 class. As support for its determination that Dr. Manouchehri acted negligently, the Committee found Dr. Manouchehri had deviated from "community standards as they apply to draft versions of curriculum materials." Dr. Manouchehri asserts the Committee's report clearly shows there is no "community of standards" and that such a lack of defined community standards prevents a finding of culpability by a preponderance of the evidence.

It should be noted the Committee's finding of plagiarism is based on a technical reading of the language. Dr. Manouchehri has argued throughout this investigation that she did not conduct plagiarism for her failure to fully cite materials included in draft versions of documents provided to the pilot MTH 362 class. In support of this allegation, Dr. Manouchehri points to the American Educational Research Association's ethical standards, discussed in greater detail below, and notes that the Committee recognized the application of these standards applies only to published research. Additionally, Dr. Paul Cobb, Peabody Chair in Teaching and Learning and Professor of Education at Vanderbilt University, has stated that there is a community standard holding published materials must appropriately cite all materials, ideas, and processes that are not originally created by the publishing author. (*See* Exhibit B.) Additionally, Dr. Esther Beneish, a teacher at Central Michigan University, has also indicated there is a clear community of standards in the academic community stating that published materials must be appropriately cited. (*See* Exhibit C.)

Dr. Manouchehri argued she did not commit plagiarism when she supplied materials that were not fully cited to her pilot MTH 362 class because the materials were a draft version, and that the final version would be fully cited. To support her argument that the published version would be fully cited, Dr. Manouchehri requested the Committee review the last draft she had worked on before leaving CMU. The "last draft" Dr. Manouchehri worked on had not been touched after she left CMU, and completed before she became aware of the nature of the plagiarism charges. The Committee's report even acknowledges a review of the pilot MTH 362 course materials shows a "natural evolution." The Committee acknowledged Dr. Manouchehri's most recent draft was properly cited. Additionally, Dr. Manouchehri directs the Committee to the taped session of her January 31, 2007 class, in which she specifically discusses with the class where class materials come from and where to locate some sources. Dr. Manouchehri also points to Dr. D'Ambrosio's comments, discussed below, concerning standards of citation in pilot projects.

Yet, the Committee failed to provide any evidence that plagiarism can occur when an individual fails to fully cite materials used in a draft version. Therefore, the Committee has failed to establish a preponderance of the evidence to demonstrate Dr. Manouchehri violated the NSF's intended definition of plagiarism.

Finally, Dr. Manouchehri argues there is no community standard with respect to the citation of materials in draft version, and that the discussion below makes it clear that no such standard exists.

Community Standards

1. American Educational Research Association

Dr. Manouchehri argues the Committee's own report indicates there is no community standard that applies to the need for full citations in draft versions of curriculum materials. Despite the Committee's finding to the contrary, a close evaluation of its report indicates there is no such set of community standards that applies to draft versions of materials being used in a pilot project and not intended as a final product. Initially, the Committee selectively adopts and applies alleged "standards" enunciated by the American Educational Research Association (AERA) as related to a publication titled *Ethical Standards*. (*See* Exhibit D.) In the Forward to the selected language adopted by the Committee, the AERA holds that, "research and education is often directed at children and other vulnerable populations. The main objective of this code is to remind us, as educational researchers, that we should strive to protect these populations" so as to "maintain the integrity of our research . . . [and] our research community. . . ." (*Id.*) It was misguided for the Committee to adopt the AERA standards as a broadly accepted set of ethical standards with respect to citation of draft materials prior to final publication when the AERA itself states the standards are aimed to protect children and other vulnerable populations. (*Id.*) Clearly, no such populations existed in the instant matter and, as such, the "standards" are inapplicable.

Importantly, the Committee notes the AERA "standards apply to research, educational researchers, and to final products," and that the Committee was "unsure as to whether they applied equally to the curricular material . . . and to draft versions of a final product." The Committee's statement indicating the AERA standards apply to final products, and uncertainty whether the AERA guidelines actually apply to draft versions of a final product, clearly demonstrate a lack of any true set of community standards regarding the proper citation of materials included in draft versions. Therefore, the Committee's statement that the materials used in the pilot MTH 362 class violate the selected AERA standards lacks reasonable credibility.

With respect to AERA Standard 1, where the Committee adopted the standard that "educational researchers must not fabricate, falsify, misrepresent authorship, evidence, data, finding, or conclusions," the preamble of that section indicates educational researchers must maintain the integrity of research by warranting their "research conclusions." (*Id.*) Dr. Manouchehri continues to assert she has never provided a final copy of the Concept project, and therefore the materials she used in draft versions of the pilot MTH 362 class cannot qualify under the standards enunciated by the AERA because they never became a final product. To further support Dr. Manouchehri's understanding that only the final product needs the proper citation, the Committee recognized Dr. Manouchehri's pre-publication draft was properly cited.

When addressing the second alleged "community standard" adopted from the AERA, the Committee cited the section on intellectual ownership, which holds:

> The work of those who have contributed to the production of an intellectual property ways short of these requirements [that is those not listed as a co-author] for authorship should be appropriately acknowledged within the product.

(*Id.*) However, the Committee fails to indicate that the preamble of the intellectual ownership section states, "intellectual ownership is predominantly a function of creative contribution. Intellectual ownership is not predominantly a function of effort expended." (*Id.*) Additionally, Section 1 of the intellectual ownership section states, "authorship should be determined based on the following guidelines, which are not intended to stifle collaboration, but rather to clarify the credit appropriately due for various contributions to research." (*Id.*) Clearly, the section on intellectual ownership and authorship is designed solely to assist when an individual should be included as a co-author for her contributions on a paper. Yet, the Committee chose to selectively adopt only language usable to establish a false community standard.

Dr. Manouchehri argues the intellectual ownership standard has no applicability to the instant matter. To begin with, none of the authors who may not have been fully cited in draft materials actually participated or "contributed" to the production of Dr. Manouchehri's pilot program. The Committee's failure to understand the context under which its alleged AERA standards should be applied amounts to a misapplication of the AERA standards. To that end, Dr. Manouchehri argues the Committee's "standard" as adopted from the AERA entirely fails to constitute any recognizable "community standard."

The Mathematics Education Community

The Committee next sought to ascertain whether community standards exist within the mathematics education community concerning whether draft materials must be properly cited or otherwise constitute plagiarism. To that end, the Committee interviewed three well-respected mathematics educators. Although each individual indicated that "ideally" curricular materials and draft materials should be held to the same standards as published research, the Committee acknowledged, "each of these mathematics educators did, to a differing extent, allow for there to be deviation from the ideal [,] or expressed that circumstances might lead to the ideal not being achieved during the period in which the materials were being developed." In fact, the three mathematics educators' opinions varied greatly, ranging from the inclusion of citations even though they may be informally expressed, to the notion that the "seriousness of omitting citations was lower for materials being piloted and revised in a classroom than for production," to including an opinion that "the pressure of time might lead to the omission of citations." Therefore, the Committee received three separate and distinct "community standards" with a range as varied as including informal citations to the complete exclusion of citations in draft materials.

Importantly, the Committee found "particularly compelling" the fact that one mathematics educator requested a summary of the information the Committee obtained and suggested a conference session covering this topic be created to address "standards for the development of curriculum materials." This comment emphasizes the truth that no set of community standards exists. The Committee admitted that while there may exist an ideal standard, "there was not a widely understood, broadly accepted set of standards" to be used for curriculum materials in draft form.

Dr. Beatriz D'Ambrosio, Professor of Mathematics Education in the Department of Mathematics and Statistics at Miami University (Ohio), is a member of the National Council of Teachers of Mathematics (the largest organization devoted to teaching and learning), and on the Editorial Panel of the Journal of Research for Mathematics Education. Her vast experience in the mathematics field is unquestionable, and her opinions concerning standards within the mathematics education community are as close to expert as can exist.

Dr. D'Ambrosio's e-mail stated that there are no community standards when it comes to dealing with materials that are under development. Dr. D'Ambrosio described situations, although not exhaustive, in which materials are under development. Those examples include: (1) a researcher engaging in a research curriculum development project and utilizing problems found from multiple sources when engaging with students or research subjects; (2) a researcher/teacher utilizing available tasks from printed material in a classroom presentation, with the goal of collecting research data involving the individual's interaction with the task; and (3) a teacher utilizing problems from available printed literature in order to enhance the learning experience of the students. (Exhibit B.)

Dr. D'Ambrosio further states there is a tradition in mathematics education of using problems with students and in research, and that the sources of the problems are varied, and that very few problems can be considered "original." (*Id.*) Dr. D'Ambrosio further states the issue of identifying the source only becomes relevant for print and published materials. (*Id.*) Finally, Dr. D'Ambrosio states that pilot materials should not be considered finalized or released to the public as a finalized product because the pilot materials are being used in order to assist the researcher in gaining incites as to the quality of the materials and their coherence within the overall project.

Dr. D'Ambrosio further states that pilot materials are being used tentatively and are often modified or eliminated from the final packet of materials that is to be published. (*Id.*) Dr. Manouchehri asserts this is exactly what was occurring in her pilot MTH 362 class.

As further evidence that there is no community of standards with respect to the proper citation of materials included in draft versions, several mathematics professors have stated no such standards exist. (*Id.*) To that end, Dr. Paul Cobb, recipient of the 2005 ICMI Hans Freudenthal medal, stated he is unaware of a set of standards within the mathematics education community holding materials used while under development are held to the same citation standards as published materials. (*Id.*) Dr. Cobb also

stated he is unaware of any widely understood and broadly accepted standards for citation of materials that are under development and used in the teaching experiment methodology. (*Id.*)

Additionally, Dr. Patricio Herbst, Associate Professor of Mathematics Education at the University of Michigan, stated it is not commonly accepted or understood that a researcher must appropriately cite all materials if the materials were not being published. (*Id.*) Professor Diana Erchick, Associate Professor of Mathematics Education at The Ohio State University, stated she is unaware of any standards within the mathematics education community respecting the proper citation of under-development materials having the same citation standards of published materials. (*Id.*) Dr. Erchick also believes that materials that are in development need not be appropriately cited prior to publication. (*Id.*) Finally, Dr. Beneish also stated she is unaware of any community standard holding draft materials are held to the same standard as published materials. (Exhibit C.)

