SLAM MICHIGAN

SYMPOSIUM ON LEARNING ANALYTICS AT MICHIGAN

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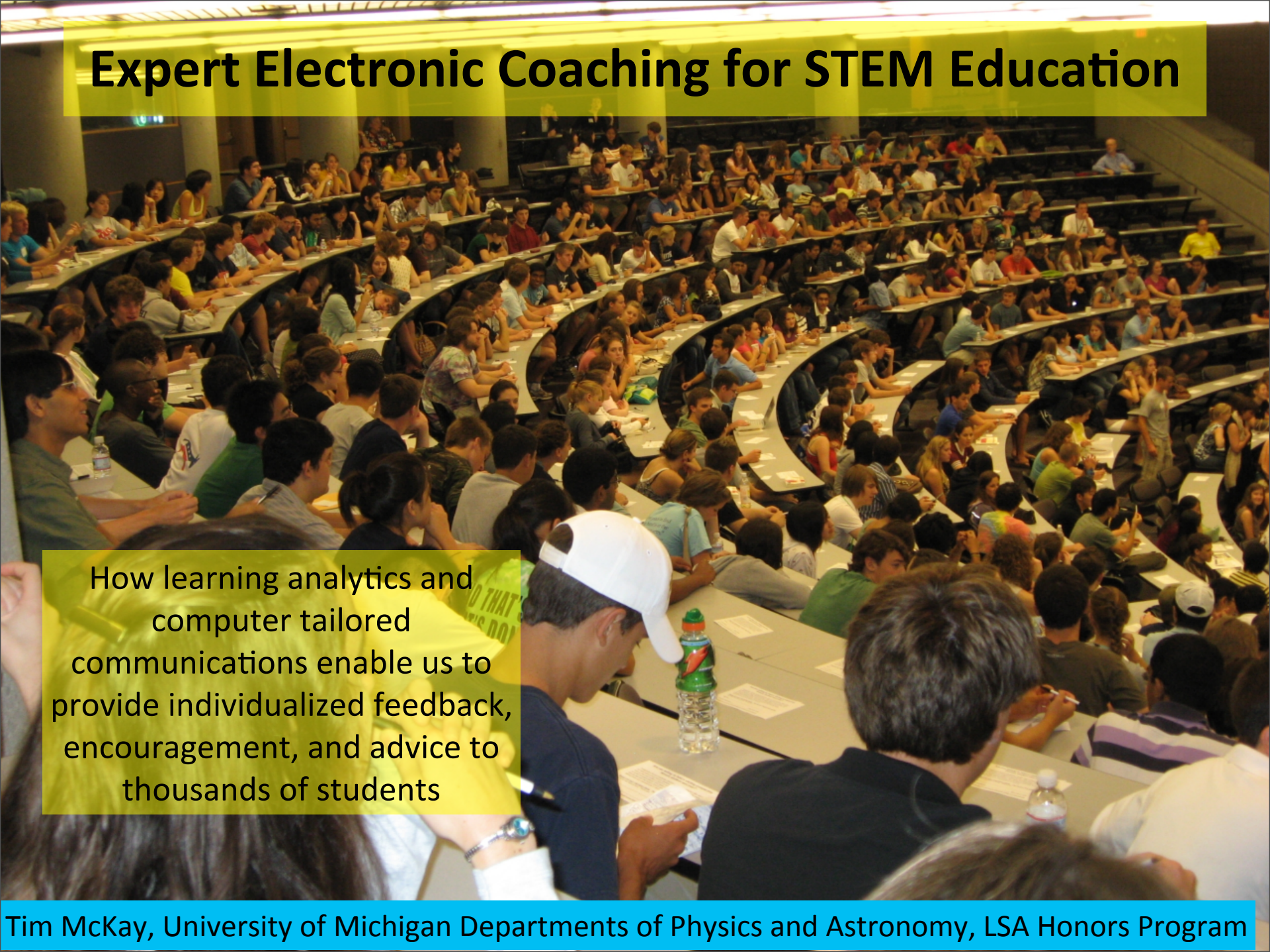
Expert Electronic Coaching for STEM Education

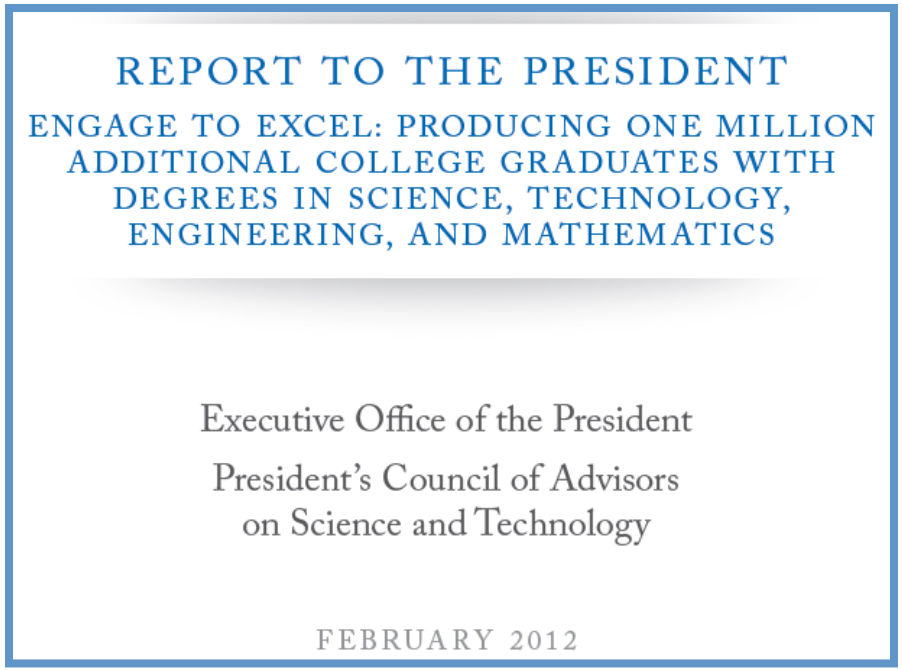


How learning analytics and computer tailored communications enable us to provide individualized feedback, encouragement, and advice to thousands of students

Tim McKay, University of Michigan Departments of Physics and Astronomy, LSA Honors Program

Challenges in STEM education

- PCAST calls for 1M more STEM majors over 10 years – a 35% increase
- Nationwide, only 40% of those intending STEM majors complete them
- The largest loss occurs during two years of large introductory courses

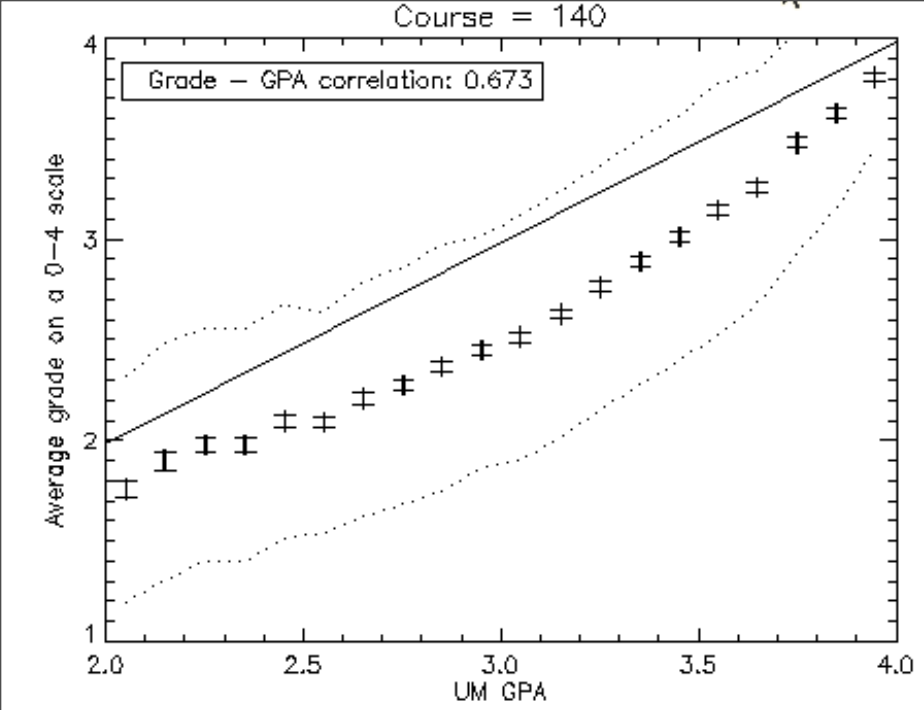


http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_feb.pdf

STEM attrition: in LSA less than 50% of those arriving intending STEM complete

- Students arrive in college with context specific diversity of background, interest, and identity
- STEM intro courses are large, uniform, and challenging
- All these factors lead to attrition: *departure from STEM is not primarily due to failure*

- Personalization: provide support able to act on
  - Background strengths and weaknesses
  - Interests, future goals, and affect
  - Real-time status, including metacognitive state
- Personalization must be done accurately, wisely, and at scale


