A View of Professional Development as Technology Transfer

Paul Eakin
Department of Mathematics
University of Kentucky
paul@ms.uky.edu

Supported by the National Science Foundation
through the Appalachian Math Science Partnership

With

- Dr. Lee Alan Roher , mathematics teacher , Boyle County High School, Boyle County, Ky
- 2009 doctoral dissertation, University of Kentucky
  - “The relationship between the degree of participation in online embedded professional development for high school mathematics teachers and student achievement in college algebra.”

“technology transfer” as opposed to “professional development”

The term “PD” communicates:

- A sense of “expert” service to enhance the productive capacity of the receiving <u>individuals</u>
  - Often a sense of “remediation”
- No sense that selection to participate enhances (or signifies) the status of the recipients in the receiving organization
- No sense that content is uniquely available from the source
- A sense of focus on general goal(s); difficult to assess

“Tech Transfer communicates :

- A sense of collegial transfer done to improve productive capacity of the receiving organization
- A sense of the receiving organization sending its best people to receive the transfer
- A sense of new knowledge of established potential to enhance productivity being communicated by its originators
- A sense of focus on specific goal(s); much easier to assess

The Evolution of Intel's Copy EXACTLY! Technology Transfer Method

Chris J. McDonald, Intel SEMATECH

Index words: copy exactly, technology transfer

Abstract

Semiconductor manufacturing is characterized by very complex process flows made up of individual process steps, many

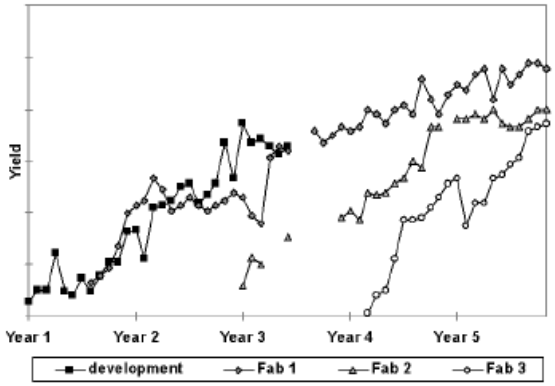
re, there
whereby
ach final
lts from
ith each

Introduction

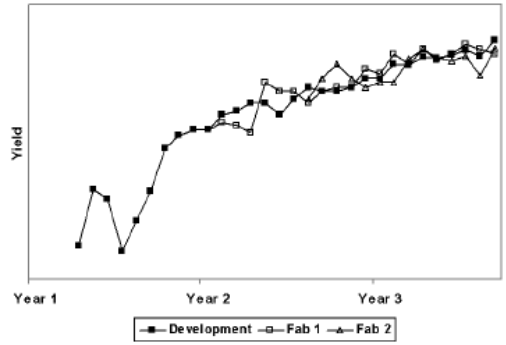
Table 1 shows the typical technology transfer approaches used over the last ten years or so. At the 1.5-micron generation, process flows were much simpler than they are today. A small band of technical experts would typically be employed to orchestrate a successful technology transfer. Generally there wou
lengthy "c

Intel Technology Journal Q4'98

cused on matching device and final product p
long as these were correct, changes would still



Technology Generation	Transfer Strategy	Comments
1.5 micron	"Make It Work"	Small band of engineers. Few ground rules needed.
1.0 and 0.8 micron	"Process Output Matching"	Copy selectively. Match to existing factory conditions.
0.5 micron	"Copy EXACTLY!"	Copy everything that might affect the process.
0.35 and 0.25 micron	"Systems Synergy"	Copy all manufacturing systems.



…….to prove ~~product quality and reliability~~ program effectiveness, the transfer from ~~R&D~~ materials development to ~~manufacturing~~ instruction, or to a new ~~factory~~ school, offered the opportunity to ~~introduce~~ promise improvements to the ~~equipment~~ teachers and ~~process~~ instruction. The latest ~~model equipment~~ curriculum or even a new ~~vendor~~ text might be chosen. ~~Process~~ Instructional recipes could be changed to improve ……

Copy Exactly!