These reputable professors all indicated there is no such thing as a community of standards respecting the full citation of draft materials.

The Concept Team

Finally, in its last attempt to ascertain "community standards," the Committee interviewed all seven members of the concept team. Having failed to find a community of standards broadly, the Committee acknowledged the goal of its investigation "was to determine if the community of project personnel had reached an understanding of the standards that should be applied to the curriculum materials as they were under development." The Committee admits each team member "indicated that no such discussions had occurred and consequently [that] there was no common understanding of the standards to be applied."

The Committee's subsequent breakdown of where the Concept team members fell with respect to citations of materials under development reveals that two Concept team members believe materials should be cited even when under development; two Concept team members failed to articulate standards; and three Concept team members believe no standards were breached because the materials were in draft form. Obviously, Dr. Manouchehri falls into the last category. Importantly, although the Committee does not specify which individuals felt which way, it is highly likely the two members who believe a breach had occurred are none other than those who reported the alleged plagiarism and who conspired to secretively remove documents from Dr. Manouchehri's students when she was away.

If the Committee were to remove the standards articulated by Dr. Lapp, Dr. DeMeyer, and Dr. Manouchehri, the Committee would likely be left with two members who failed to articulate standards, as well as two members who believe no standards were breached because the materials were in draft form. Regardless, the seven Concept team members demonstrate the absolute lack of community standards respecting proper citation for draft materials. Moreover, Dr. Smith specifically informed

the Committee no such standards existed, and that Dr. Lapp was aware that materials did not need to be cited. (Exhibit B.)

In reviewing a totality of the evidence presented by the Committee, it is impossible to see how a preponderance of evidence exists establishing a community of standards holding the need for full citation of sources contained within a draft version, and the failure of doing so constitutes plagiarism. It also appears unjustified to find Dr. Manouchehri violated any standards when the Committee acknowledged there was "no common understanding of the standards to be applied."

Conclusion

The Committee has failed to establish an individual can commit plagiarism when he fails to fully cite material from others in the context of draft materials, and specifically when dealing within the "teaching experiment" methodology. Dr. Manouchehri has always recognized she was using other individuals' materials in the development and draft materials of her pilot MTH 362 class, and that it was her belief all citations need only be included in the final product. To that end, the Committee recognized Dr. Manouchehri's pre-publication draft had properly cited all materials it was using. Additionally, the Committee has provided no evidence, let alone a preponderance of evidence, to establish that it is understood in the academic community that material in draft versions needs to be fully cited, while an overwhelming majority of mathematics professors stated no such standards exist. (Exhibit B.) In fact, the Committee's own inquiries into community standards and other professors' statements evidences a clear community standard that plagiarism occurs only in finished or published products. *See* AERA Ethical Standard I(A). (*Id.*)

At best, the Committee was only able to establish that there exists an "ideal" standard that all materials should be properly cited, even in draft materials. This ideal notwithstanding, it is improper to hold Dr. Manouchehri culpable for plagiarism simply because she failed to abide by the "ideal standard" while not violating any articulated standard regarding citation of materials in draft versions, and adhering to the generally accepted standard within the mathematics education community. (*Id.*)

The Committee's determination that Dr. Manouchehri was negligent in her alleged plagiarism "based on community standards as they apply to draft versions of curriculum material" is also unsupported by a preponderance of the evidence. As articulated above, the AERA standards apply to published materials. The three mathematics education community members failed to articulate any definite standard to be applied respecting draft materials and the Concept team itself provided five individuals who articulated the belief that no standards exist or that no standards were breached, while only providing two team members who believed that standards had clearly been breached. Dr. Manouchehri argues any reasonable reviewer of these facts would find that no "community standards" exist with respect to the need to fully cite materials included in draft versions not meant for publication.

Therefore, Dr. Manouchehri respectfully requests this Committee reverse its finding that Dr. Manouchehri negligently violated established community standards by failing to fully cite materials included in draft versions. Additionally, Dr. Manouchehri respectfully requests this Committee to reverse its holding that she engaged in plagiarism as defined by the NSF because no evidence has been presented to indicate materials used in draft versions are held to the same standard of citation as published material -- and that finding an individual guilty of plagiarism in non-finalized draft material constitutes a gross misapplication of the NSF's definition of plagiarism.

ALLEGATION 2 -- Did Dr. Azita Manouchehri fail to abide by IRB approved protocols?

Dr. Manouchehri wholly supports the Committee's conclusion that allegations alleging she violated the IRB approved protocol are unsupported. Again, Dr. Manouchehri believes the second allegation was not made in good faith, but understands the serious nature of the allegation and was happy to read the Committee's response to this allegation.

CMU

CENTRAL MICHIGAN UNIVERSITY

21 December 2007

Dr. Joseph A. Alutto
Executive Vice President and Provost
The Ohio State University
203 Bricker Hall
190 North Oval Mall
Columbus, OH 43210-1358

Dear Provost Alutto:

Allegations of research misconduct have been levied against Dr. Azita Manouchehri for her role in the authorship of the grant submission, "CONCEPT: Connecting Concept and Pedagogical Education of Pre-service Teachers" which was funded by the National Science Foundation and for materials developed during the execution of the work. Dr. Manouchehri participated in the development of the grant submission and served as a Co- Principal Investigator on this award from the funding date of 1 June 2005 until 28 August 2007.

It is our understanding that Dr. Manouchehri currently holds an appointment as Professor in Mathematics Education at The Ohio State University, The School of Teaching and Learning.

This letter serves as official notification of "The Investigative Stage of the Procedures for Handling Allegations of Misconduct" as presented in the "Office of Research and Sponsored Programs Central Michigan University, Policy on Research Integrity" dated as 26 June 1995. The investigation is being administratively conducted through our Office of Research and Sponsored Programs by our Vice Provost for Research, Dr. Janine E. Janosky.

The investigation is expected to be completed on or before 13 April 2007, after which we will forward a copy of the report to you.

Sincerely,

E. Gary Shapiro
Interim Executive Vice President/
Provost

c: Dr. Janine E. Janosky
Vice Provost for Research
Central Michigan University

Dr. Robert T. McGrath
Senior Vice President for Research
The Ohio State University

Dr. Azita Manoucherhri
The Ohio State University

EXECUTIVE VICE PRESIDENT/PROVOST
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EXHIBIT A

Bloomberg No. 5137

INVESTIGATION COMMITTEE

AZITA MANOUCHEHRI

-and-

CENTRAL MICHIGAN UNIVERSITY

AFFIDAVIT OF AZITA MANOUCHEHRI

STATE OF OHIO)
) SS.
COUNTY OF Franklin)

I, Azita Manouchehri, being first duly sworn, depose and say:

1. I have personal knowledge of the following facts, and if sworn as a witness, I can testify competently thereto.

2. I am currently employed by The Ohio State University, and have been employed there since August of 2007.

3. I am currently employed as a mathematics professor with The Ohio State University.

4. Dr. Paul Cobb, Peabody Chair in Teaching and Learning, Professor of Education at Vanderbilt University, and the 2005 recipient of the ICMI Hans Freudenthal medal, sent an e-mail correspondence to me dated April 9, 2008. (Attachment 1.)

5. In Dr. Cobb's e-mail, he specifically stated that the academic community maintains a standard holding published material must appropriately cite all materials, ideas, and processes that are not originally created by the publishing author.

EXHIBIT
B

Bloomberg No. 5137

(Attachment 1.)

6. Dr. Cobb's e-mail also stated he is unaware of a set of standards within the mathematics education community holding materials used while under development are held to the same citation standards as published materials. (Attachment 1.)

7. Further, Dr. Cobb's e-mail states he is unaware of any widely understood and broadly accepted standards for the citation of materials that are under development using a teaching experiment methodology. (Attachment 1.)

8. I also received an e-mail correspondence from Dr. Patricio Herbst, Associate Professor of Mathematics Education at the University of Michigan School of Education, dated April 9, 2008. (Attachment 2.)

9. In Dr. Herbst's e-mail, he stated it is not commonly accepted or understood that a researcher must appropriately cite all materials if the materials were not being published. Specifically, Dr. Herbst stated that materials need not be cited if they are an in-house matter. (Attachment 2.)

10. On April 9, 2008, I received an e-mail communication from Dr. Ken Smith, Chair of the Department of Mathematics and Statistics at Sam Houston State University. (Attachment 3.)

11. Dr. Smith's e-mail states that he informed the investigation committee there were no standards of citation during the teaching experiment, specifically for citation of materials used in the classroom as part of the pilot projects. (Attachment 3.)

12. Dr. Smith's e-mail also states that, during the teaching experiment, the goal was to find tasks, exercises, and projects that stimulated the students to think and explore. (Attachment 3.)

13. Dr. Smith's e-mail further states he and Dr. Lapp's entire emphasis was on creativity, exploration, and finding materials that worked. Dr. Smith's e-mail also states there was never any discussion amongst the Concept Team about citing other people's materials, indicating it would be futile to cite another individual's materials when the idea may not be included in the final report. (Attachment 3.)