Course = 140
Grade – GPA correlation: 0.673
Average grade on a 0–4 scale
UM GPA
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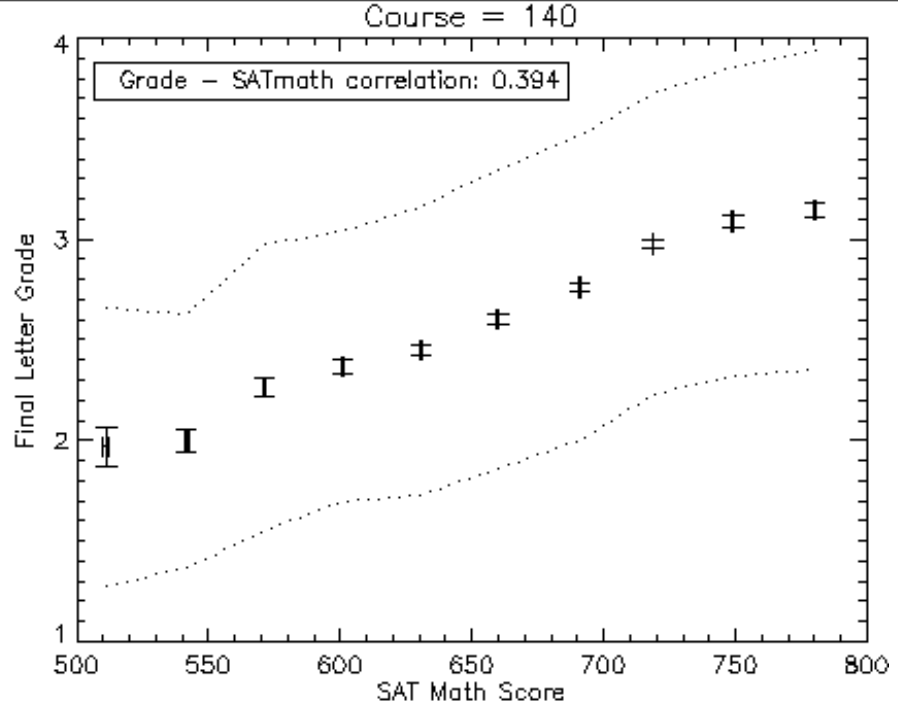
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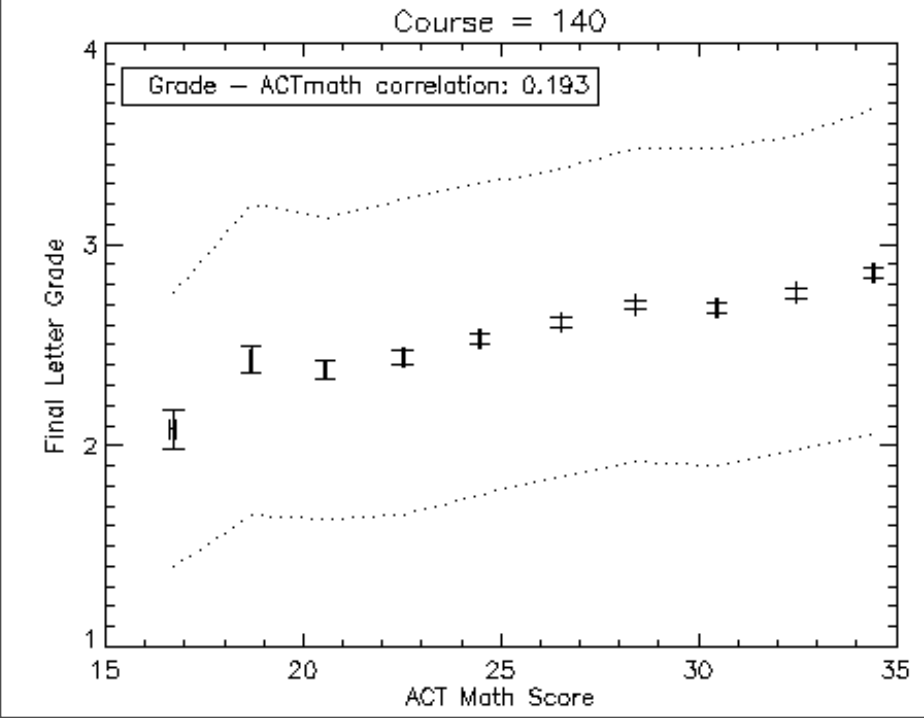
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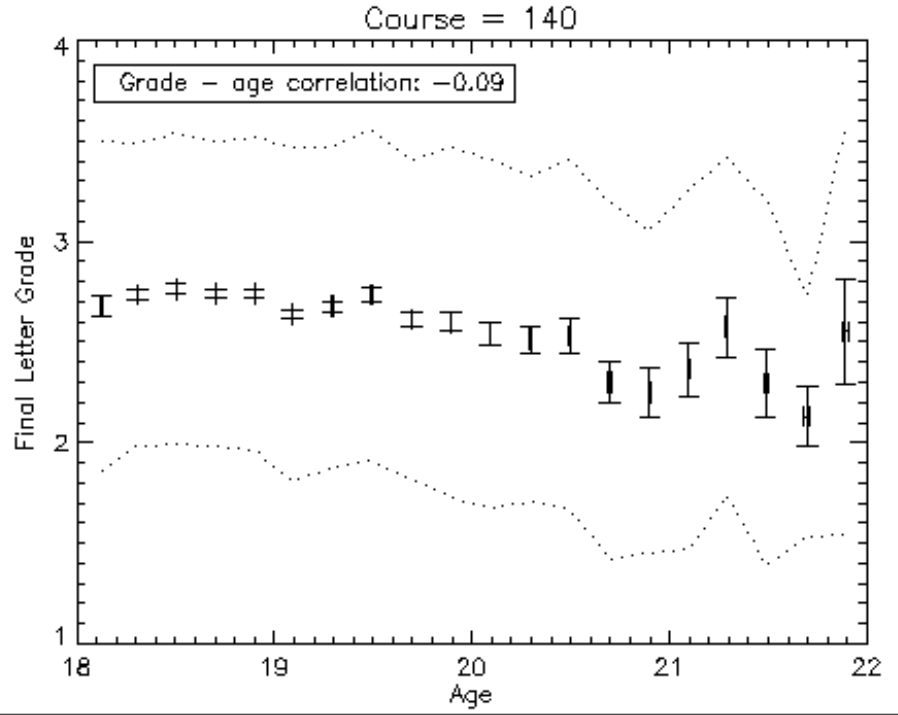
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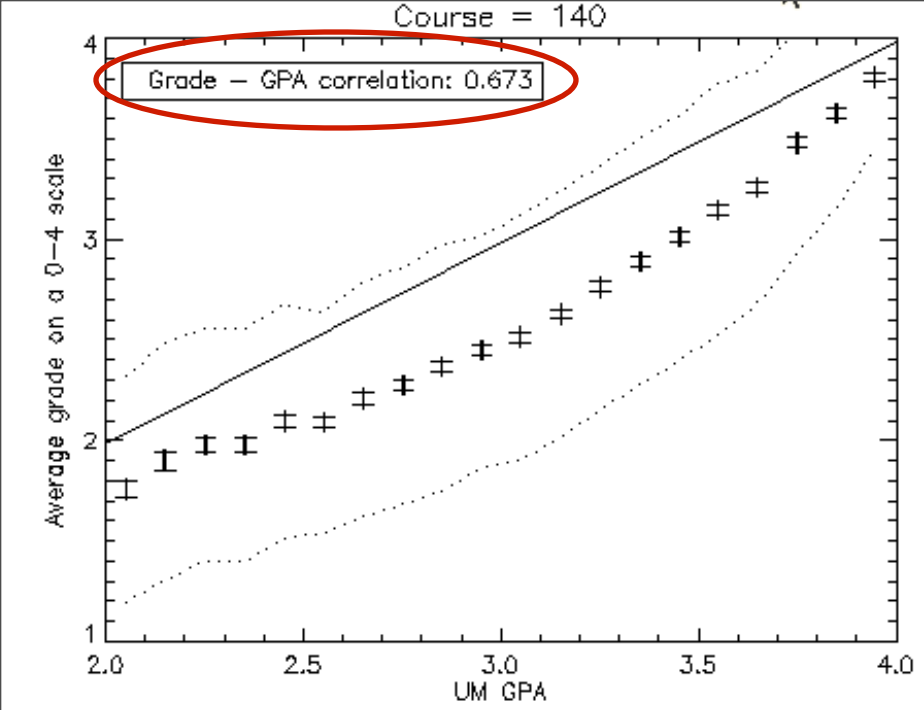
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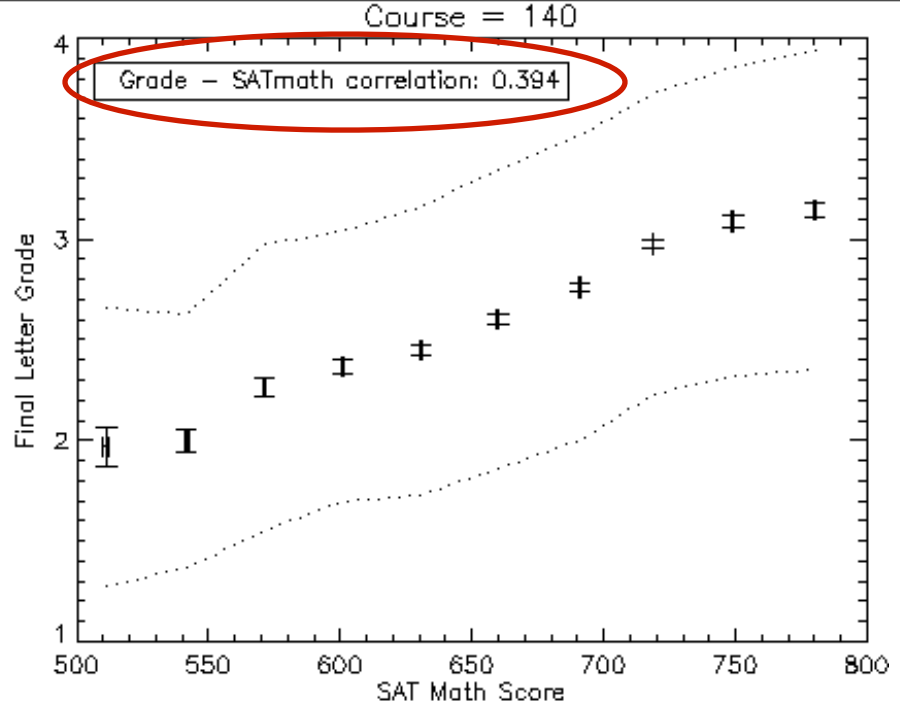
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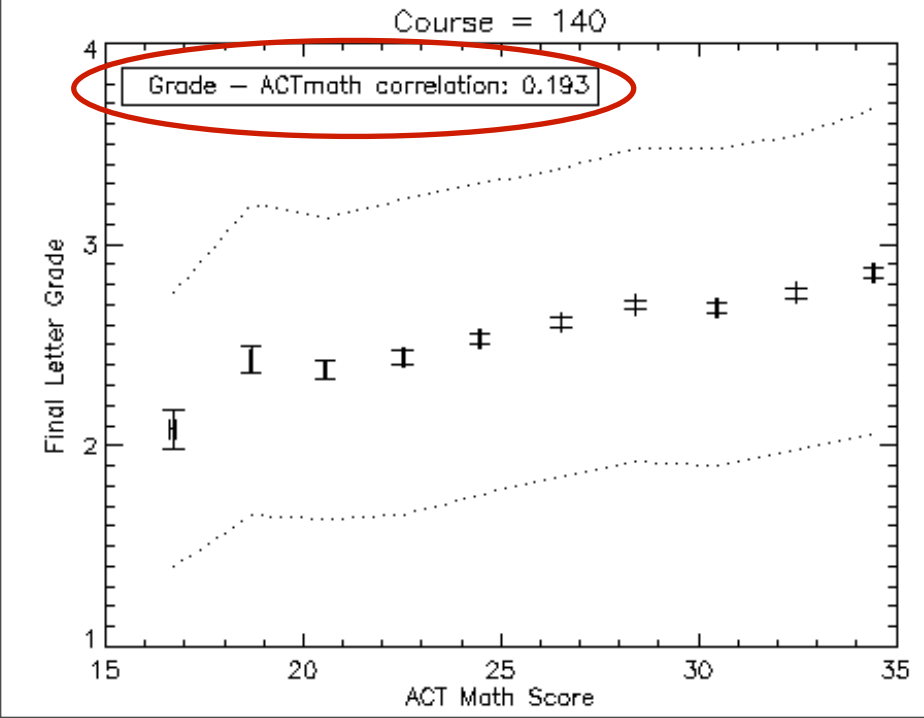
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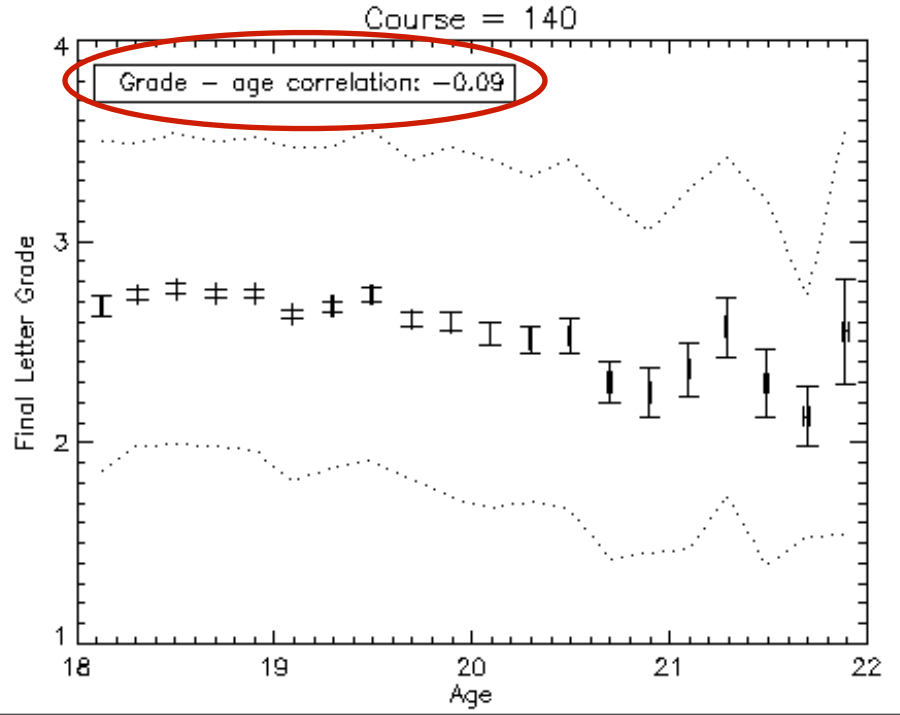
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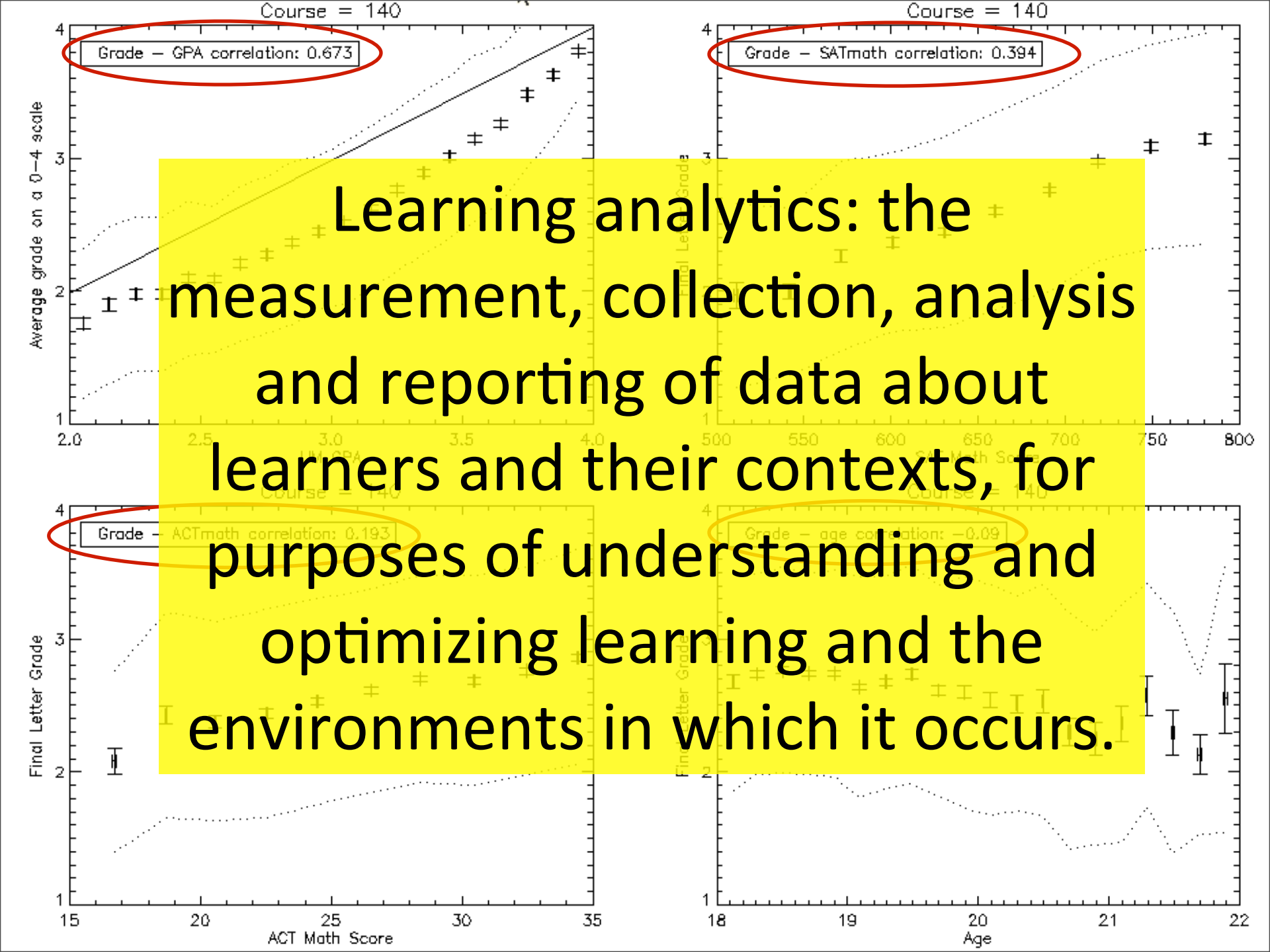
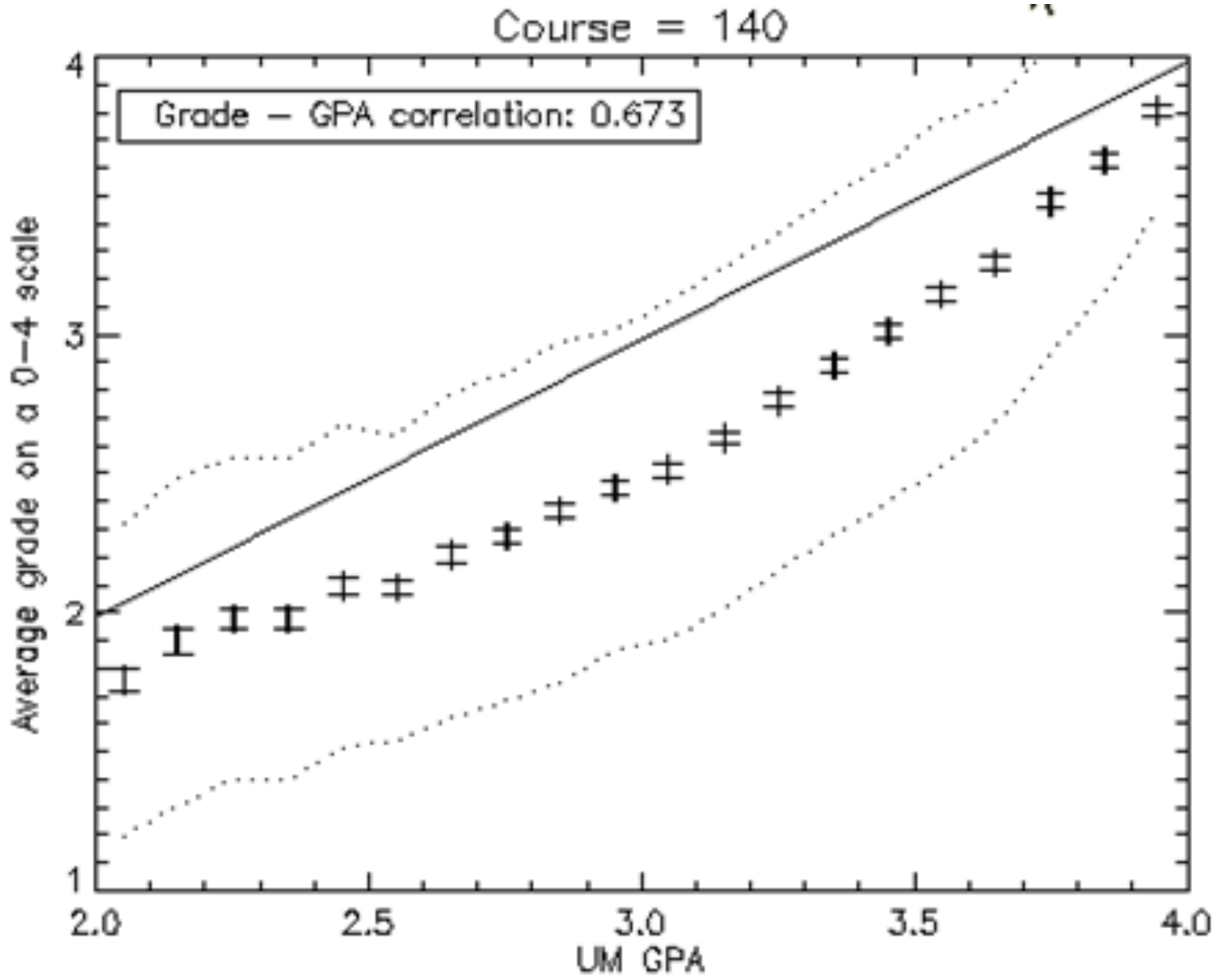