Transfer the technology along with all of the tools and the capacity to employ them in exactly the same manner and as productively as the developers.

Access to Algebra: A Copy Exactly! Experiment

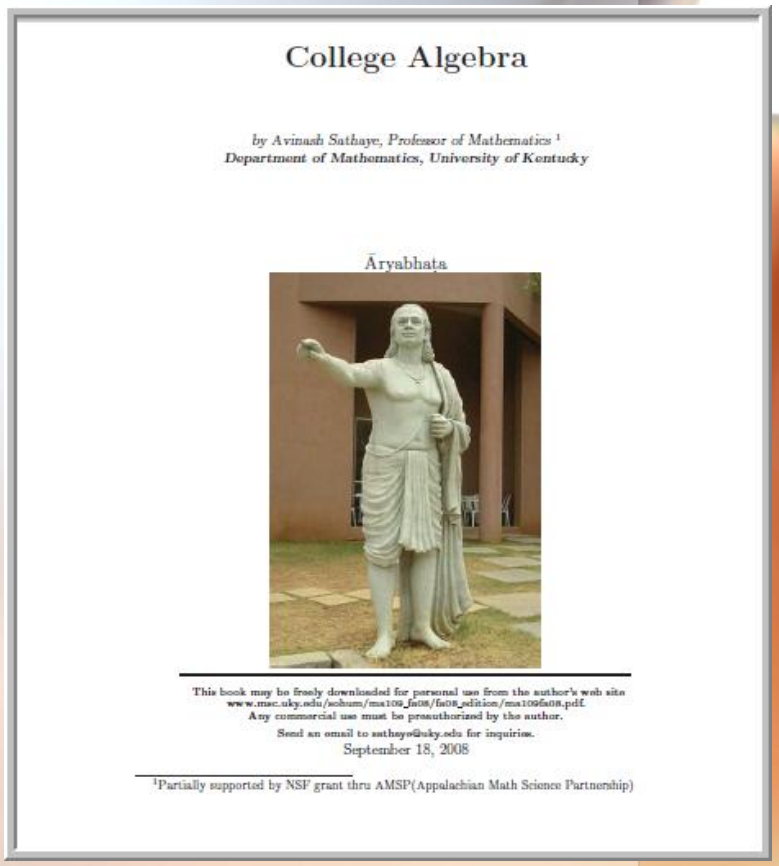
- **The Technology**: A College Algebra Course
  - Application: Production of college credit in college algebra
- **Objective:** Transfer to 7 Appalachian Secondary Schools (14 Math Teachers) the capacity to offer "exactly" the same course as that taught on campus.
- **Question 1.** What precisely is to be "transferred" and how do we determine if it has been transferred "exactly"
- **Question 2**: Is the course content substantially new to the recipients?

The course

- Very classical approach to content (sixth to nineteenth century mathematics)
  - technology (calculators) for “arithmetic”
- New (free) text written specifically for the project
  - Large amount of “new” material
    - Not familiar to most teachers
    - Some not familiar to new graduate students
- Companion graduate course for teachers on coordinate free approach to the same material

College Algebra by Avinash Sathaye

- Studies the interplay between algebra and geometry
  - geometric information in coefficients of algebraic expressions.
- Emphasis on a few primary tools
  - Euclidean algorithm
  - Aryabhata Algorithm
  - Cramer's Rule
  - Complex numbers
  - Binomial Theorem
- Companion web homework
- Free, open source
- Written specifically for this project



College Algebra

by Avinash Sathaye, Professor of Mathematics [1]
Department of Mathematics, University of Kentucky

Āryabhaṭa

This book may be freely downloaded for personal use from the author's web site www.ms.uky.edu/sohum/ma109_fa08/fa08_edition/ma109fa08.pdf.
Any commercial use must be preauthorized by the author.
Send an email to sathaye@uky.edu for inquiries.
September 18, 2008

[1]Partially supported by NSF grant thru AMSP(Appalachian Math Science Partnership)

http://www.ms.uky.edu/~sohum/ma109/ma109_fa08/

Question 10

The fraction $\frac{308,712}{334,248}$ is not in lowest terms since both the numerator and denominator are even. So $\frac{308,712}{334,248}$ and $\frac{154,356}{167,124}$ are fractions that represent the same rational number, r. Find the fraction in "lowest terms" which represents r. That is, write $r = \frac{A}{B}$ where A and B are both positive and have no common factor other than 1.