14. Furthermore, Dr. Smith's e-mail indicates that in his 23 years as a faculty member at Central Michigan University, he is unable to recall the University ever providing directed guidance on citation of materials under development. (Attachment 3.)

15. Finally, Dr. Smith's e-mail indicates he informed the investigation committee that he strongly advised they interview the advisory committee, and interview members of the Concept project advisory committee, as they were also involved in the discussion and creation of classroom materials. (Attachment 3.)

16. Dr. Diana Erchick, Associate Professor at The Ohio State University, sent me an e-mail dated April 10, 2008. (Attachment 4.)

17. Dr. Erchick's e-mail states she is unaware of specific standards holding draft materials need to be fully cited or that draft materials are held to the same citation standards as published materials. (Attachment 4.)

18. Dr. Beatriz D'Ambrosio, Professor of Mathematics Education in the Department of Mathematics and Statistics at Miami University of Ohio, sent me an e-mail communication dated April 10, 2008. Dr. D'Ambrosio is a prominent member of the

National Council of Teachers of Mathematics, and is on the editorial panel of three international journals, including the Editorial Panel of the Journal of Research for Mathematics Education. (Attachment 5.)

19. Dr. D'Ambrosio's e-mail stated she is offering her professional prospective regarding the following points. (Attachment 5.)

20. Dr. D'Ambrosio stated there is a common academic community standard that published materials must be appropriately cited. (Attachment 5.)

21. Dr. D'Ambrosio's e-mail stated she is unaware of any comparable standards or set standards within the mathematic education community respecting whether materials that are under development are held to the same citation standards as published materials. Specifically, Dr. D'Ambrosio stated this situation applies to a researcher involved in research curriculum development projects and using problems found in multiple sources when engaging with students or research subjects, when a researcher/teacher uses materials available in printed sources in a class room, collecting research data involving the students' reactions to the materials, or when a teacher uses problems available in printed literature to enhance the learning experience of the students. (Attachment 5.)

22. Dr. D'Ambrosio's e-mail further states there is a tradition in mathematics education of using problems with students in research, and that very few problem can be considered original. (Attachment 5.)

23. Dr. D'Ambrosio's e-mail stated the issue of identifying sources will only become relevant for print and published materials. (Attachment 5.)

24. Dr. D'Ambrosio's e-mail stated materials used in a pilot program should not be considered finalized or released to the public as a finalized product because

the pilot materials are being used to assist the researcher in gaining incite to the quality of the materials and its coherence with the overall project. (Attachment 5.)

25. Dr. D'Ambrosio further states materials used in a pilot program are tentatively being used and are often modified or eliminated from the final collection of materials. (Attachment 5.)

26. During my employment with Central Michigan University, I never received guidance containing the proper procedure regarding the citation or non-citation of draft materials.

27. Further Affiant sayeth not.

Azita Manouchehri

Subscribed and sworn to before me
this 11 day of April, 2008

Tierra D. Woods, Notary Public
County of: Franklin, Ohio
My Com. Expires: 3-8-2012

TIERRA WOODS - NOTARY PUBLIC
COMM. EXPIRES MAR 8, 2012
STATE OF OHIO

FedEx Kinko Downtown
180 N High Street
Columbus, Ohio 43215

James T. Feeny

From: Paul Cobb [paul.cobb@vanderbilt.edu]
Sent: Wednesday, April 09, 2008 6:30 PM
To: AZITA MANOUCHEHRI
Subject: Re: Teaching experiment

Paul:

You are GREAT! Thank you so much for taking the time to write back so quickly.

Do I have your permission to release your professional perspective about "standards" (or lack thereof) for citation in a statement?

Sure.

Paul.

----- Original Message -----
From: Paul Cobb <paul.cobb@vanderbilt.edu>
Date: Wednesday, April 9, 2008 6:03 pm
Subject: Re: Teaching experiment
To: Azita Manouchehri <manouchehri.1@osu.edu>

<font style="font-style: normal; font-weight: normal; background-color: <div class="SP_MS" id="ms10">rgb</div>(245, 248, 240); font-size: 14<div class="SP_MS" id="ms11">px</div>;">> Re: Teaching experiment

> Azita,

> Here's a quick reply from Atlanta airport.

ATTACHMENT 1

Blumberg No. 5197

> We know that the academic community maintains the standard that published material must appropriately cite all materials, ideas, and processes that are not originally created by the publishing author. I assume you agree with this.

> Yes

> 1. Are you aware of a specific set of standards within the mathematics education community respecting whether materials used while under development should be held to the same citation standards as published materials?

> No.

> 2. To your knowledge, during the development of materials, is it commonly accepted or understood that a researcher must appropriately cite all materials as if the materials were being published?

> I am not sure I understand the question. Do you mean that materials have been developed and will be disseminated? If so, I think that actual standards are, in practice, far less stringent than is that case for research papers.

> 3. In your professional opinion if the materials under development are used as part of a pilot program suing a teaching experiment methodology, should such materials be considered finalized and/or released to the public as finalized products?

> From my point of view, it is fine if curriculum developers can take some of the ideas for instructional activities described in a report of a teaching experiment -- however an acknowledgement would be appreciated.

> 4. To your knowledge, are there any widely understood, broadly accepted standards for the citation of materials that are under development using a teaching experiment methodology?

> No, I do not think there are such standards. I imagine that you will get a range of responses to question 3.

> would you be willing to allow me to share your responses with a larger community? YES NO

> Yes.

> Paul.

Azita Manouchehri
Mathematics Education
The Ohio State University

The School of Teaching and Learning
244 Arps Hall
1945 N. High St.
Columbus, Ohio 43210-1172
Fax: 614-292-7695
Phone: 614-688-4258
E-mail: manouchehri.1@osu.edu

James T. Feeny

From: Azita Manouchehri [manouchehri.1@osu.edu]
Sent: Thursday, April 10, 2008 10:39 AM
To: James T. Feeny
Subject: Fwd: Re: quick question

Original-recipient: rfc822;manouchehri.1@osu.edu
Date: Wed, 09 Apr 2008 20:33:59 -0400
From: Patricio Herbst <pgherbst@umich.edu>
Subject: Re: quick question
To: AZITA MANOUCHEHRI <manouchehri.1@osu.edu>
X-CanItPRO-Stream: 11_tagonly_no_subject
X-Canit-Stats-ID: Bayes signature not available

you can quote me on that.

On Apr 9, 2008, at 8:16 PM, AZITA MANOUCHEHRI wrote:

Not a problem.

I am particularly interested in this part:

> To your knowledge, during the development of materials, is it commonly accepted or understood that a researcher must appropriately cite all materials as if the materials were being published.

> No. especially if it is an inhouse matter. While you are developing stuff you don't expect those of your inner circle to police your steps. If you choose to report to the whole community something that you are developing and you are aware of using someone else's idea, the fair thing would be to cite it.

Someone has been accused of plagirism during the development phase for not having cited what was being piloted (using a teaching experiment methodology). the motive, as I see it, is to steal a grant and they are destroying this person in a well plotted conspiracy.

Anyways, thanks for the discussion. I have heard from a numnber of people and the obvious thing is that we don't have standards. In fact someone suggested that we should organize a session atAERA about this.

ATTACHMENT 2
Hearing No. 5137

James T. Feeny

From: Azita Manouchehri [manouchehri.1@osu.edu]
Sent: Wednesday, April 09, 2008 12:19 PM
To: James T. Feeny
Subject: Fwd: Standards of citation

Original-recipient: rfc822;manouchehri.1@osu.edu
Date: Wed, 09 Apr 2008 11:05:34 -0500
From: Ken Smith <kenwsmith@shsu.edu>
Subject: Standards of citation
To: AZITA MANOUCHEHRI <manouchehri.1@osu.edu>
X-Greylist: Sender IP whitelisted,
not delayed by milter-greylist-3.0 (mail3.shsu.edu [158.135.1.170]); Wed,
09 Apr 2008 11:05:35 -0500 (CDT)
X-SHSU-M1-MailScanner-Information: Sam Houston State University
X-SHSU-M1-MailScanner: Found to be clean
X-SHSU-M1-MailScanner-SpamCheck: not spam, SpamAssassin (not cached,
score=-2.002, required 5.5, BAYES_00 -2.60, HTML_MESSAGE 0.00,
SPF_SOFTFAIL 0.60)
X-CanItPRO-Stream: 11_tagonly_no_subject
X-Canit-Stats-ID: Bayes signature not available

Hi Azita,

As I said to the investigative committee, there were NO standards of citation during the teaching experiment. Our goal, during the teaching experiment, was to find tasks, exercises, projects that stimulated students to think and explore. My conversations with Doug were along the line, "Have you thought of doing such-and-such; the students seemed really motivated by that idea" or "I went over such-and-such in my class but it fell flat..." The entire emphasis (with Doug & me) was on creativity, exploration, finding GOOD things. There was NEVER any discussion about citing other people's "good ideas"; instead we wanted to know if these "good ideas" *worked.* (Why stop to cite an exercise or idea when it might be bad anyway?)

Our work was exploration; it was creative. No emphasis on citation.

Furthermore, in 23 years as a faculty member at Central Michigan University, I do not recall the university ever providing direct guidance on citation of classroom materials. I was aware of the Kinko's type of issues -- "Don't photocopy a textbook and distribute it to your class" -- but I often gave out small short articles or textbook questions or copies of a paragraph (or, of course, copies of a comic strip!) without *any* university guidance on how I should cite the material.

I strongly suggested to the committee that since the Advisory Committee was involved in the discussion (and creation) of classroom materials, that they should be interviewed. The committee seems to have ignored that request.

ATTACHMENT 3

Bluminberg No. 5137

What do I need to do to make this part of your affidavit? (You have my permission to use the above material. Heck, you can publish it in The Chronicle of Higher Ed, for that matter! <smile>.)