Learning analytics: the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs.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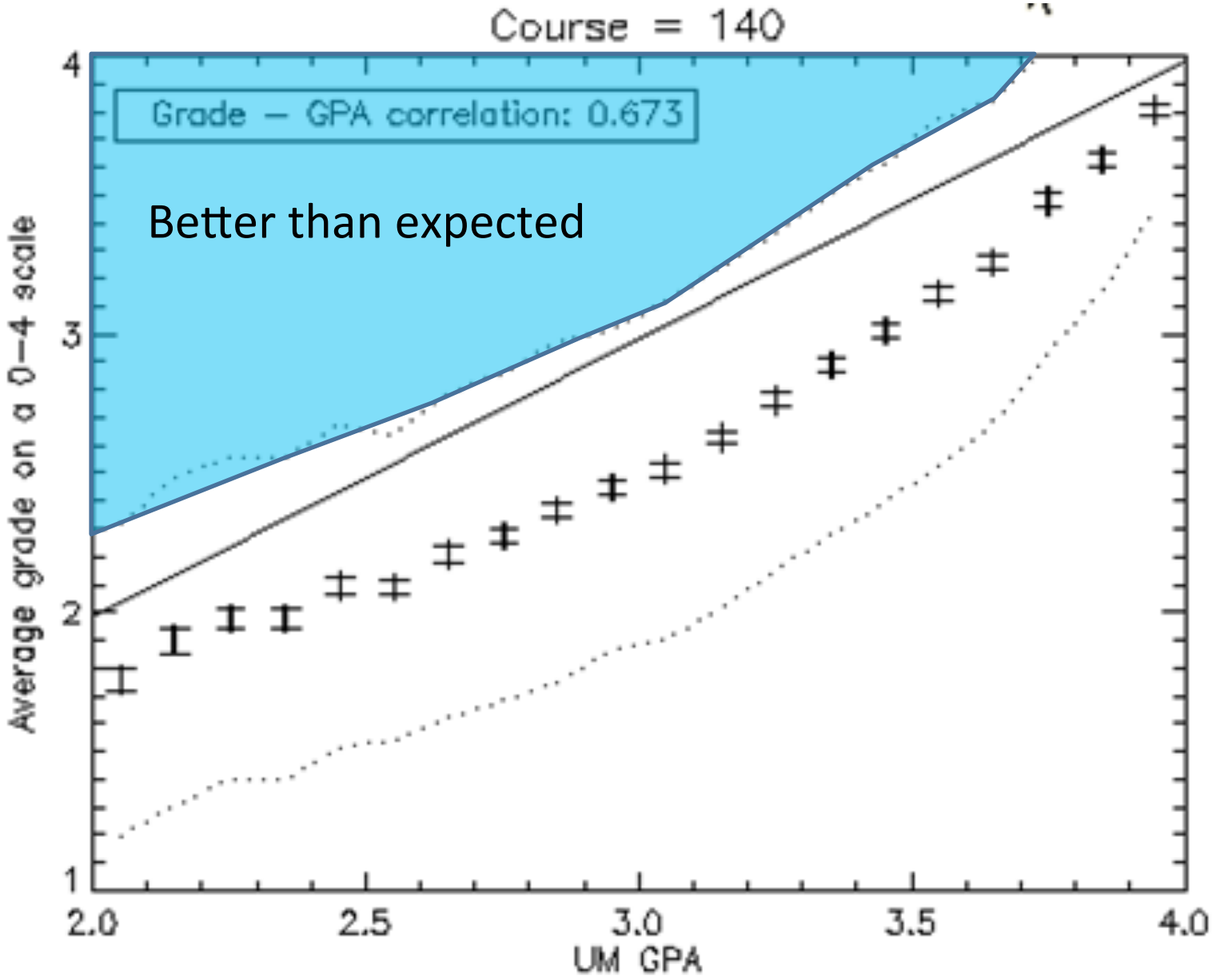
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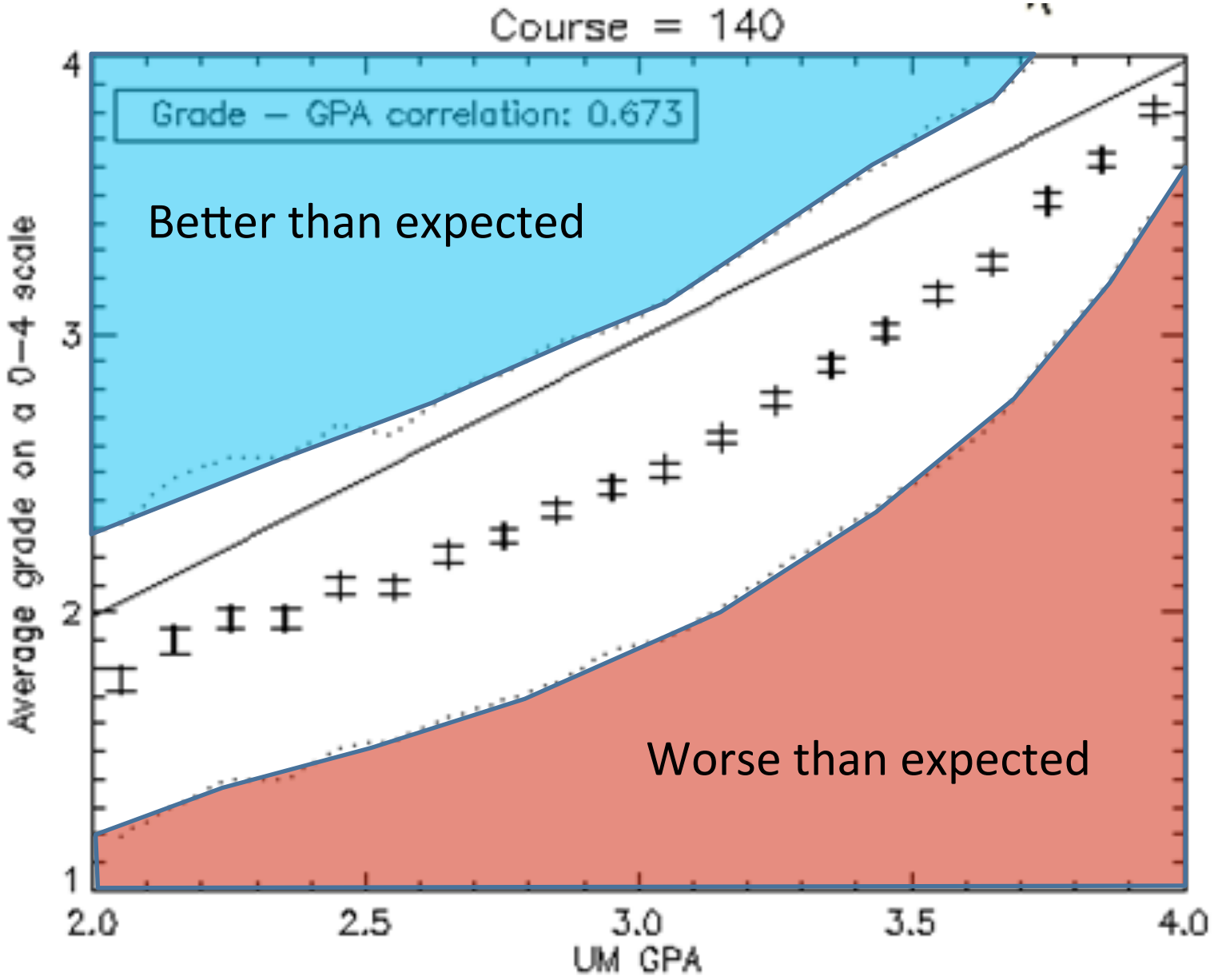
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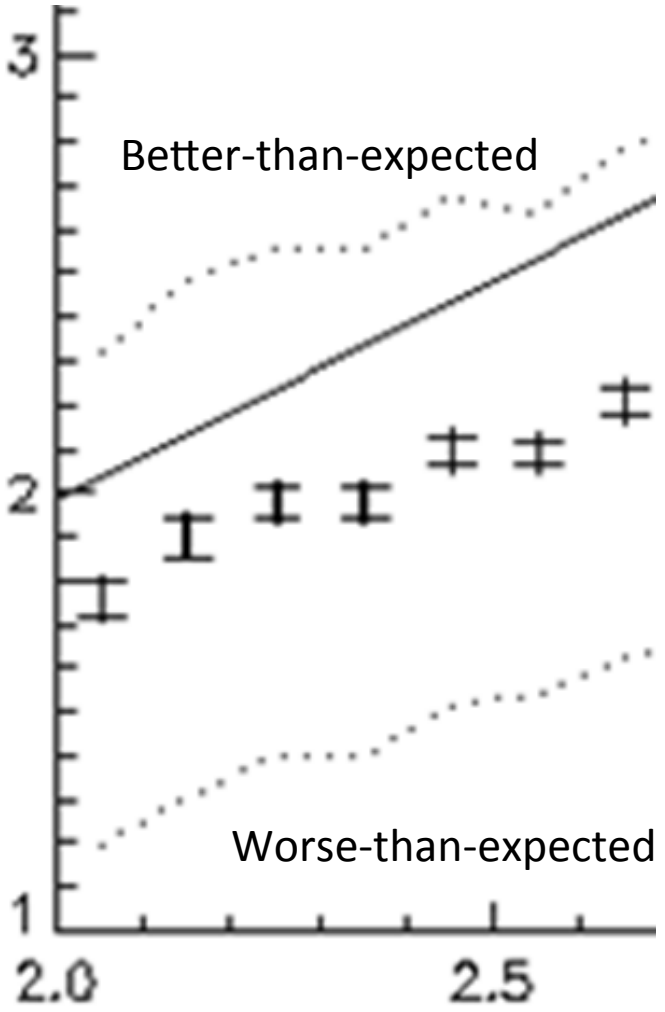
Grade prediction plus