$A =$ _____ $B =$ _____

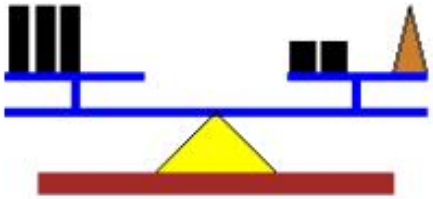
Remember not to include commas in your answers.

	1	0	308712
0	0	1	334248
-1	1	0	308712
-12	-1	1	25536
-11	13	-12	2280
-5	-144	133	456
	733	-677	0

733*308712 = 677*334248

Answer = $\frac{677}{733}$

Question 16



Larry has a balance, a large collection of 43 gram weights and another large collection of 37 gram weights. He also has a golden object which is supposed to weigh exactly 6 grams and he wants to check the weight. Complete the following Aryabhata table

minus quotient	Answer 1	Answer 2	Remainders
	1	0	43
	0	1	37

and use part of it for a recipie to place weights of one type on one side of the balance and weights of the other type on the opposite side so that the scale will perfectly balance if the weight of the object is correct. To do this, one would place [ ] of the 37 gram weights in the left pan and [ ] the 43 gram weights in the right pan.

Solution:

-6*43+7*37=1

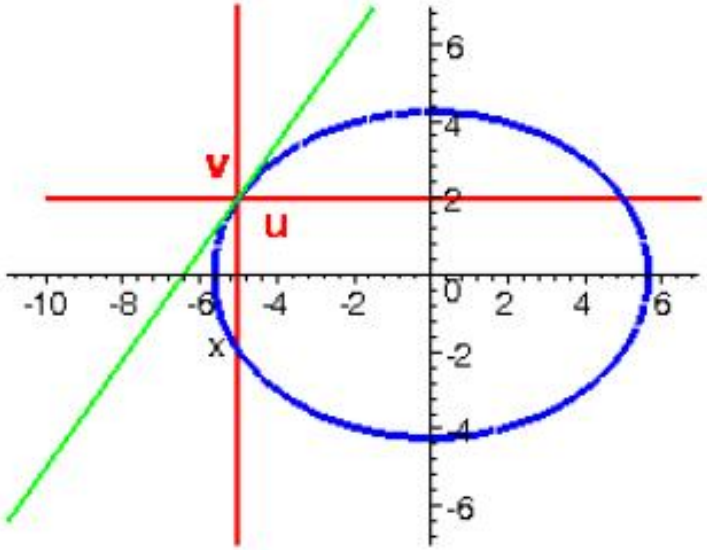
6*(-6*43) + 6*(7*37) = 6*1

-42*37 + 36*43 = 6

36* 43 = 6 + 42* 37

	1	0	43
-1	0	1	37
-6	1	-1	6
-6	-6	7	1
	37	-43	0

Question 1



Solution:

$$9x^2 + 16y^2 - 289 = 0$$

$$9(u-5)^2 + 16(v+2)^2 - 289 = 0$$

$$9u^2 - 90u + 16v^2 + 64v = 0$$

$$-90u + 64v = 0$$

$$-90(x+5) + 64(y-2) = 0$$

$$-90x - 578 + 64y = 0$$

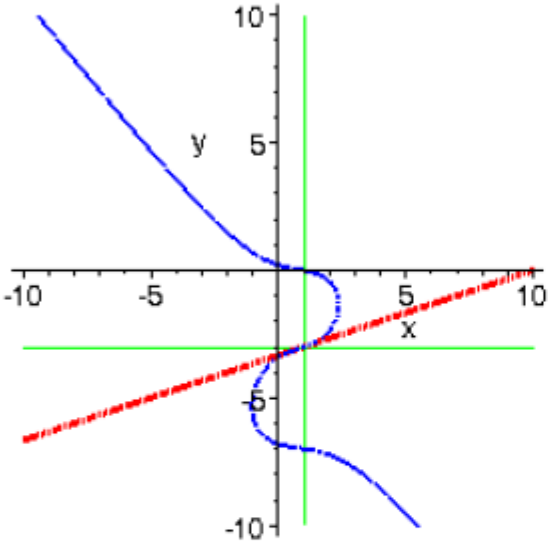
$$y = \frac{45x}{32} + \frac{289}{32}$$

The graph of the ellipse E, with equation $9 \cdot x^2 + 16 \cdot y^2 - 289 = 0$ is shown. The vertical line is the graph of x = -5 and the horizontal line v is the graph of $y = 2$. Their intersection $P(-5, 2)$ is on E (i.e. is a solution to the equation). As in section 10.1 pf the text, substitute $x = u - 5$, $y = v + 2$ to get $9 \cdot u^2 - 90 \cdot u + 16 \cdot v^2 + 64 \cdot v = 0$ which is the equation for the ellipse in terms of u, v.

(i) In terms of u, v the equation of the tangent line to E at P is [ ] $\cdot u +$ [ ] $\cdot v +$ [ ] $= 0$.

(ii) In terms of x, y the equation of the tangent line at P is $y =$ [ ]

Question 6



Solution:

$$-8x+5+5x^2-2x^3-y^3-10y^2-21y=0$$

$$-8u+60+5(u+1)^2-2(u+1)^3-(v-3)^3-10(v-3)^2-21v=0$$

$$-4u-21v+60+\text{higher order terms}=0$$

$$-4(x-1)-21(y+3)=0$$

$$-4x-59-21y=0$$

The point $P(1,-3)$ lies on the graph of $-8\cdot x+5+5\cdot x^2-2\cdot x^3-y^3-10\cdot y^2-21\cdot y=0$. If, as in section 10.1 of the text, make the substitution $x=u+1$, $y=v-3$ in this equation to produce an equation for the graph, expressed in (u,v) coordinates.

(i) The (u,v) coordinates of the point P are (_____ , _____).

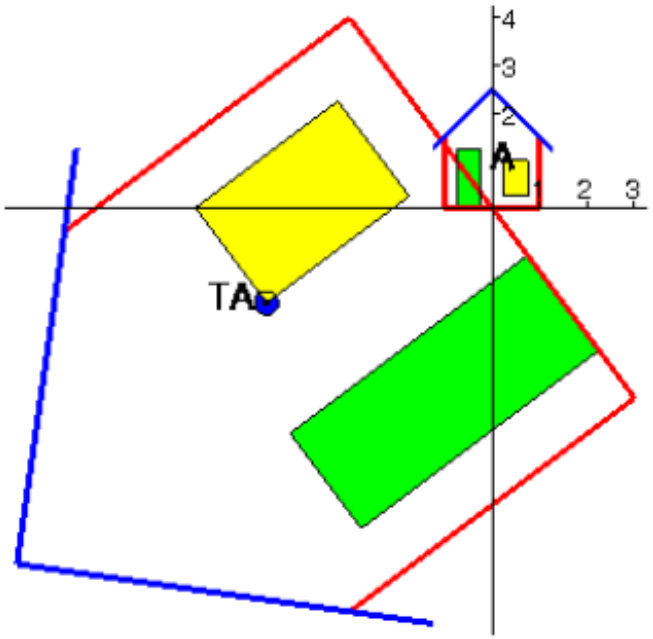
(ii) In (u,v) coordinates the equation for the tangent line to the graph at P is

_____ $=0$.

(iii) In (x,y) coordinates the equation of the tangent line is _____ $x+12y+$ _____ $=0$.