Ken

--- --- --- --- --- --- --- --- ---

Ken W. Smith, Chair, Dept. of Mathematics & Statistics

Sam Houston State University, Huntsville, TX 77341

936-294-1563; fax: -1882

Homepage: http://www.shsu.edu/~kws006

Personal homepage: http://www.kenwsmith.com/

--

Azita Manouchehri
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244 Arps Hall
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Fax: 614-292-7695
Phone: 614-688-4258
E-mail: manouchehri.1@osu.edu
http://ehe.osu.edu/edtl

James T. Feeny

From: Diana Erchick [erchick.1@osu.edu]
Sent: Thursday, April 10, 2008 1:33 PM
To: Azita Manouchehri
Subject: Re:

On Apr 10, 2008, at 12:13 PM, Azita Manouchehri wrote:

> Patti and Diana:
>
> I would appreciate it if you could respond to the following questions offering your professional perspective as researcher.s I know you are busy at NCTM and may not have time to do this but I hope that you will check mail sometime today. I need responses by this evening.
>
> Also, please indicate whether you would be willing to testify to the accuracy of the responses you are providing. If you need a context for this I will be glad to provide it to you.
>
> ---
>
> We know that the academic community maintains the standard that published material must appropriately cite all materials, ideas, and processes that are not originally created by the publishing author. I assume you agree with this.
>
> Yes
>
> 1. Are you aware of a specific set of standards within the mathematics education community respecting whether materials used while under development should be held to the same citation standards as published materials?

Not that I know of. There are some practices, but those are individual. For instance, I feel that all contributors should be noted, and generally, as curriculum materials, instruments, scholarly writing are shared for academic purposes, they are expected to be cited as such if used by *others*. See #4 below.

> 2. To your knowledge, during the development of materials, is it commonly accepted or understood that a researcher must appropriately cite all materials as if the materials were being published?

No. If materials are in development, one typically only has it complete with all accurate citations once it is in a form to be distributed. In other words, while a document is in preparation, citations might only be added as a final stage, before submission for publication.

ATTACHMENT 4

3. In your professional opinion if the materials under development are used as part of a pilot program, should such materials be considered finalized and/or released to the public as finalized products?

If materials are released in a pilot program, I would *not* consider them finalized and/or released to the public. I have never known scholars to implement pilots and expect them to be viewed as finalized! It's not finalized until it is published.

I believe determining if the *materials* (as opposed to the program through which they were disseminated) are in the pilot (development) phase is the discriminating factor. If the materials are, then they should not be considered finalized either.

4. To your knowledge, are there any widely understood, broadly accepted standards for the citation of materials that are under development?

Not that I know of. There are some not uncommon practices. For instance, one often sees materials at conferences with a "Do not cite without author permission" note included. And that is not so much to protect the academic property, but, because the materials are not yet published, and thus still in development, the author, expecially after scholarly presentation and discussion, may make adjustments in the product. But that practice is a choice, and not because of any widely accepted standard. I would expect this would hold true for things like curriculum materials or program materials, too.

would you be willing to allow me to share your responses with a larger community? YES

Am I allowed to use your responses in a statement? YES

Thanks much.

a.

Also, could you please provide a snapshot of you: Name, title, years of teaching university, research experience.

Diana B. Erchick
Associate Professor, Mathematics Education
Years of university teaching: 12
Research experience: Currently I am lead PI on a state-wide research project and a Co-Pi on another state-wide research project. In one of those projects I also manage a program of research studies being conducted within the professional development program grounding the main study. I have completed a number of smaller studies over the past few years, and have earned 2 university research awards while here at Ohio State. I also work with doctoral students on dissertations, masters students on their final projects, and undergraduates honors students on their thesis projects. I currently have an UG honors student working on a thesis project for which she has been awarded a grant and has won a first place award in a research forum.

--

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****

Diana B. Erchick, Ph.D.
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Coordinator, Education Department, OSU Newark

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(FAX): 740-366-5047

Home Page: http://www.newark.osu.edu/derchick
MCP link: http://www.newark.osu.edu/derchick/MCP_Program/

Once there is seeing, there must be acting. Otherwise, what is the use of seeing? --Thich Nhat Nanh

James T. Feeny

From: D'Ambrosio, Beatriz S. Dr. [dambrobs@muohio.edu]
Sent: Thursday, April 10, 2008 4:02 PM
To: Azita Manouchehri
Subject: Re: standards of citation
Attachments: Citations Azita.doc

Azita, Attached are my comments. I am also including the text here in case you need the email. Please read carefully and let me know if there is something I have misunderstood. I struggled to understand your fourth question. I interpreted it one way, but may have misunderstood. I will check email later this afternoon to know if this works. Call me if you want to talk about this. My phone will be off during my talk from 3:00 – 4:30 (Utah time).

Bia

April 10, 2008

Dear Azita,

I am a Professor of Mathematics Education in the Department of Mathematics and Statistics at Miami University, Oxford, Ohio. In this role I have been conducting research in mathematics education and teaching future and practicing mathematics teachers. I received my PhD in mathematics education in 1987. Given my experiences in the field, and my experiences on the editorial panel of three international journals, I am offering my professional perspective regarding the following questions you raise.

"We know that the academic community maintains the standard that published material must appropriately cite all materials, ideas, and processes that are not originally created by the publishing author."

I agree with this statement and will build my arguments on this shared understanding within the community. In fact, there are commonly agreed upon standards for such citations. These standards can be found easily in the publication manuals, and other accessible documents readily available to all authors in the community of researchers in education in general and mathematics education in particular.

"Are you aware of a specific set of standards within the mathematics educaton community respecting whether materials used while under development should be held to the same citation standards as publication materials?"

There are no comparable standards that I am aware of dealing with materials that are under development. By materials under development I am referring to situations of the following type (this is not meant to be an exhaustive list, but rather offer some examples):
1) A researcher is involved in a research curriclum development project and uses problems found in multiple sources when engaging with students or research subjects.
2) A researcher/teacher picks tasks available in printed sources to use with a classroom, collecting research data involving the individuals' interaction with the tasks.
3) A teacher uses problems available in the printed literature with his/her students to enhance the learning experience.

There is a tradition in mathematics education of using problems with students and in research. The sources of problems are varied and there are very few problems that can be considered original. In print, it is common practice to acknowledge where one came to know of a problem, but that does not mean that the problem is original in that citation. Most problems used in mathematics education can be traced historically to previous publications and often to historical documents pre-dating its appearance in the literature with a citation.

Regardless of the source of the problem, the issue of identifying the source is only relevant for print and published materials.

ATTACHMENT 5

"To your knowledge, during the development of materials, is it commonly accepted or understood that a researcher must appropriately cite all materials as if the materials were being published?"

No, it is not commonly accepted that the materials will be cited as if they were being published.

"In your professional oinion if the materials under development are used as part of a pilot program, should such matrials be considered finalized and/or released to the public as finalized products?"

Pilot materials should not be considered finalized and/or released to the public as finalized products. Pilot materials are being used in order for the researcher to gain insights as to the quality of the materials and its coherence with the overall project. Pilot materials are tentatively being used and are often modified or eliminated from the final collection of materials included in a development project. It is unrealistic to imagine or conclude that all the materials included in a pilot will ultimately be part of the final published product.

"To your knowledge, are there any widely understood, broadly accepted standards for the citation of materials that are under development?"

I am not aware of any standards for the citation of materials under development. Authors will often stamp materials under development with the phrase "Draft -- do not cite." Colleagues respect the written stamped request and usually seek verbal permission from the authors to use such materials in their own efforts or to refer to the unpublished materials. It is not clear that this is a standard procedure, but rather one that we have assumed over time as simply a common practice.

I am willing to allow you to share my responses with a larger community.

I give you my permission to use my responses in any statement you make regarding these issues.

Sincerely,

Beatriz S. D'Ambrosio
Department of Mathematics and Statistics
Miami University
Oxford OH

On 4/10/08 10:35 AM, "Azita Manouchehri" <manouchehri.1@osu.edu> wrote:

> Bia:
>
> I would appreciate it if you could respond to the following questions offering your professional perspective as a researcher. I know you are busy at NCTM and may not have time to do this but I hope that you will check mail sometime today. I need responses by this evening.
>
> Also, please indicate whether you would be willing to testify to the accuracy of the responses you are providing. If you need a context for this I will be glad to provide it to you.
>
> ---
>
> We know that the academic community maintains the standard that published material must appropriately cite all materials, ideas, and processes that are not originally created by the publishing author. I assume you agree with this.
>
> Yes NO

1. Are you aware of a specific set of standards within the mathematics education community respecting whether materials used while under development should be held to the same citation standards as published materials?

2. To your knowledge, during the development of materials, is it commonly accepted or understood that a researcher must appropriately cite all materials as if the materials were being published?

3. In your professional opinion if the materials under development are used as part of a pilot program, should such materials be considered finalized and/or released to the public as finalized products?

4. To your knowledge, are there any widely understood, broadly accepted standards for the citation of materials that are under development?

would you be willing to allow me to share your responses with a larger community? YES NO

Am I allowed to use your responses in a statement? YES NO

Thanks much.

a.

Also, could you please provide a snapshot of you: Name, title, years of teaching university, research experience.

INVESTIGATION COMMITTEE

AZITA MANOUCHEHRI

-and-

CENTRAL MICHIGAN UNIVERSITY

AFFIDAVIT OF [*Esther Beneish*]

STATE OF ___Michigan_____)
) SS.
COUNTY OF __Isabella_____)

I ***[Esther Beneish]***, being first duly sworn, depose and say:

1. I have personal knowledge of the following facts, and if sworn as a witness, I can testify competently thereto.

2. I am currently employed by [***Central Michigan University***] and have been employed there since [***2002***].

3. I am currently employed as a mathematics professor with my employer.

4. I am aware there is an academic community standard that published material must appropriately cite all materials, ideas, and processes that are not originally created by the publishing author.