- Two important themes:
  - Exploring dispersion in outcomes at each predicted grade provides insight into existing successful strategies
  - Knowing where students are coming from, where they stand, and where they're headed is **actionable intelligence**



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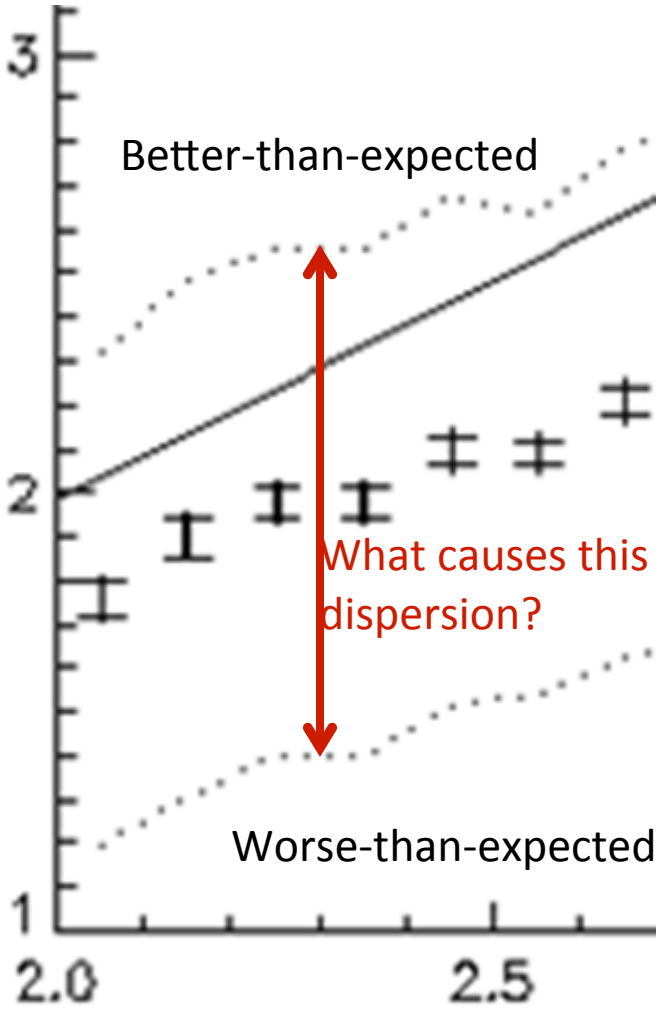

Better and Worse-than-expected

- BTE and WTE performance occurs at *all* levels of expected performance
  - A **C** student receiving a **B**
  - An **A** student receiving their first **B+**
- The impact of this *relative performance* on STEM retention is large
- This impact is exacerbated by grade inflation, slower in STEM fields…

- A complex array of factors correlate with BTE/WTE performance

  Strong support networks *used well*

  First-generation status

  Underrepresentation and stereotype threat, especially in gender

  External overcommittment
- We learn about these from **both quantitative and qualitative data**

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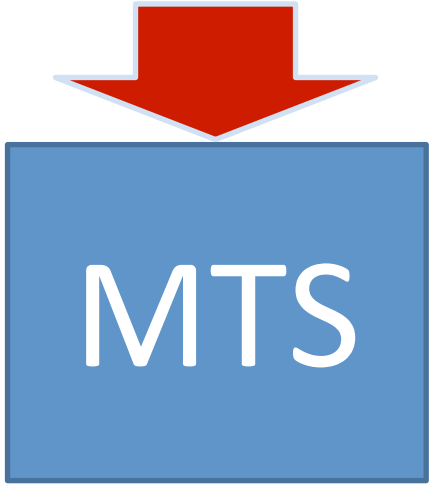
Learning analytics make all of these explorations possible, even the qualitative ones.

How does E^{2}Coach work?

The Michigan Tailoring System: a mature open-source software system for creating content designed specifically for an individual based on data about that individual

How does E²Coach work?