Hint

Question 3



The transformation T maps the plane onto itself by multiplication by a complex number. That is, there is a complex number $C = a + ib$ such that for any point $P(x, y)$, $T(P)$ is the point corresponding to the complex number $C \cdot P$. For a particular complex number C the transformation T takes the smaller house in the diagram to the larger one. The point $A = \left(\frac{1}{4}, 1\right)$ (the upper left corner of the window) on the smaller house is taken to the point $T(A) = \left(-\frac{19}{4}, -2\right)$ on the larger house.

The complex number $C =$ _____

The small house is rotated _____ degrees counterclockwise and expanded by a factor of _____

Solution:

$$T(A) = C\,A$$

$$A = \left(\frac{1}{4}, 1\right) = \frac{1}{4} + i$$

$$T(A) = \left(-\frac{19}{4}, -2\right) = -\frac{19}{4} - 2i$$

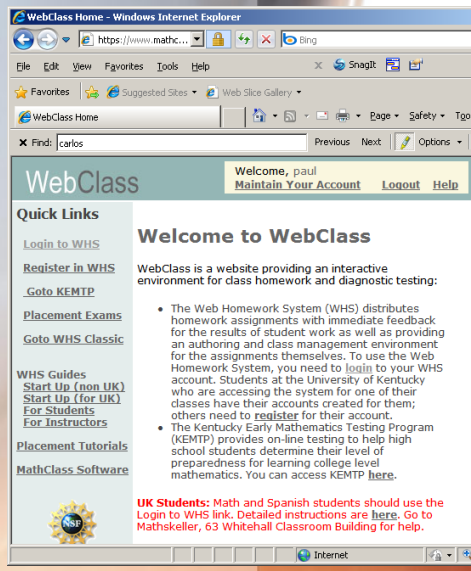
$$-\frac{19}{4} - 2i = C\left(\frac{1}{4} + i\right)$$

$$C = \frac{\frac{1}{4} + i}{-\frac{19}{4} - 2i} = -3 + 4i$$

$$\|C\| = \sqrt{(-3)^2 + 4^2} = 5$$

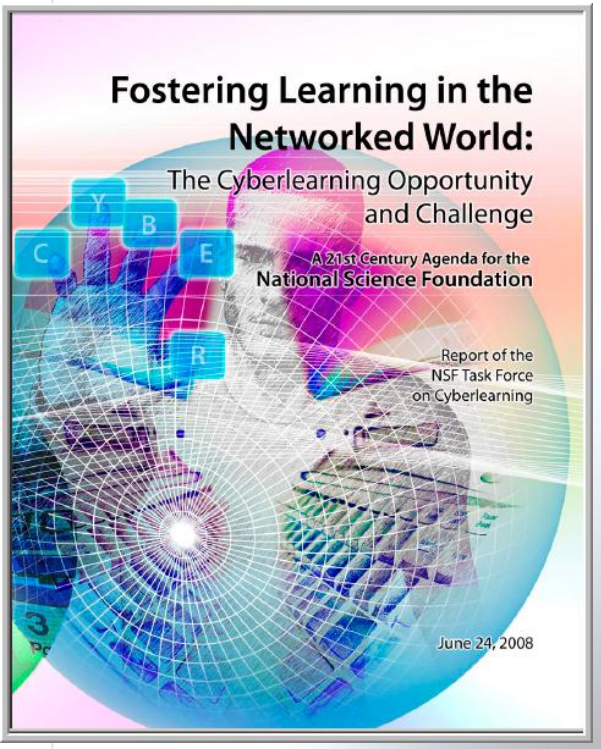
$$\theta = \arctan\left(\frac{4}{-3}\right) + \pi = 126.8698 \text{ deg}$$

- Exams, homework, communications, materials distribution, attendance, etc . are managed through a very large mathematics instruction support system called “mathclass”
  - developed at UK over the last 10 years
    - –Mainly with NSF (AMSP) support
    - –5000 students (2,000,000 grading transactions) per semester
    - –Open source



- The Mathclass system provides both the packaging mechanism and transfer methodology

- An open source "cyberlearning platform" in the sense of *Fostering Learning in the Networked World*
  - Report of NSF Task Force on Cyberlearning , June 2008



".. common, open cyberlearning platform that supports a full range of teaching and learning activities, including assessment and analysis. ……."