5. To my knowledge, there is no specific set of standards within the mathematics education community respecting whether materials used while under development should be held to the same citation standards as published materials.

EXHIBIT
C

Bloomberg No. 5157

6. To my knowledge, during the development of materials, it is not commonly accepted or understood that a researcher must appropriately cite all materials as if the materials were being published. I understand such a lack of community standards is not ideal.

7. To the extent materials under development are used as part of a pilot program, such materials are not considered finalized and/or released to the public as finalized products.

8. To my knowledge, there are no widely understood, broadly accepted standards for the citation of materials that are under development.

9. Further Affiant sayeth not.

Esther Beneish

Esther Beneish

[INSERT NAME]

Subscribed and sworn to before me
this 9 day of April, 2008

Karmen K. Grondin

Karmen K. Grondin, Notary Public
County of:
State of:
My Com. Expires:

KARMEN K. GRONDIN
Notary Public, Clare County, MI
Acting in Isabella County, MI
My Commission Expires: Dec. 27, 2011

ETHICAL STANDARDS OF THE AMERICAN EDUCATIONAL RESEARCH ASSOCIATION

FOREWORD

Educational researchers come from many disciplines, embrace several competing theoretical frameworks, and use a variety of research methodologies. AERA recognizes that its members are already guided by codes in the various disciplines and, also, by organizations such as Institutional Review Boards (IRBs). AERA's code of ethics incorporates a set of standards designed specifically to guide the work of researchers in education. Education, by its very nature, is aimed at the improvement of individual lives and societies. Further, research in education is often directed at children and other vulnerable populations. A main objective of this code is to remind us, as educational researchers, that we should strive to protect these populations, and to maintain the integrity of our research, of our research community, and of all those with whom we have professional relations. We should pledge ourselves to do this by maintaining our own competence and that of people we induct into the field, by continually evaluating our research for its ethical and scientific adequacy, and by conducting our internal and external relations according to the highest ethical standards.

The standards that follow remind us that we are involved not only in research but in education. It is, therefore, essential that we continually reflect on our research to be sure that it is not only sound scientifically but that it makes a positive contribution to the educational enterprise.

I. Guiding Standards: Responsibilities to the Field

A. Preamble. To maintain the integrity of research, educational researchers should warrant their research conclusions adequately in a way consistent with the standards of their own theoretical and methodological perspectives. They should keep themselves well informed in both their own and competing paradigms where those are relevant to their research, and they should continually evaluate the criteria of adequacy by which research is judged.

B. Standards

1. Educational researchers should conduct their professional lives in such a way that they do not jeopardize future research, the public standing of the field, or the discipline's research results.

2. Educational researchers must not fabricate, falsify, or misrepresent authorship, evidence, data, findings, or conclusions.

3. Educational researchers must not knowingly or negligently use their professional roles for fraudulent purposes.

4. Educational researchers should honestly and fully disclose their qualifications and limitations when providing professional opinions to the public, to government agencies, and others who may avail themselves of the expertise possessed by members of AERA.

5. Educational researchers should attempt to report their findings to all relevant stakeholders, and should refrain from keeping secret or selectively communicating their findings.

6. Educational researchers should report research conceptions, procedures, results, and analyses accurately and sufficiently in detail to allow knowledgeable, trained researchers to understand and interpret them.

7. Educational researchers' reports to the public should be written straightforwardly to communicate the practical significance for policy, including limits in effectiveness and in generalizability to situations, problems, and contexts. In writing for or communicating with non-researchers, educational researchers must take care not to misrepresent the practical or policy implications of their research or the research of others.

8. When educational researchers participate in actions related to hiring, retention, and advancement, they should not discriminate on the basis of gender, sexual orientation, physical disabilities, marital status, color, social class, religion, ethnic background, national origin, or other attributes not relevant to the evaluation of academic or research competence.

9. Educational researchers have a responsibility to make candid, forthright personnel recommendations and not to recommend those who are

manifestly unfit.

10. Educational researchers should decline requests to review the work of others where strong conflicts of interest are involved, or when such requests cannot be conscientiously fulfilled on time. Materials sent for review should be read in their entirety and considered carefully, with evaluative comments justified with explicit reasons.

11. Educational researchers should avoid all forms of harassment, not merely those overt actions or threats that are due cause for legal action. They must not use their professional positions or rank to coerce personal or sexual favors or economic or professional advantages from students, research assistants, clerical staff, colleagues, or any others.

12. Educational researchers should not be penalized for reporting in good faith violations of these or other professional standards.

II. Guiding Standards: Research Populations, Educational Institutions, and the Public

A. Preamble. Educational researchers conduct research within a broad array of settings and institutions, including schools, colleges, universities, hospitals, and prisons. It is of paramount importance that educational researchers respect the rights, privacy, dignity, and sensitivities of their research populations and also the integrity of the institutions within which the research occurs. Educational researchers should be especially careful in working with children and other vulnerable populations. These standards are intended to reinforce and strengthen already existing standards enforced by Institutional Review Boards and other professional associations. Standards intended to protect the rights of human subjects should not be interpreted to prohibit teacher research, action research, and/or other forms of practitioner inquiry so long as: the data are those that could be derived from normal teaching/learning processes; confidentiality is maintained; the safety and welfare of participants are protected; informed consent is obtained when appropriate; and the use of the information obtained is primarily intended for the benefit of those receiving instruction in that setting.

B. Standards

1. Participants, or their guardians, in a research study have the right to be informed about the likely risks involved in the research and of potential

consequences for participants, and to give their informed consent before participating in research. Educational researchers should communicate the aims of the investigation as well as possible to informants and participants (and their guardians), and appropriate representatives of institutions, and keep them updated about any significant changes in the research program.

2. Informants and participants normally have a right to confidentiality, which ensures that the source of information will not be disclosed without the express permission of the informant. This right should be respected when no clear understanding to the contrary has been reached. Researchers are responsible for taking appropriate cautions to protect the confidentiality of both participants and data to the full extent provided by law. Participants in research should be made aware of the limits on the protections that can be provided, and of the efforts toward protection that will be made even in situations where absolute confidentiality cannot be assured. It should be made clear to informants and participants that despite every effort made to preserve it, confidentiality may be compromised. Secondary researchers should respect and maintain the confidentiality established by primary researchers. In some cases, e.g., survey research, it may be appropriate for researchers to ensure participants of anonymity, i.e., that their identify is not known even to the researcher. Anonymity should not be promised to participants when only confidentiality is intended.

3. Honesty should characterize the relationship between researchers and participants and appropriate institutional representatives. Deception is discouraged; it should be used only when clearly necessary for scientific studies, and should then be minimized. After the study, the researcher should explain to the participants and institutional representatives the reasons for the deception.

4. Educational researchers should be sensitive to any locally established institutional policies or guidelines for conducting research.

5. Participants have the right to withdraw from the study at any time, unless otherwise constrained by their official capacities or roles.

6. Educational researchers should exercise caution to ensure that there is no exploitation for personal gain of research populations or of institutional settings of research. Educational researchers should not use their influence over subordinates, students, or others to compel them to participate in

research.

7. Researchers have a responsibility to be mindful of cultural, religious, gender, and other significant differences within the research population in the planning, conduct, and reporting of their research.

8. Researchers should carefully consider and minimize the use of research techniques that might have negative social consequences, for example, experimental interventions that might deprive students of important parts of the standard curriculum.

9. Educational researchers should be sensitive to the integrity of ongoing institutional activities and alert appropriate institutional representatives of possible disturbances in such activities which may result from the conduct of the research.

10. Educational researchers should communicate their findings and the practical significance of their research in clear, straightforward, and appropriate language to relevant research populations, institutional representatives, and other stakeholders.

11. Informants and participants have a right to remain anonymous. This right should be respected when no clear understanding to the contrary has been reached. Researchers are responsible for taking appropriate precautions to protect the confidentiality of both participants and data. Those being studied should be made aware of the capacities of the various data-gathering technologies to be used in the investigation so that they can make an informed decision about their participation. It should also be made clear to informants and participants that despite every effort made to preserve it, anonymity may be compromised. Secondary researchers should respect and maintain the anonymity established by primary researchers.

III. Guiding Standards: Intellectual Ownership

A. Preamble. Intellectual ownership is predominantly a function of creative contribution. Intellectual ownership is not predominantly a function of effort expended.

B. Standards

1. Authorship should be determined based on the following guidelines, which are not intended to stifle collaboration, but rather to clarify the credit appropriately due for various contributions to research.

   a. All those, regardless of status, who have made substantive creative contribution to the generation of an intellectual product are entitled to be listed as authors of that product.

   b. First authorship and order of authorship should be the consequence of relative creative leadership and creative contribution. Examples of creative contributions are: writing first drafts or substantial portions; significant rewriting or substantive editing; and contributing generative ideas or basic conceptual schemes or analytic categories, collecting data which require significant interpretation or judgment, and interpreting data.

   c. Clerical or mechanical contributions to an intellectual product are not grounds for ascribing authorship. Examples of such technical contributions are: typing, routine data collection or analysis, routine editing, and participation in staff meetings.

   d. Authorship and first authorship are not warranted by legal or contractual responsibility for or authority over the project or process that generates an intellectual product. It is improper to enter into contractual arrangements that preclude the proper assignment of authorship.

   e. Anyone listed as author must have given his/her consent to be so listed.

   f. The work of those who have contributed to the production of an intellectual product in ways short of these requirements for authorship should be appropriately acknowledged within the product.

   g. Acknowledgement of other work significantly relied on in the development of an intellectual product is required. However, so long as such work is not plagiarized or otherwise inappropriately used, such reliance is not ground for authorship or ownership.

   h. It is improper to use positions of authority to appropriate the work of

others or claim credit for it. In hierarchical relationships, educational researchers should take care to ensure that those in subordinate positions receive fair and appropriate authorship credit.

i. Theses and dissertations are special cases in which authorship is not determined strictly by the criteria elaborated in these standards. Authorship in the publication of work arising from theses and dissertations is determined by creative intellectual contributions as in other cases.

j. Authors should disclose the publication history of articles they submit for publication; that is, if the present article is substantially similar in content and form to one previously published, that fact should be noted and the place of publication cited.