Expertise of hundreds of students, dozens of instructors and behavior change experts



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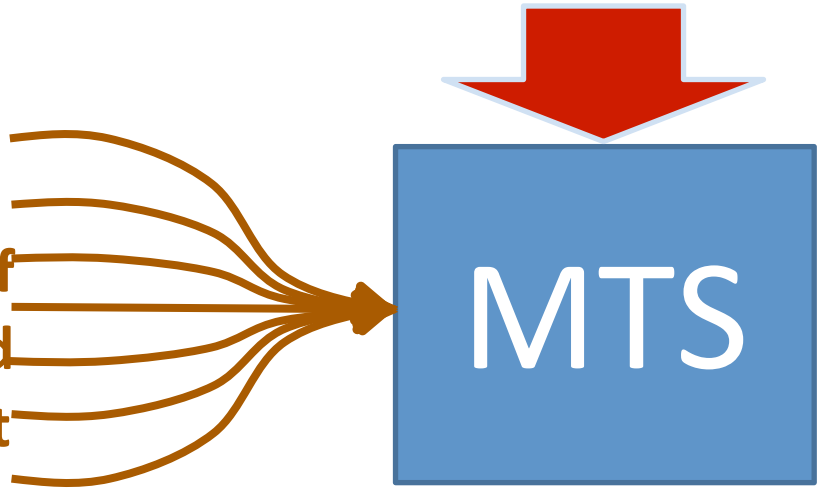

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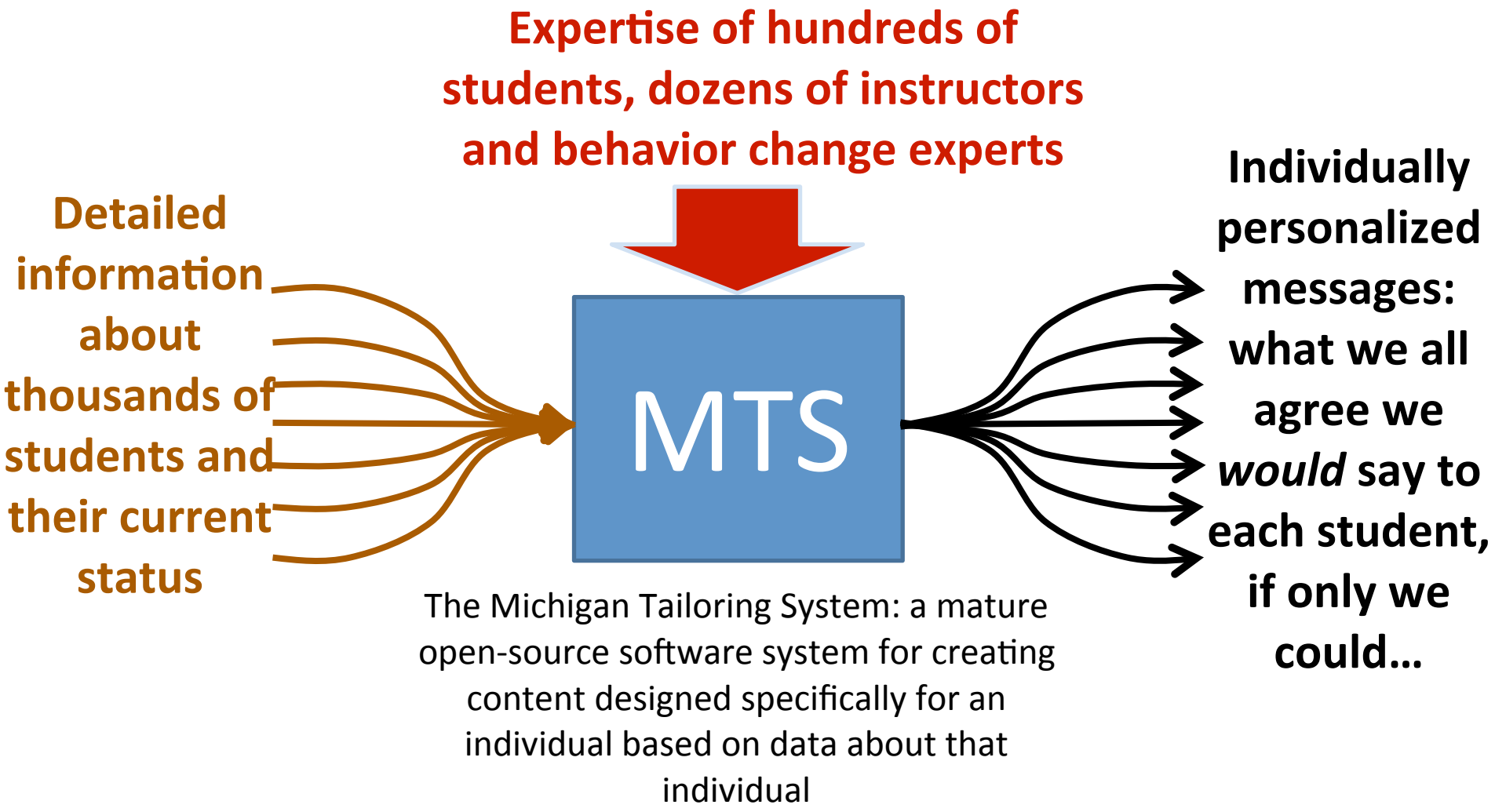

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How does E²Coach work?

Where the principal effort lies

Expertise of hundreds of students, dozens of instructors and behavior change experts

Detailed information about thousands of students and their current status

Individually personalized messages: what we all agree we *would* say to each student, if only we could…

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What do we tailor on?

- Knowledge of each course and its structure
- Input from the course gradebook
  - Homework scores
  - Classroom response
  - Exams
- **Students opt-in: they choose to participate**

- Input from the student

  Detailed background in physics, math

  Goals and interests

  Co-enrollments

  Planned effort

  Desired and expected grades

  Self-efficacy, confidence, approaches to physics

Which students opted-in?

			Physics 140	Physics 240	Physics 135	Physics 235	All Courses
Engineering	Both Genders	Enrolled	292	145	1	0	438
		Total	551	306	2	1	860
		Percent	53.0%	47.4%	N/A	N/A	50.9%
	Male	Enrolled	196	102	1	0	299
		Total	416	245	2	1	664
		Percent	47.1%	41.6%	N/A	N/A	45.0%
	Female	Enrolled	96	43	0	0	139
		Total	135	61	0	0	196
		Percent	71.1%	70.5%	N/A	N/A	70.9%
Non-Engineering	Both Genders	Enrolled	92	43	187	174	496
		Total	181	80	288	403	952
		Percent	50.8%	53.8%	64.9%	43.2%	52.1%
	Male	Enrolled	47	28	81	61	217
		Total	112	59	134	200	505
		Percent	42.0%	47.5%	60.4%	30.5%	43.0%
	Female	Enrolled	45	15	106	113	279
		Total	69	21	154	203	447
		Percent	65.2%	71.4%	68.8%	55.7%	62.4%

1812 students total, 934 joined

Female students are substantially more likely to seek help from E^2Coach *and other resources* (as reported in their surveys…)

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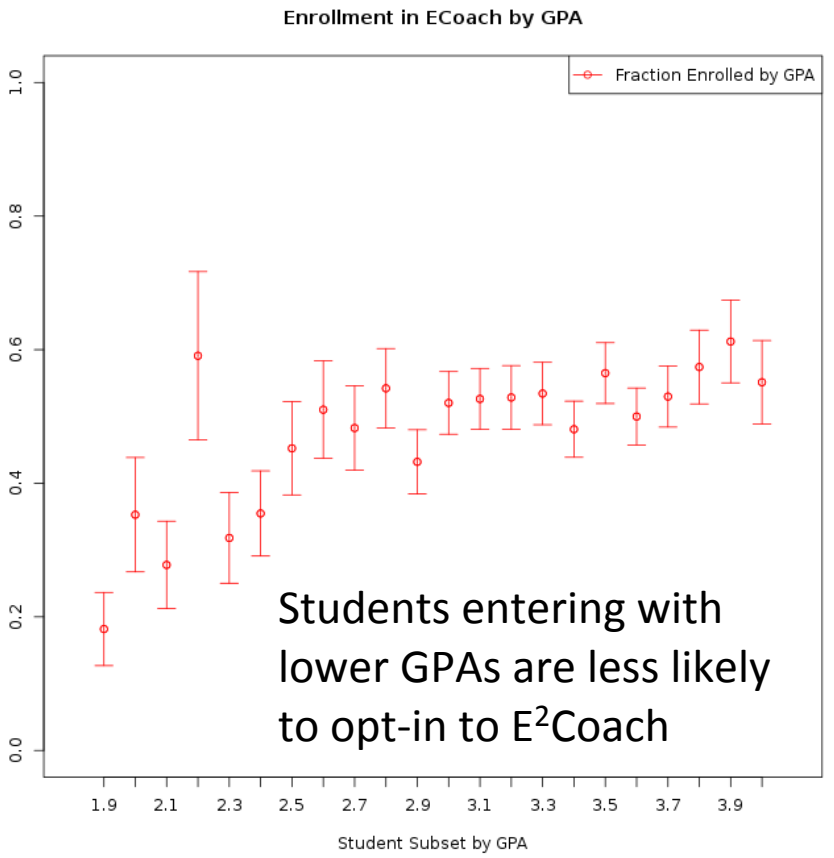
		Total	181	80	28
		Percent	50.8%	53.8%	64.9
	Male	Enrolled	47	28	81
		Total	112	59	13
		Percent	42.0%	47.5%	60.4
	Female	Enrolled	45	15	10
		Total	69	21	15
		Percent	65.2%	71.4%	68.8



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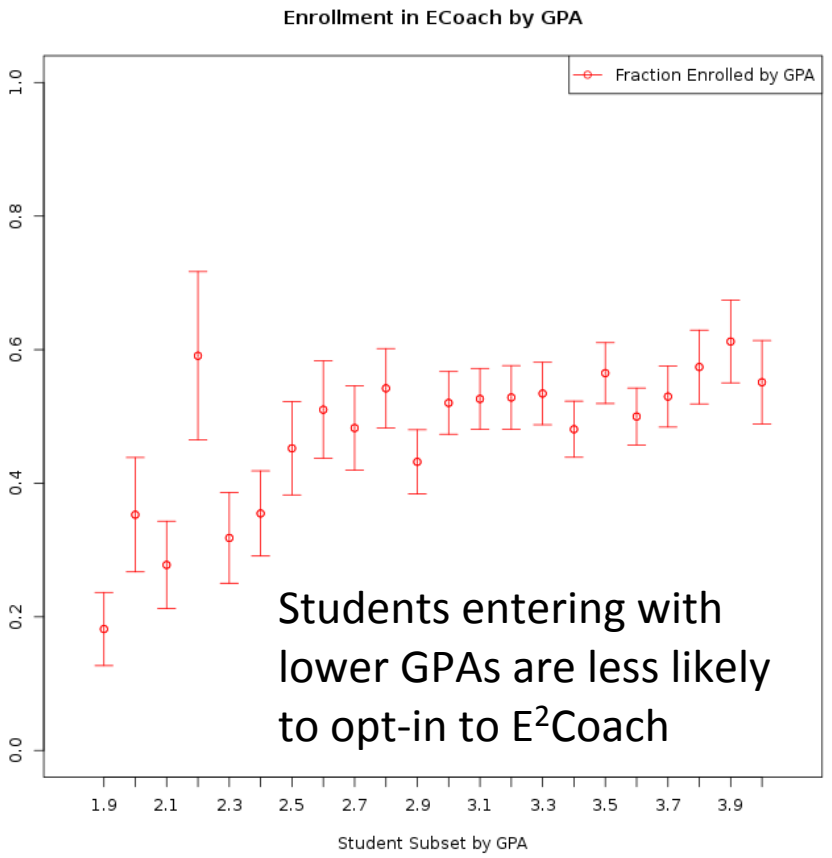
	Both Genders	Total	181	80	3
		Percent			
		Enrolled	47	28	1
		Percent	42.0%	47.5%	6
	Female	Total	69	21	1
		Percent			6

We contemplate building E²Coach into the structure of these courses, effectively making it required for all students. This will help us to reach all who might benefit from it.