" … collection of learning modules on the platform that teachers can easily integrate into their practice "

Project Format

- Course structured as coordinated, multi-section university course with on-campus and off-campus sections
- Participating teachers have their own "sections"
- All sections use the same text, syllabus, calendar
  - All students do (personal versions of) same online homework on the same schedule
  - All exams are open-response, commonly graded, taken at the same time

- On-campus sections taught by experienced on-campus instructors
- Teachers formally treated as teaching assistants in mathematics:
  - all have math degrees or course equivalent
  - most lacked 18-graduate hour Southern Association requirement to qualify as independent instructor and “teacher of record”
    - Not a problem because of rigid UK control of curriculum, assessments, and (college) grades
- First off-campus “sections” were small:

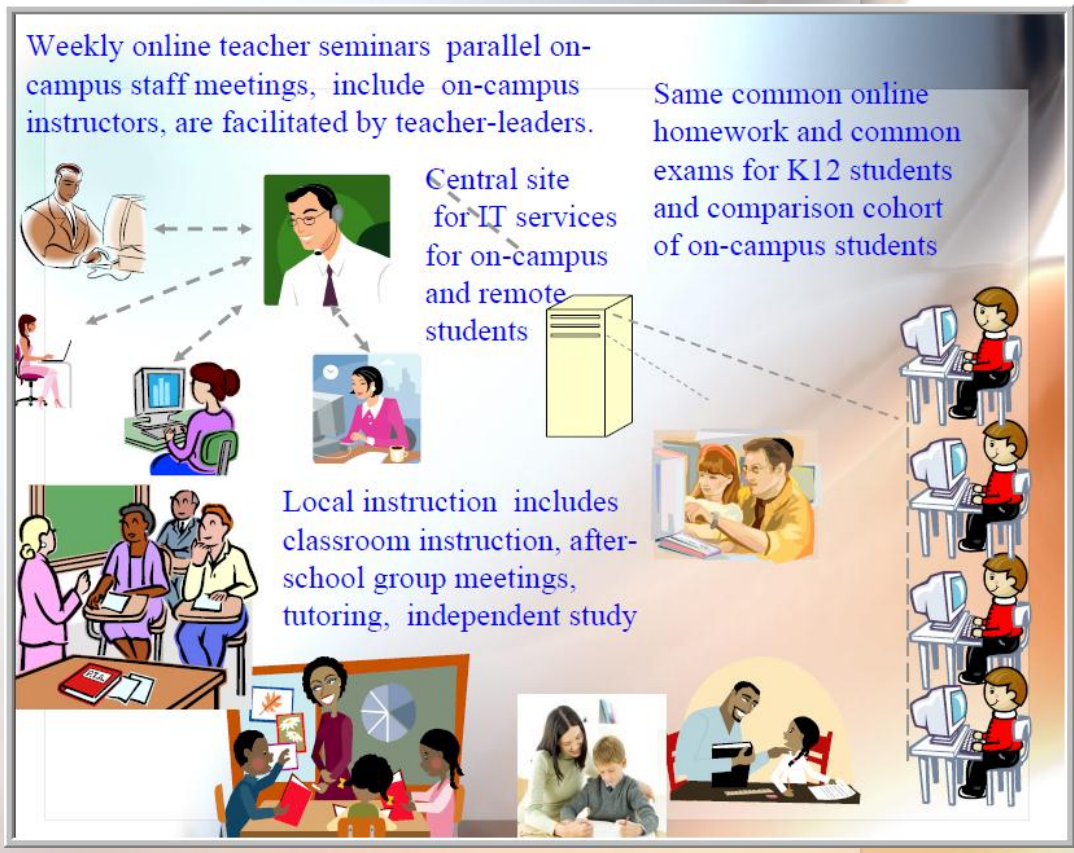
  (2-6) students/teacher in initial semester