2. While under suitable circumstances, ideas and other intellectual products may be viewed as commodities, arrangements concerning the production or distribution of ideas or other intellectual products must be consistent with academic freedom and the appropriate availability of intellectual products to scholars, students, and the public. Moreover, when a conflict between the academic and scholarly purposes of intellectual production and profit from such production arise, preference should be given to the academic and scholarly purposes.

3. Ownership of intellectual products should be based upon the following guidelines:

a. Individuals are entitled to profit from the sale or disposition of those intellectual products they create. They may therefore enter into contracts or other arrangements for the publication or disposition of intellectual products, and profit financially from these arrangements.

b. Arrangements for the publication or disposition of intellectual products should be consistent with their appropriate public availability and with academic freedom. Such arrangements should emphasize the academic functions of publication over the maximization of profit.

c. Individuals or groups who fund or otherwise provide resources for the development of intellectual products are entitled to assert claims to a fair share of the royalties or other profits from the sale or disposition

of those products. As such claims are likely to be contentious, funding institutions and authors should agree on policies for the disposition of profits at the outset of the research or development project.

d. Authors should not use positions of authority over other individuals to compel them to purchase an intellectual product from which the authors benefit. This standard is not meant to prohibit use of an author's own textbook in a class, but copies should be made available on library reserve so that students are not forced to purchase it.

IV. Guiding Standards: Editing, Reviewing, and Appraising Research

A. Preamble. Editors and reviewers have a responsibility to recognize a wide variety of theoretical and methodological perspectives and, at the same time, to ensure that manuscripts meet the highest standards as defined in the various perspectives.

B. Standards

1. AERA journals should handle refereed articles in a manner consistent with the following principles:

   a. Fairness requires a review process that evaluates submitted works solely on the basis of merit. Merit shall be understood to include both the competence with which the argument is conducted and the significance of the results achieved.

   b. Although each AERA journal may concentrate on a particular field or type of research, the set of journals as a whole should be open to all disciplines and perspectives currently represented in the membership and which support a tradition of responsible educational scholarship. This Standard is not incompatible with giving serious consideration to innovative work and should not be used to discourage perspectives not yet fully established in traditional scholarship.

   c. Blind review, with multiple readers, should be used for each

submission, except where explicitly waived. (See #3.)

d. Judgments of the adequacy of an inquiry should be made by reviewers who are competent to read the work submitted to them. Editors should strive to select reviewers who are familiar with the research paradigm and who are not so unsympathetic as to preclude a disinterested judgment of the merit of the inquiry.

e. Editors should insist that even unfavorable reviews be dispassionate and constructive. Authors have the right to know the grounds for rejection of their work.

2. AERA journals should have written, published policies for refereeing articles.

3. AERA journals should have a written, published policy stating when solicited and non-refereed publications are permissible.

4. AERA journals should publish statements indicating any special emphases expected to characterize articles submitted for review.

5. In addition to enforcing standing strictures against sexist and racist language, editors should reject articles that contain *ad hominen* attacks on individuals or groups or insist that such language or attacks be removed prior to publication.

6. AERA journals and AERA members who serve as editors of journals should require authors to disclose the full publication history of material substantially similar in content and form to that submitted to their journals.

V. Guiding Standards: Sponsors, Policymakers, and Other Users of Research

A. Preamble. Researchers, research institutions, and sponsors of research jointly share responsibility for the ethical integrity of research, and should ensure that this integrity is not violated. While it is recognized that these parties may sometimes have conflicting legitimate aims, all those with responsibility for research should protect against compromising the standards of research, the community of researchers, the subjects of research, and the users of research.

They should support the widest possible dissemination and publication of research results. AERA should promote, as nearly as it can, conditions conducive to the preservation of research integrity.

B. Standards

1. The data and results of a research study belong to the researchers who designed and conducted the study, unless specific contractual arrangements have been made with respect to either or both the data and results, except as noted in II B.4. (participants may withdraw at any stage.)

2. Educational researchers are free to interpret and publish their findings without censorship or approval from individuals or organizations, including sponsors, funding agencies, participants, colleagues, supervisors, or administrators. This understanding should be conveyed to participants as part of the responsibility to secure informed consent.

3. Researchers conducting sponsored research retain the right to publish the findings under their own names.

4. Educational researchers should not agree to conduct research that conflicts with academic freedom, nor should they agree to undue or questionable influence by government or other funding agencies. Examples of such improper influence include endeavors to interfere with the conduct of research, the analysis of findings, or the reporting of interpretations. Researchers should report to AERA attempts by sponsors or funding agencies to use any questionable influence.

5. Educational researchers should fully disclose the aims and sponsorship of their research, except where such disclosure would violate the usual tenets of confidentiality and anonymity. Sponsors or funders have the right to have disclaimers included in research reports to differentiate their sponsorship from the conclusions of the research.

6. Educational researchers should not accept funds from sponsoring agencies that request multiple renderings of reports that would distort the results or mislead readers.

7. Educational researchers should fulfill their responsibilities to agencies funding research, which are entitled to an accounting of the use of their funds, and to a report of the procedures, findings, and implications of the funded research.

8. Educational researchers should make clear the bases and rationales, and the limits thereof, of their professionally rendered judgments in consultation with the public, government, or other institutions. When there are contrasting professional opinions to the one being offered, this should be made clear.

9. Educational researchers should disclose to appropriate parties all cases where they would stand to benefit financially from their research or cases where their affiliations might tend to bias their interpretation of their research or their professional judgments.

VI. Guiding Standards: Students and Student Researchers

A. Preamble. Educational researchers have a responsibility to ensure the competence of those inducted into the field and to provide appropriate help and professional advice to novice researchers.

B. Standards

1. In relations with students and student researchers, educational researchers should be candid, fair, non-exploitative, and committed to their welfare and progress. They should conscientiously supervise, encourage, and support students and student researchers in their academic endeavors, and should appropriately assist them in securing research support or professional employment.

2. Students and student researchers should be selected based upon their competence and potential contributions to the field. Educational researchers should not discriminate among students and student researchers on the basis of gender, sexual orientation, marital status, color, social class, religion, ethnic background, national origin, or other irrelevant factors.

3. Educational researchers should inform students and student researchers concerning the ethical dimensions of research, encourage

their practice of research consistent with ethical standards, and support their avoidance of questionable projects.

4. Educational researchers should realistically apprise students and student researchers with regard to career opportunities and implications associated with their participation in particular research projects or degree programs. Educational researchers should ensure that research assistantships be educative.

5. Educational researchers should be fair in the evaluation of research performance, and should communicate that evaluation fully and honestly to the student or student researcher. Researchers have an obligation to report honestly on the competence of assistants to other professionals who require such evaluations.

6. Educational researchers should not permit personal animosities or intellectual differences vis-à-vis colleagues to foreclose student and student researcher access to those colleagues, or to place the student or student researcher in an untenable position with those colleagues.

The *Ethical Standards of the American Educational Research Association* were developed and, in June 1992, adopted by AERA to be an educational document, to stimulate collegial debate, and to evoke voluntary compliance by moral persuasion. The Ethical Standards were revised in 1996 and in 2000. Accordingly, it is not the intention of the Association to monitor adherence to the Standards or to investigate allegations of violations to the Code.

Design Experiments in Educational Research

by Paul Cobb, Jere Confrey, Andrea diSessa, Richard Lehrer, and Leona Schauble

In this article, the authors first indicate the range of purposes and the variety of settings in which design experiments have been conducted and then delineate five crosscutting features that collectively differentiate design experiments from other methodologies. Design experiments have both a pragmatic bent—"engineering" particular forms of learning—and a theoretical orientation—developing domain-specific theories by systematically studying those forms of learning and the means of supporting them. The authors clarify what is involved in preparing for and carrying out a design experiment, and in conducting a retrospective analysis of the extensive, longitudinal data sets generated during an experiment. Logistical issues, issues of measure, the importance of working through the data systematically, and the need to be explicit about the criteria for making inferences are discussed.

In this short article, we draw on our collective experience of conducting design experiments for a range of purposes in variety of settings in order to delineate prototypical characteristics of the methodology and to describe what is involved in conducting a design experiment. Although the term *design experiment* is most closely associated with Brown (1992) and Collins (1992), pedagogical design has informed the development of theories of instruction for well over a century. Prototypically, design experiments entail both "engineering" particular forms of learning and systematically studying those forms of learning within the context defined by the means of supporting them. This designed context is subject to test and revision, and the successive iterations that result play a role similar to that of systematic variation in experiment.