General Information

- Your name is
- Your uniqname is
- You're taking Physics **140**
- You're a **male**
- You're in the **College of Engineering**
- You've completed **1 semester** thus far
- Your cumulative GPA is a **2.9**
- The highest level of education your parents have received is **a 4-year College Degree (BA, BS)**
- You **do not** currently work
- The top three things you value are **music, spiritual or religious values and sense of humor**
- You values these things because:
- You're also involved in **religious organzations**

Future Plans

- You are **an Engineering major**
- More specifically, you are **a Mechanical Engineering major**
- You're looking to **get a job** after your graduate

General Information

- Your name is
- Your uniqname is
- You're taking Physics **140**
- You're a **male**

Science and Math Background

- The highest level of physics you took in high school is **non-AP Physics**
- The highest level of math you took in high school is **AP calc AB**
- You **did not** take the SAT
- Your ACT math score is **30**
- Thus far in your college career, your math experience includes: **taking Math 115**
- Thus far in your college career, your chemistry experience includes: **receiving AP Credit or testing out of Intro Chemistry**
- You **have not** taken a biology class thus far in college

This Semester

- You are currently enrolled in: **Math 116 and Engineering 100**
- You are taking this course because **it is required by your concentration**
- You want to receive **an A** in this class and are **not confident** you can achieve this
- You expect to receive **a B-** in this class
- You plan on spending **4** studying outside of class, **3 hours** preparing for exams, and **2 hours per week** doing your Mastering Physics
- You actually spent **-1** studying for the first exam
- You plan on **going to helproom less than 3 times a semester**
- You plan on **going to office hours once every two weeks**
- You **are unsure what CSP is**

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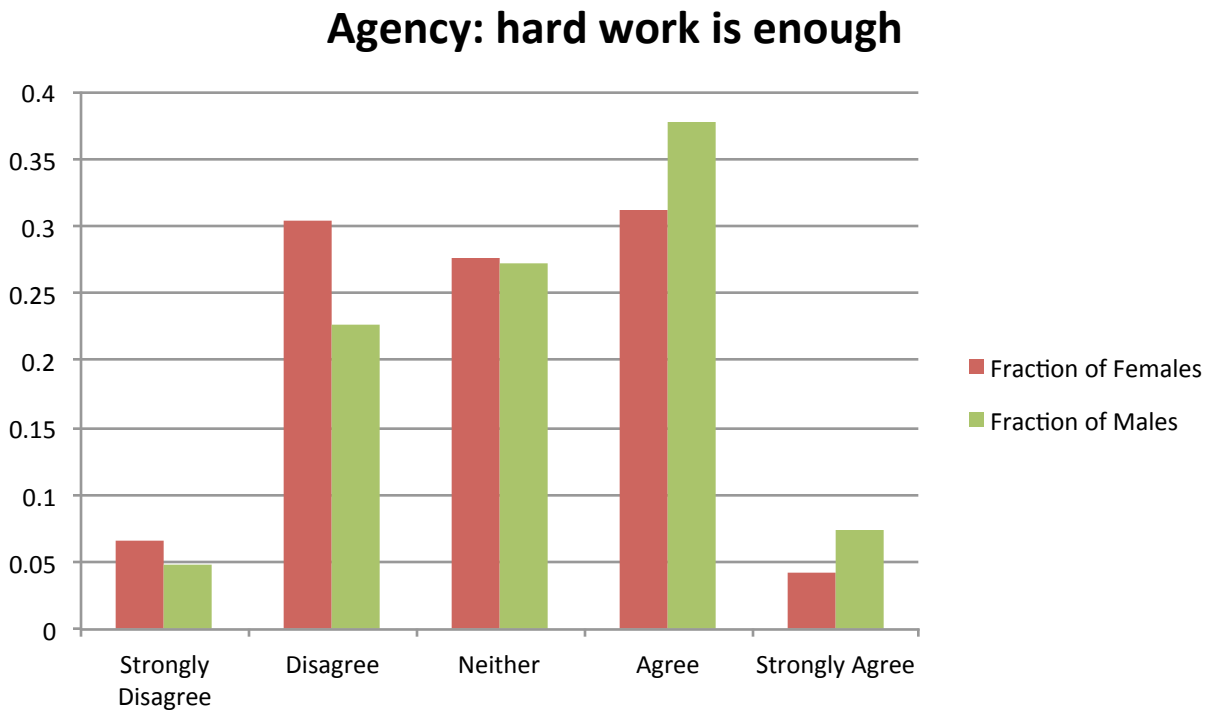
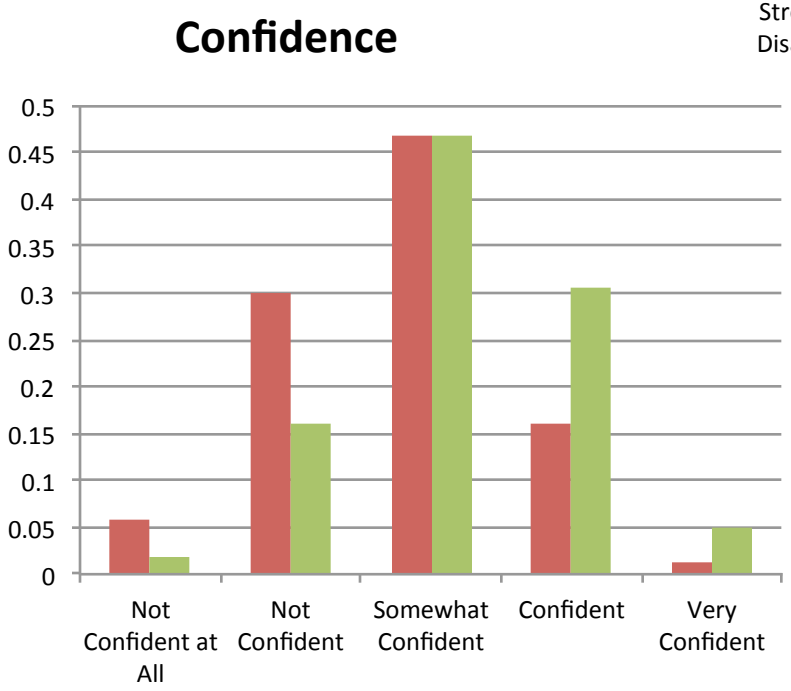
Attitudes

- You **agree** with the statement "A significant problem in learning physics is being able to memorize all the information I need to know."
- You **disagree** with the statement "Basic math skills (solving equations, trigonometry, basic calculus) will pose a challenge to me in this course."
- You **agree** with the statement "In doing a physics problem, if my calculation gives a result very different from what I'd expect, I'd trust the calculation rather than going back through the problem."
- You **neither agree nor disagree** with the statement "If I can't solve a physics problem, it is usually because I didn't work on it hard enough."
- You **strongly agree** with the statement "Nearly everyone is capable of understanding physics if they work at it."
- You **disagree** with the statement "Understanding physics basically means being able to recall something you've read or been shown."
- You **disagree** with the statement "Spending a lot of time understanding where formulas come from is a waste of time."
- You **strongly agree** with the statement "A significant challenge in learning physics is being able to apply a few fundamental principles in many circumstances."
- You **neither agree nor disagree** with the statement "If I don't understand a scientific concept, it is usually because I didn't work on it hard enough."

Agency: If I don't understand a scientific concept, it is usually because I didn't work on it hard enough.





Confidence: How confident are you that you can receive your desired grade?

Interesting gender differences in affect questions

Design and delivery of messages

- Course-specific technical advice
- Normative information
- Goal derived motivators
- Testimonials specific to the moment
- Data graphics predicting outcomes and tracking improvement