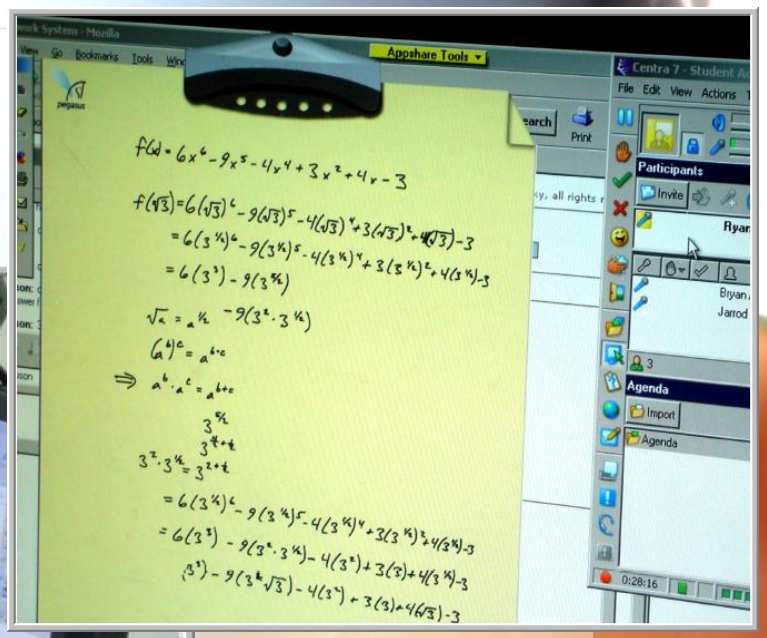
On-campus Comparison Group

- Students from an NSF STEP program at UK
  - Focus on Appalachian and Minority Science, Technology, Engineering, and Mathematics Majors (AMSTEMM)
- Motivated, well supported
- Interested in science, math
- Majority from Appalachian Kentucky
- Demographics, academic preparation largely reflect those of AA students