Design experiments are conducted to develop theories, not merely to empirically tune "what works." These theories are relatively humble in that they target domain-specific learning processes. For example, a number of research groups working in a domain such as geometry or statistics might collectively develop a design theory that is concerned with the students' learning of key disciplinary ideas in that domain. A theory of this type would specify successive patterns in students' reasoning together with the substantiated means by which the emergence of those successive patterns can be supported. This emphasis on theories reflects the view that the explanations and understandings inherent in them are essential if educational improvement is to be a long-term, generative process. Design experiments ideally result in greater understanding of a *learning ecology*—a complex, interacting system involving multiple elements of different types and levels—by designing its elements and by anticipating how these elements function together to support learning. Design experiments therefore constitute a means of addressing the complexity that is a hallmark of educational settings. Elements of a learning ecology typically include the tasks or problems that students are asked to solve, the kinds of discourse that are encouraged, the norms of participation that are established, the tools and related material means provided, and the practical means by which classroom teachers can orchestrate relations among these elements. We use the metaphor of an ecology to emphasize that designed contexts are conceptualized as interacting systems rather than as either a collection of activities or a list of separate factors that influence learning. Beyond just creating designs that are effective and that can sometimes be affected by "tinkering to perfection," a design theory explains why designs work and suggests how they may be adapted to new circumstances. Therefore, like other methodologies, design experiments are crucibles for the generation and testing of theory.

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Design experiments are pragmatic as well as theoretical in orientation in that the study of function—both of the design and of the resulting ecology of learning—is at the heart of the methodology. This emphasis on function in a realized context holds for all design experiments even though they are conducted in a diverse range of settings that vary in both type and scope:

- One-on-one (teacher-experimenter and student) design experiments in which a research team conducts a series of teaching sessions with a small number of students. The aim is to create a small-scale version of a learning ecology so that it can be studied in depth and detail (Cobb & Steffe, 1983; Steffe & Thompson, 2000).
- Classroom experiments in which a research team collaborates with a teacher (who might be a research team member) to assume responsibility for instruction (Cobb, 2000; Confrey & Lachance, 2000; Gravemeijer, 1994).
- Preservice teacher development experiments in which a research team helps organize and study the education of prospective teachers (Simon, 2000).
- In-service teacher development studies in which researchers collaborate with teachers to support the development of a professional community (Lehrer & Schauble, 2000; Stein, Silver, & Smith, 1998).
- School and school district restructuring experiments in which a research team collaborates with teachers, school administrators, and other stakeholders to support organizational change (Confrey, Bell, & Carrejo, 2001).

Crosscutting Features of Design Experiments

We identify five crosscutting features that apply to these diverse types of design experiments. First, the purpose of design

experimentation is to develop a class of theories about both the process of learning and the means that are designed to support that learning, be it the learning of individual students, of a classroom community, of a professional teaching community, or of a school or school district viewed as an organization. We interpret processes of learning broadly to encompass what is typically thought of as knowledge, but also the evolution of learning-relevant social practices and even constructs such as identity and interest. When we look across these diverse types of design experiments, the means for supporting learning encompass the affordances and constraints of material artifacts, teaching and learning practices, and policy levers (e.g., performance-based pay), as well as other forms of mediation that might, for example, include the negotiation of domain-specific norms—such as what counts as a "good" scientific question in a classroom (Wertsch, 1998). It is apparent from this broad view of means of support that it is often necessary to document learning ecologies at multiple levels (Kelly & Lesh, 2000). In the case of an in-service teacher development experiment, for example, the research team might focus simultaneously on the norms and practices of a professional teaching community, the participating teachers' pedagogical reasoning and instructional practices, and their students' reasoning in a particular content domain. A challenge that arises in such cases is therefore that of coordinating multiple levels of analysis.

Although, as a practical matter, a design experiment is conducted in a limited number of settings, it is apparent from the concern for theory that the intent is not merely to investigate the process of supporting new forms of learning in those specific settings. Instead, the research team frames selected aspects of the envisioned learning and of the means of supporting it as paradigm cases of a broader class of phenomena. In the case of a one-on-one design experiment, for example, the broader theoretical goal might be to develop a psychological model of the process by which students develop a deep understanding of particular mathematical ideas, together with the types of tasks and teacher practices that can support that learning. In the case of a school district restructuring experiment, the theoretical goal might be to develop an interpretive framework that explicates the relations between teachers' instructional practices and the institutional settings in which teachers develop and refine their practices. In these and other types of design experiments, the initial design formulated when preparing for an experiment and the new form of learning it is designed to support are viewed as instances of broader classes of phenomena, thereby opening them to theoretical analysis.

The second crosscutting feature is the highly interventionist nature of the methodology. Design studies are typically test-beds for innovation. The intent is to investigate the possibilities for educational improvement by bringing about new forms of learning in order to study them. Consequently, there is frequently a significant discontinuity between typical forms of education (these could be studied naturalistically) and those that are the focus of a design experiment. The design developed while preparing for an experiment draws on prior research and attempts to cash in the empirical and theoretical results of that research. The process of engineering the forms of learning being studied provides the research team with a measure of control when compared with purely naturalistic investigation. Furthermore, in attempting to support a specified form of learning, the researcher is more likely to encounter relevant factors that contribute to the emergence of that form and to become aware of their interrelations.

By its very nature, the study of phenomena as complex as learning ecologies precludes complete specification of everything that happens. It is therefore all the more important to distinguish in the specification of the design between elements that are the target of investigation and those that may be ancillary, accidental, or assumed as background conditions. For example, in a study of children's mathematical development, classroom norms of justification might be assumed as background and the emphasis placed instead on conceptual development. Alternatively, the development of norms might serve as a primary target of investigation (e.g., Yackel & Cobb, 1996). The use of prior research to both specify a design and justify the differentiation of central and ancillary conditions is central to the methodology.

The third crosscutting feature builds on the first two: Design experiments create the conditions for developing theories yet must place these theories in harm's way. Thus, design experiments always have two faces: prospective and reflective. These two faces are familiar to all empirical scientists, but the forms they take in design experiments are somewhat specialized. On the prospective side, designs are implemented with a hypothesized learning process and the means of supporting it in mind in order to expose the details of that process to scrutiny. An equally important objective is to foster the emergence of other potential pathways for learning and development by capitalizing on contingencies that arise as the design unfolds.

On the reflective side, design experiments are conjecture-driven tests, often at several levels of analysis. The initial design is a conjecture about the means of supporting a particular form of learning that is to be tested. During the conduct of the design study, however, more specialized conjectures are typically framed and tested. For example, during a classroom design experiment, an initial conjecture about a prospective interaction between characteristics of tasks as they are realized in the classroom and student responses may be tested. If this conjecture is refuted, alternative conjectures can be generated and tested.

Together, the prospective and reflective aspects of design experiments result in a fourth characteristic, *iterative design*. As conjectures are generated and perhaps refuted, new conjectures are developed and subjected to test. The result is an iterative design process featuring cycles of invention and revision. Of course, to design iteratively demands systematic attention to evidence about learning and, as we later describe, this often involves the parallel development of measures sensitive to the changing ecology of learning. The intended outcome is an explanatory framework that specifies expectations that become the focus of investigation during the next cycle of inquiry.

The fifth feature of design experimentation again reflects its pragmatic roots: Theories developed during the process of experiment are humble not merely in the sense that they are concerned with domain-specific learning processes, but also because they are accountable to the activity of design. The theory must do real work. General philosophical orientations to educational matters—such as constructivism—are important to educational practice, but they often fail to provide detailed guidance in organizing instruction. The critical question that must be asked is

whether the theory informs prospective design and, if so, in precisely what way? Rather than grand theories of learning that may be difficult to project into particular circumstances, design experiments tend to emphasize an intermediate theoretical scope (diSessa, 1991) that is located between a narrow account of a specific system (e.g., a particular school district, a particular classroom) and a broad account that does not orient design to particular contingencies. For example, the claim that invented representations are good for mathematics and science learning probably has some merit, but it specifies neither the circumstances in which these representations might be of value nor the learning processes involved and the manner in which they are supported. In contrast to most research methodologies, the theoretical products of design experiments have the potential for rapid pay-off because they are filtered in advance for instrumental effect. They also speak directly to the types of problems that practitioners address in the course of their work.

Preparing for a Design Experiment

As we have emphasized, a crucial issue to be addressed when one conducts any type of design experiment is that of clarifying its theoretical intent: What is the point of the study? For illustrative purposes, we will exemplify this aim for the case of classroom design experiments, although it applies equally to other kinds of design experiments, such as those that focus on school districts or larger educational systems, out-of-school learning contexts, workplaces, and the like.

Most classroom design experiments are conceptualized as cases of the process of supporting groups of students' learning in a particular content domain. The theoretical intent, therefore, is to identify and account for successive patterns in student thinking by relating these patterns to the means by which their development was supported and organized. However, different classroom design experiments may set their focus on different constellations of issues. For example, one might focus on the relation between classroom norms or standards for mathematical or scientific argumentation, and student learning. Another study might emphasize the ways in which diversity in students' prior experiences can be capitalized upon as a resource to ensure that all students have access to significant disciplinary ideas.

In addition to clarifying the theoretical intent of the experiment, the research team must also specify the significant disciplinary ideas and forms of reasoning that constitute the prospective goals or endpoints for student learning. This usually involves drawing on and synthesizing the prior research literature to identify central organizing ideas for a domain (e.g., the notion of distribution as a central idea for statistical analysis, Lehrer & Schauble, 2002; McClain, Cobb, & Gravemeijer, 2000). In the process of specifying instructional goals, a research team frequently proposes an alternative conception of a domain (e.g., typicality, center, variation, and relative frequency as characteristics of the single, overarching idea of distribution rather than as a set of discrete curriculum topics). Another source of discontinuity in curricular specification is that new resources, such as computer software, might be developed to support the envisioned form of learning. Yet another is that evolving theories of knowledge informed by analyses of how knowledge is used in complex settings may implicate different performances as indicative of deep understanding (diSessa, in press), such as the ability to innovate procedures in small-group design episodes in contrast to individual application of a given procedure.