- Each student receives a personalized web page

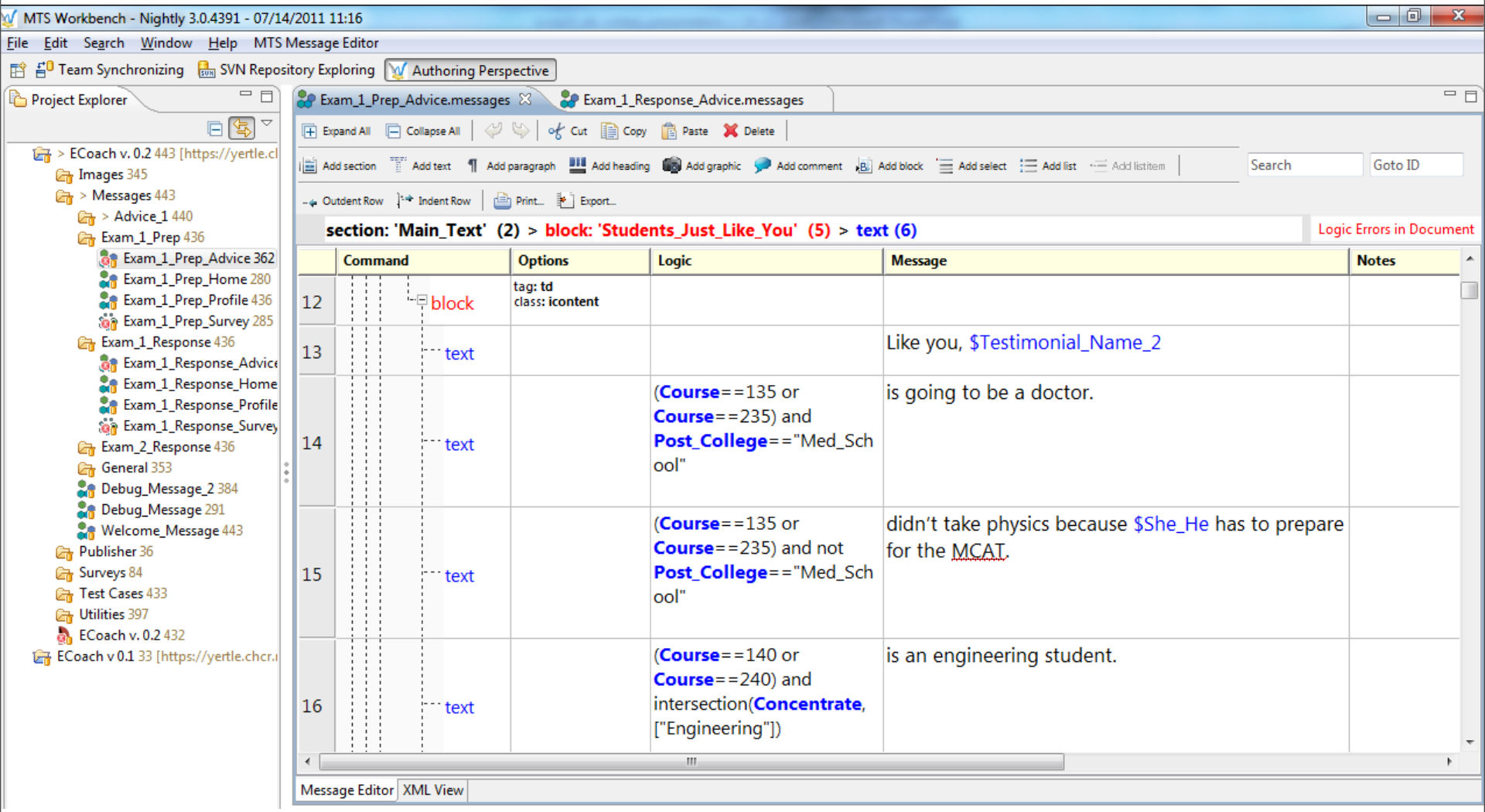
  Home

  Advice

  Profile

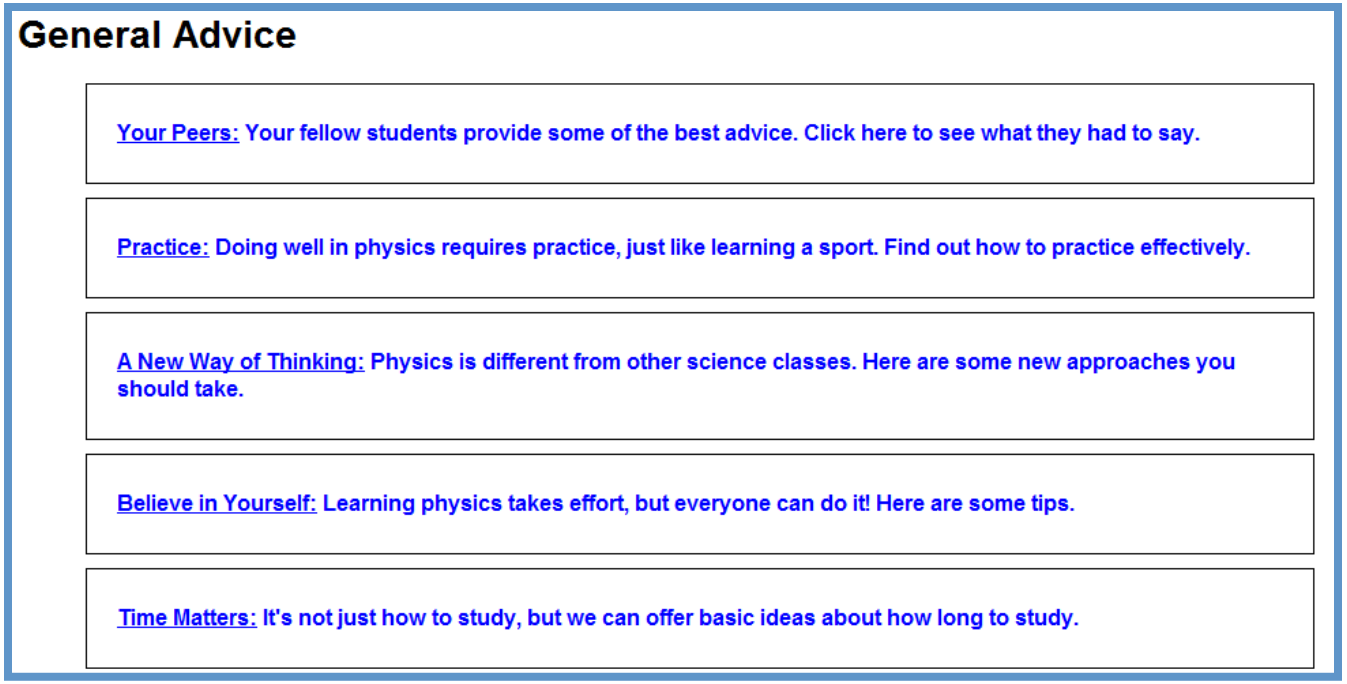
  Status
- Updated when significant new information arrives (e.g. after exams)

E²Coach in the Michigan Tailoring System Workbench



What we provide

- Tailored advice on all aspects of the course, including testimonials from relevant peers



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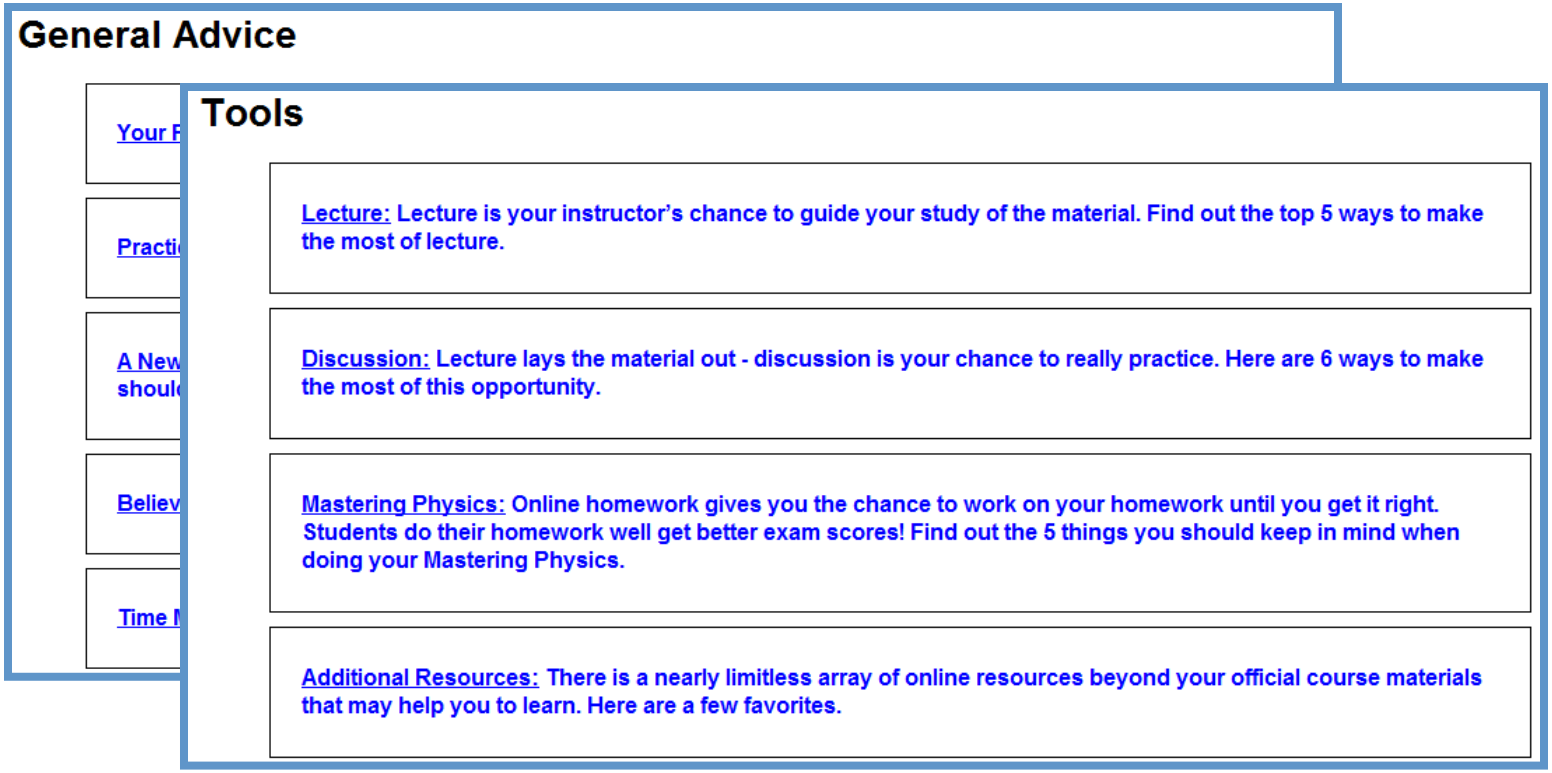

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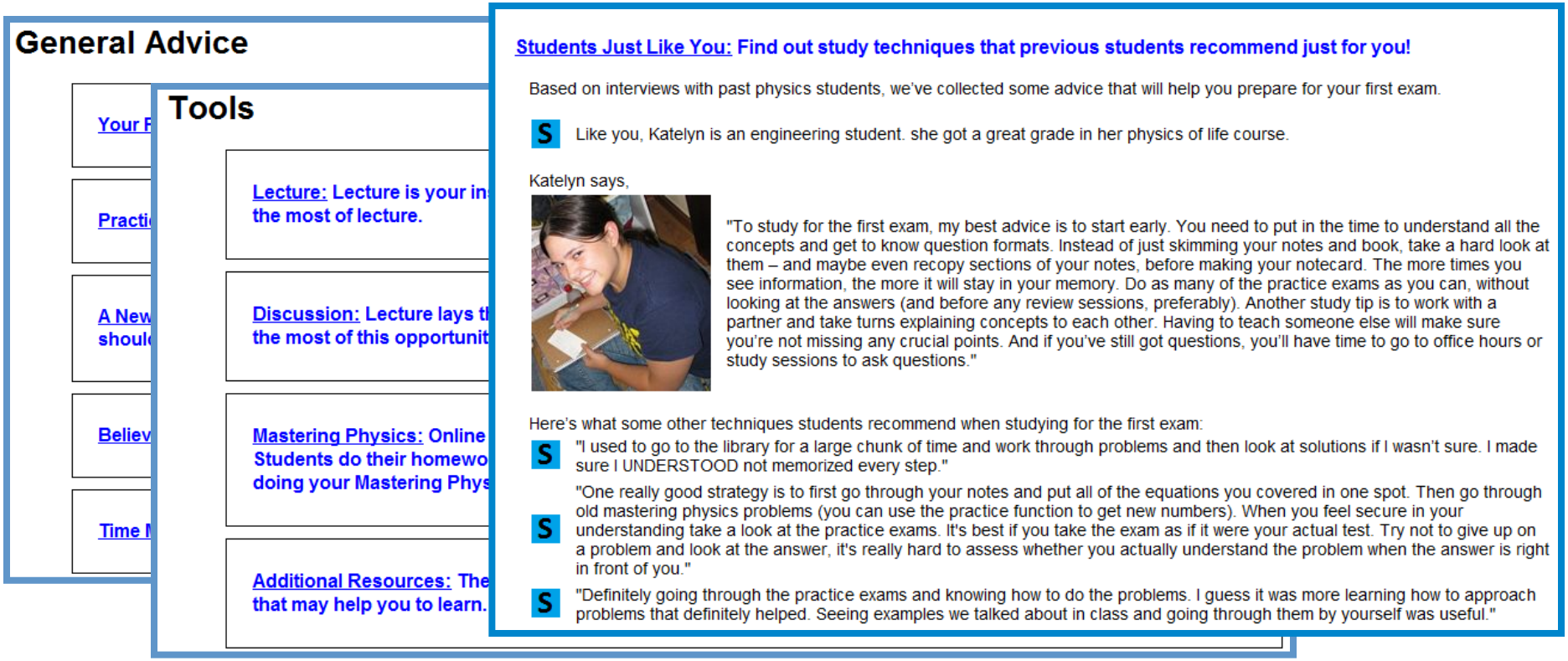
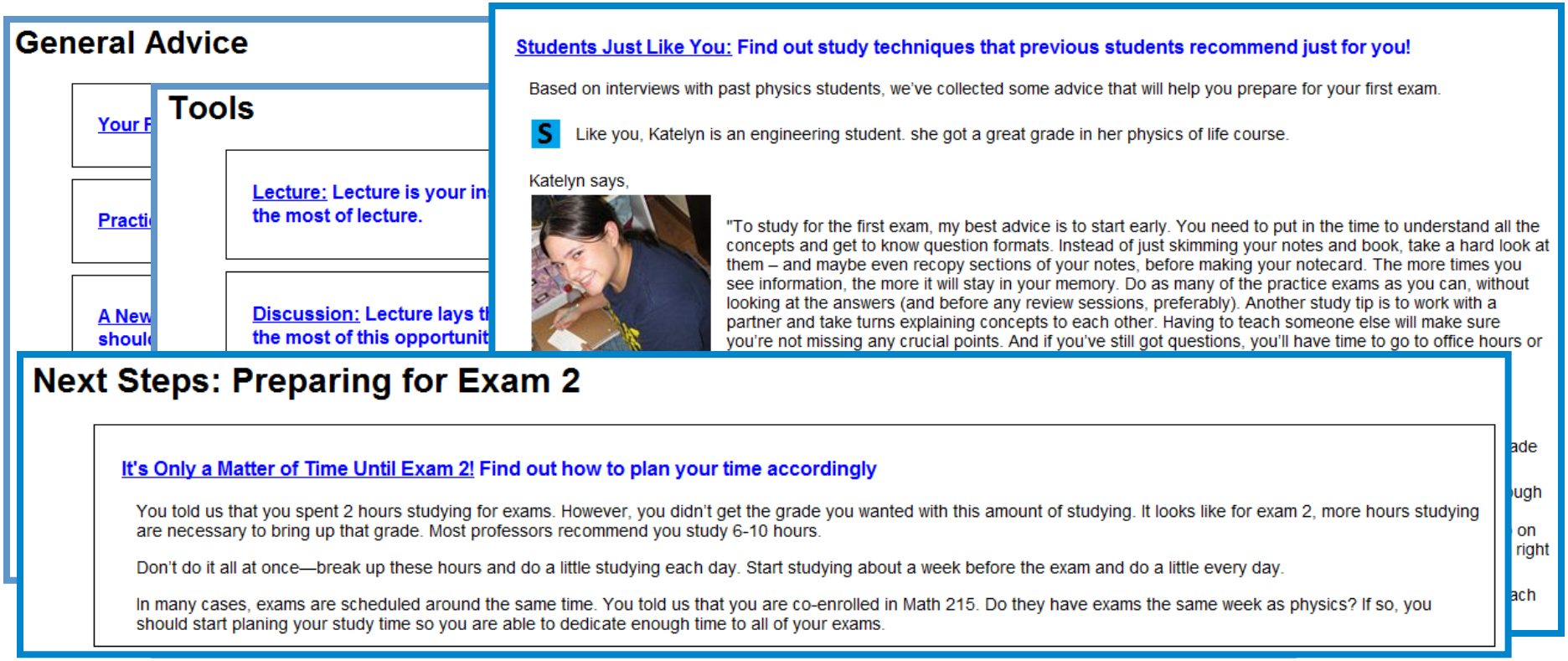