Transfer Program

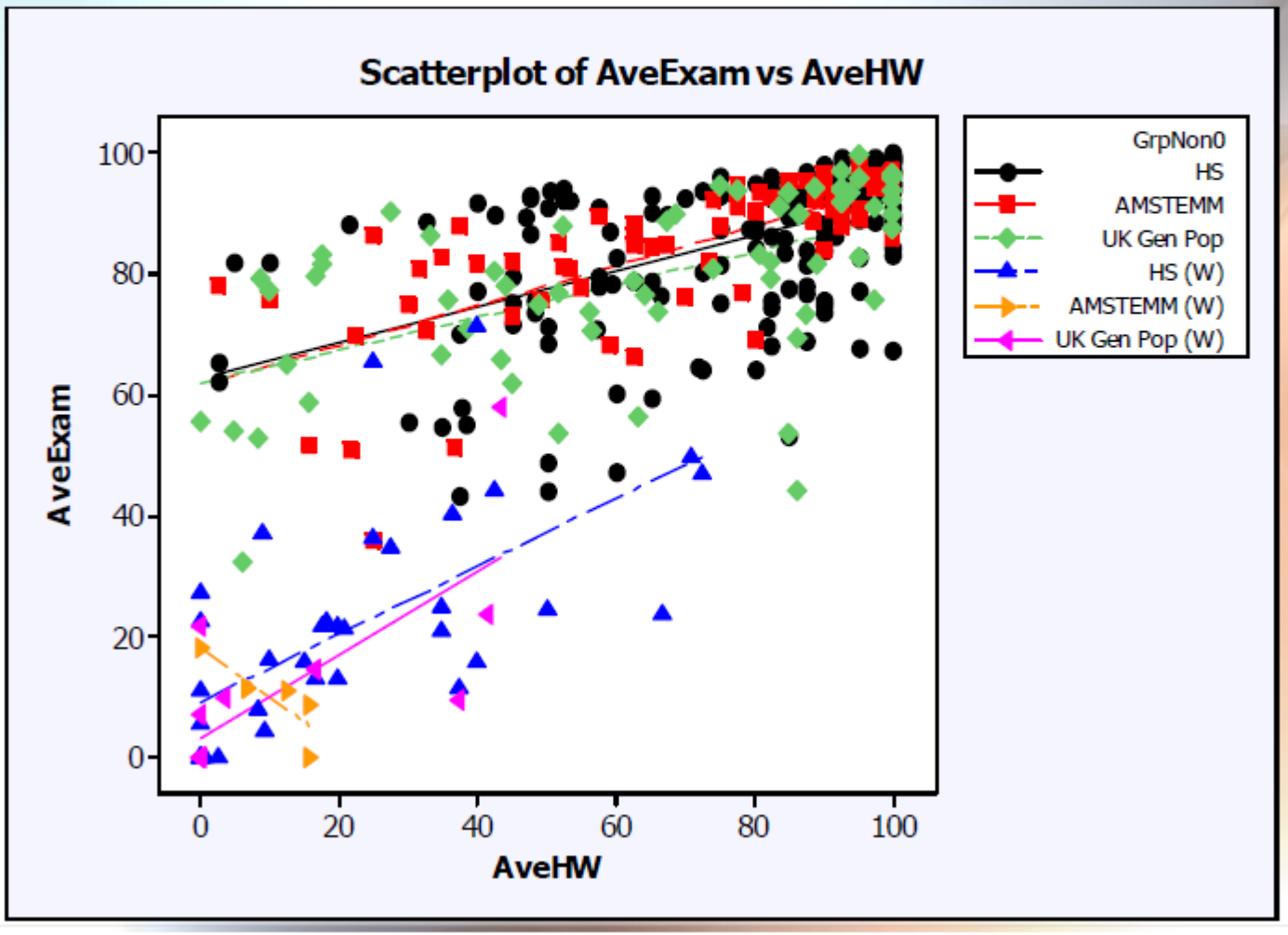
- Summer:
  - Initial 1-day “face-to-face” meeting for intro to program and technology
  - 4-day “webinar” walkthrough of course with faculty materials developers
- Fall:
  - Weekly synchronous online seminar (course staff meeting) to go over upcoming material, instructional issues




Appshare Tools
Centra 7 - Student
File Edit View Actions
Participants
Invite
Agenda
Import
Agenda
0:28:16

Some Outcomes

Homework vs Test Average
Fall 2007- Spring 2008



Grade distributions: Fall 07-Spring 08

	A	B	C	D	E(F)	W	total
College Students 2007 Fall	16 39%	12 29%	5 12%	4 10%	1 2%	3 7%	41
Secondary Students 2007 Fall	27 43%	12 19%	6 10%	4 6%	3 5%	11 17%	63
Secondary Students 2008 Spring	26 34%	13 17%	12 16%	7 9%	4 5%	14 18%	76
Percentages are rounded to the nearest integer, so rows may not total 100%							

Note: AMSTEMM did not have a section of MA109 in Spring 2008.

Student success vs PD participation

	Teachers	Total	Total Enrolled HS Students	HS Students receiving College Algebra credit	Success Rate
F 06	Systematic Participation	9	28	26	93%
	Non-systematic Participation	5	14	3	21%*
S 07	Systematic Participation	11	21	19	90%
	Non-systematic Participation	3	9	3	33%*
F 07	Systematic Participation	3	27	20	74%
	Non-systematic Participation	5	40	25	62.5%
S 08	Systematic Participation	4	28	19	67%
	Non-systematic Participation	5	48	32	67%

* = skewed by outlier

Most S07-S 08 are repeating from previous semester

Paul Eakin
paul@ms.uky.edu