As part of the process of preparing for a classroom design experiment, the research team also specifies its assumptions about the intellectual and social starting points for the envisioned forms of learning. To achieve the instructional agenda, the team identifies current student capabilities, current practices, and other resources on which it might be able to build. In relatively well-researched domains, the team can draw on the literature to develop conjectures about students' initial interpretations and understandings. However, in less researched areas, the team typically needs to conduct pilot work to document these understandings and, thus, the consequences of students' prior instructional histories. In the course of this pilot work, the team might also develop new methods for assessing aspects of student reasoning that need to be documented, given the purposes of the experiment.

When the conjectured starting points, elements of a trajectory, and prospective endpoints have been specified, the challenge is to formulate a design that embodies testable conjectures about both significant shifts in student reasoning and the specific means of supporting those shifts. In well-studied domains, the research team might have a reasonable level of confidence in some of their conjectures. However, in others, where knowledge is less developed, the team regards its conjectures as speculative and begins the experiment with the expectation that many will prove to be unviable. Even then, the advantage of explicating conjectures at the outset is that they orient the research team to identify and account for successive patterns in student thinking.

The means of supporting student learning are usually construed broadly, consistent with an acknowledgement of the complexity of teaching and learning. This relatively encompassing view of the means of support implies that the research team must generate multiple forms of data to adequately document the learning ecology. Because we have focused on classroom learning, it is important to emphasize that the focus and means of documentation vary with the institutional setting. For example, in a science museum, the built environment may constitute an important means for focusing visitor attention, communicating how to initiate the activity at hand, and framing reasonable interpretations of the outcome.

Conducting a Design Experiment

As we have indicated, a primary goal for a design experiment is to improve the initial design by testing and revising conjectures as informed by ongoing analysis of both the students' reasoning and the learning environment. The size of the research team and the expertise of the members vary depending on the type and purpose of the experiment. For example, it might be feasible for a single researcher who conducts the teaching sessions and a graduate assistant who records the sessions to carry out a one-on-one design experiment. In the case of a classroom design experiment conducted in collaboration with a teacher in a relatively well-researched domain, the team might include the teacher, a researcher, and two graduate assistants. The crucial determinant in any type of design experiment is that the team collectively has the expertise to accomplish the functions associated with developing an initial design, conducting the experiment, and carrying

out a systematic retrospective analysis. Thus, in an experiment with a relatively broad scope that encompasses multiple classrooms and attends to the organizational setting at the school and district level, two or more researchers might be involved whose combined expertise includes the design and analysis of classroom learning environments, professional teaching communities, and schools as institutions.

Regardless of the type of experiment, strong involvement of the leaders of the research team is essential. The locus of that participation is again defined by the scope and purpose of the experiment. Accordingly, if the scope is district reform, the team leaders will need to be actively involved in nested levels of activity, extending from policy forums (such as school board or content standards meetings) to professional development settings to classrooms. If the scope is more constrained, for example, to a single classroom, the team leaders may be present in the classroom as the design unfolds.

There are at least four important functions that require ongoing direct engagement in the research setting and the associated planning and interpretive activities. These functions collectively compose researcher leadership in the conduct of design experiments. First, a clear view of the anticipated learning pathways and the potential means of support must be maintained and communicated within the research team, even while responding to contingency. Maintaining such an overview can be a daunting challenge, even for an experienced researcher. Second, the extended nature of most design experiments calls for the cultivation of ongoing relationships with practitioners. These relationships are sustained by the negotiation of a shared enterprise, which is typically developed over the long haul as lead researchers consistently demonstrate their personal commitment. Third, because of the reciprocal emphasis on learning and the means that support it, design researchers seek to develop a deep understanding of the ecology of learning—not simply to facilitate logistics, but because this understanding is a theoretical target for the research. As part of the process of refining conjectures, subtle and often unanticipated cues need to be recognized and drawn into a larger perspective. Fourth and finally, regular debriefing sessions are the forum in which past events are interpreted and prospective events are planned for. These sessions are the sites where the intelligence of the study is generated and communicated.

One of the distinctive characteristics of the design experiment methodology is that the research team deepens its understanding of the phenomenon under investigation while the experiment is in progress. It is therefore important that the team generates a comprehensive record of the ongoing design process. It is standard procedure in most engineering disciplines to keep records to support the retrospective analysis of the experiment (Edelson, 2002). Accordingly, the research team may employ audio records of meetings and logs to document the evolving conjectures, together with the observations that are viewed as either supporting or questioning a conjecture.

In addition to self-consciously building and documenting the design and its rationale, the team members, like all researchers, have a responsibility for communicating what they learn in ways that are open to public scrutiny. This implies a commitment to generate data that support the systematic analysis of the phenomenon under investigation. At a minimum, this entails the generation of data on both learning and the means by which that learning was generated and supported. In practice, achieving these aims frequently requires the collection and coordination of a complex array of data sources—for example, products of learning (such as student work); classroom discourse; body posture and gesture; tasks and activity structures; patterns of social interaction; inscriptions, notations, and other tools; and responses to interviews, tests, or other forms of assessment. Because the team often intends to use these data sources to track changes over time, the task is further complicated by the need to collect extended records of each type. Technological support for the generation of these forms of data (e.g., video cameras, sophisticated audio-recording systems, mass electronic storage devices) enables these efforts but also imposes its own challenges (e.g., the development of tools and procedures for managing and analyzing large quantities of data).

The team draws on a variety of data sources that may bear on the broader phenomena framing any particular design experiment. Consider, for example, an experiment in which the team has framed the process of cultivating students' interests in disciplinary ideas as an explicit focus of investigation. In this case, team members might document the nature of students' engagement not only in the target classroom but also in out-of-school activities. Multiple sources of data ensure that retrospective analyses conducted when the experiment has been completed will result in rigorous, empirically grounded claims and assertions. Of course, no data collection can be complete, and the revision of the data collection procedures may be a part of the iterative process. As with traditional experimental and quasi-experimental designs, the viability of the conclusions drawn from data depends on the soundness of the process that generated the data.

Attending to the process by which data are generated means attending to the problem of measure. Much of the cleverness of excellent design experiments resides in how the team handles issues of measurement. An obvious point, although one that is often overlooked, is that all measurements (even observations) are *indexes* to constructs of interest, not the constructs themselves. For example, consider all the decisions that must be made when using video as data, even though the surface impression is one of non-problematic capture (Hall, 2000). Measures are created, not found, and decisions about the creation of measures are among the most important made. An otherwise impeccable design will produce no useful information about the phenomena of interest if problems of construct validity are not successfully resolved. Measures that are feasible to administer, and that provide precise and reliable scores, may or may not adequately capture the phenomenon of interest. Because design experiments need to generate results that do work with respect to subsequent cycles of design, they focus on problems of construct validity.

Conducting Retrospective Analysis

An educational accomplishment is characterized by contingency in which earlier events open up, enable, and also constrain the events that follow. Accounting for this process requires an historical or retrospective explanation, one that provides a trustworthy account of the process whereby a series of events—each of which is local and contingent—can be seen as part of an emergent and potentially reproducible pattern. For example, consider

a third-grade class working together to explore conjectures about whether the volume of a plant's canopy grows proportionally over the plant's life cycle. One might want to understand how such a capability came to be. Producing an explanation of this kind requires showing how the students' earlier histories of learning (e.g., about geometric similarity, rates, and plants) bear on the events under consideration. Doing so requires justifying both selection (among all events) and rational reconstruction that focuses on issues of cause and relative importance of events in the class's unfolding history. For this reason, it is methodologically advantageous to cultivate diverse points of view from members of the research team. Diversity of expertise and backgrounds among members of the research team can be an important resource for developing alternative interpretations, as can asking different team members to assume primary responsibility for representing particular perspectives during the analysis.

A central challenge in conducting retrospective analyses is to work systematically through the extensive, longitudinal data sets generated in the course of a design experiment so that the resulting claims are trustworthy. As part of this process, it is important to be explicit about the criteria and types of evidence used when making particular types of inferences so that other researchers can understand, monitor, and critique the analysis. A primary aim when conducting a retrospective analysis is to place the design experiment in a broader theoretical context, thereby framing it as a paradigm case of the more encompassing phenomena specified at the outset. In this regard, retrospective analyses can be contrasted with the analyses conducted while the experiment is in progress in that the latter are typically oriented toward the goal of supporting the learning of the participants. For example, in a classroom experiment, the research team may, under the pressure of time, intuitively and successfully modify aspects of its instructional design. Retrospective analysis attempts to generate a coherent framework that accounts for these effects, thus making it possible to anticipate outcomes in future designs. In sum, retrospective analyses results in situated accounts of learning that relate learning to the means by which it can be supported and organized.

The situated nature of retrospective analyses is a strength of the methodology, given the overall goal of engineering new forms of learning and the tendency of "high" theory to pass over what may be important details in an effort to paint phenomena in uniform terms. In particular, because the resulting accounts of learning are tied to the means by which it was generated, the design team is always in a position to develop testable conjectures about how those means of support and, thus, the instructional design might be improved. "What works" is underpinned by a concern for "how, when, and why" it works, and by a detailed specification of what, exactly, "it" is. This intimate relationship between the development of theory and the improvement of instructional design for bringing about new forms of learning is a hallmark of the design experiment methodology.

In summary, design experiments are extended (iterative), interventionist (innovative and design-based), and theory-oriented enterprises whose "theories" do real work in practical educational contexts. Although design experiments share many individual characteristics with other ways of conducting science in the service of education, the constellation of crosscutting themes we have identified distinguishes a genre of science with high promise but also with a host of characteristic difficulties that researchers need to manage effectively to achieve that promise.

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