What we provide

- Tailored advice on all aspects of the course, including testimonials from relevant peers



E^2Coach Status and Future

- E^2Coach for physics launched in January 2012: four courses, 1835 students total, 953 enrolled
- In Fall 2012 we will make it a required element of these courses
- Examples of E2Coach content being delivered now are provided…
- Ultimate goal: a tailored communication interface between each student and the University – ***in both courses and academic advising***

Tools

Lecture: Lecture is your instructor's cha

Discussion:

How to Approach Studying

Students Just Like You: Find out study techniques that previous students recommend just for you!

Next Steps: Preparing for Exam 2

How Things are Going

Don't "Choke": Learn about recent research that will help you to perform to your fullest potential in a pressure situation.

When you sit down in the Dennison lecture hall ready to take an exam, are you nervous? When the test begins are you able to start the problems right away or do you find yourself choking under the pressure?

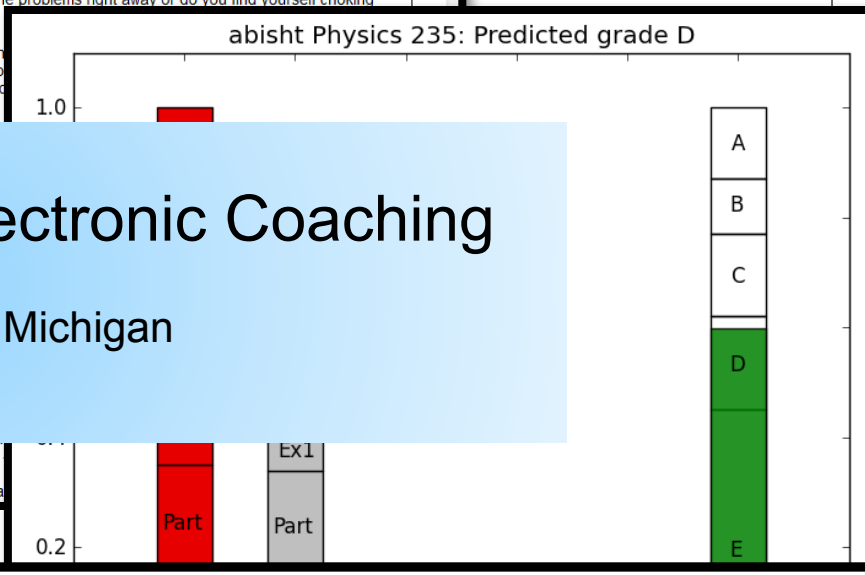
R The popular book Choke: what the secrets of the brain reveal about getting it right when you have to by Sian Beilock explores th
of it like this: when it comes to an exam, it's only natural to be a little nervous. However, you can handle this anxiety in one of two
go or you can choke. If you cave under the pressure, you lose some of your brain power to stress and self-doubt; you literally do
problems in front of you and your working memory capacity is limited. This leads to poor performance.

Luckily, Beilock has several sug
improve your working memory c

- **Reaffirm your self-wort**
  Reaffirming yourself, espe
- **Map out your complexit**
  highlight that this one test
- **Write about your worrie**
  in high-pressure situation
- **Meditate away the worr**
  your cognitive horsepowe
- **Think differently.** Think
  stereotyped to be bad at
  Focus on your credentials
- **Reinterpret your reacti**
  circumstances, such as w
  rather than negative ("I ar
- **Pause your choke.** Walk
  helps you to let go of your focus on irrelevant problem details and instead think in a new way or from an alternative perspective
  lead to a breakthrough and success.
- **Educate the worries.** Merely drawing attention to the stereotypes you may hold - for instant, "Girls can't do math" or "Whites a
  yourself tha
  stereotypes
  diagnostic

E²Coach: Expert Electronic Coaching

University of Michigan



Hello John!

Welcome to your ECoach site. We'll be here eve

It's especially important for you to do well becau
physics right when you design a steering mecha

You can turn to us for advice about using your s

You told us that the grade you want to receive is
sure that you can do well. ECoach will be here e

Where Does Physics Fit?

You told us that you value independence, learni
work associated with your other classes. There

We see that you have many strengths coming in

- You've already learned some Mechanics
- You're confident in your math skills
- Physics is applicable to your everyday life

There are also some factors that could be poten

- Physics is a difficult subject for anyone to
- You said that you're not taking this course
- Physics requires a different way of thinkin

Welco

Hello again T

We see that

Thinking abo
humor. You
upon those
able to laug
the advice th

This exam 1

Let's make sure you're u

0.8

0.0

Breakdown Exam1 Exam2 Exam3

Students Just Like You: Find out what your peers tell you about the first exam!

We've interviewed several past physics students to see what advice they'd give to someone like you after the first exam. Here's what they had to say:

S Blythe took physics of life and earned an exceptional grade. Like you, she didn't take physics because she had to prepare for the MCAT.

Blythe says,

"Don't Lose hope! Go over what you got wrong and talk to someone about how you should have done/approached those problems. Switch up studying techniques if you think that will help. As you learn the new material, you now have a sense of how it might be turned into an exam question – so keep those thoughts in the back of your head as you go along."

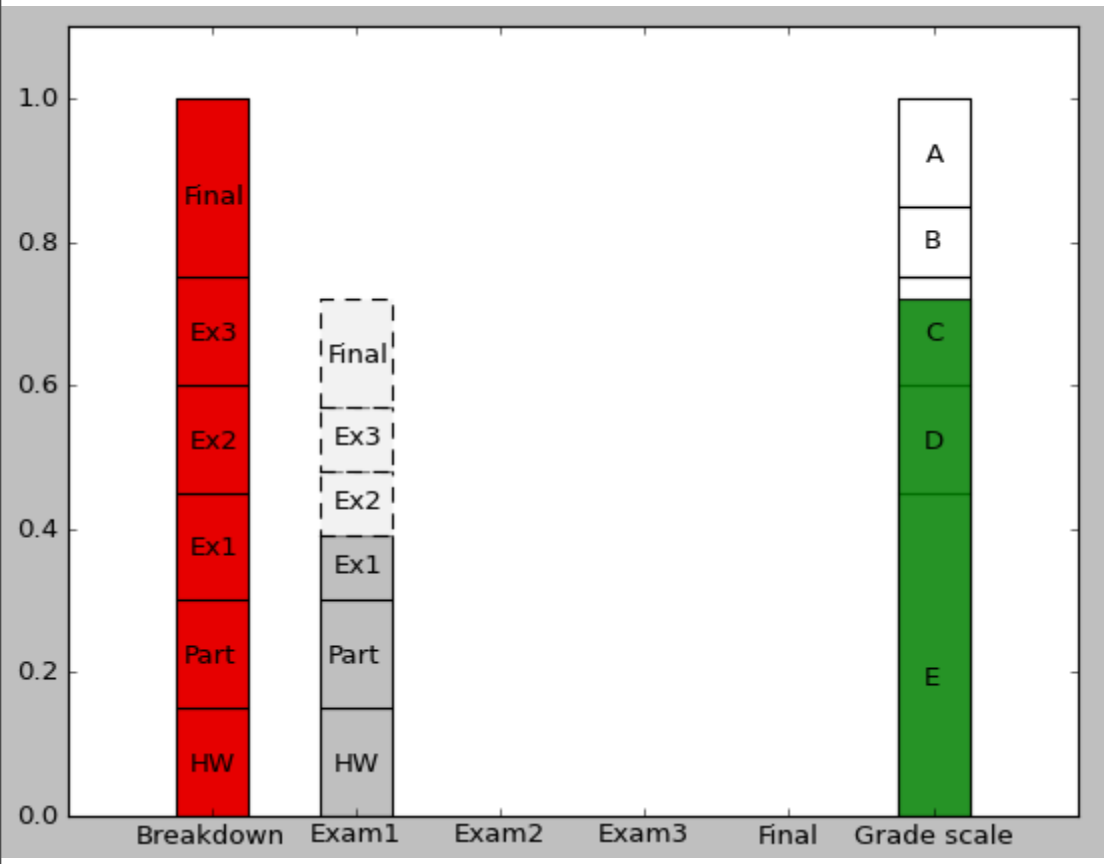
Other students would tell you,

S "Make sure to know what the important concepts are before focusing on specific details. If something wasn't covered in class or mentioned at all, chances are that it is less important and doesn't need to be the prime focus of your studying. Make sure to go to the exam review session (if there is one), office hours before the exam, as well as the class period before the exam. A general outline of the exam is usually provided during one/all of these times and can help you know exactly what to focus on during your study time. Another potential issue is study habits. There are many resources to help change your study habits for the better. Everyone learns differently, but a quiet environment with no distractions is generally a good way to study initially. I do recommend, once you have grasped the concepts on your own, to get together with your peers and discuss the concepts/do practice problems together. I have learned so much through my peers—I believe they are one of the most underrated resources."

S "I would evaluate what you are already doing. Then throw out what is wasting time and look for new methods. See what other students are doing, what the professor says and ask people in the help room."

What we provide

- Personalized feedback on status and prospects



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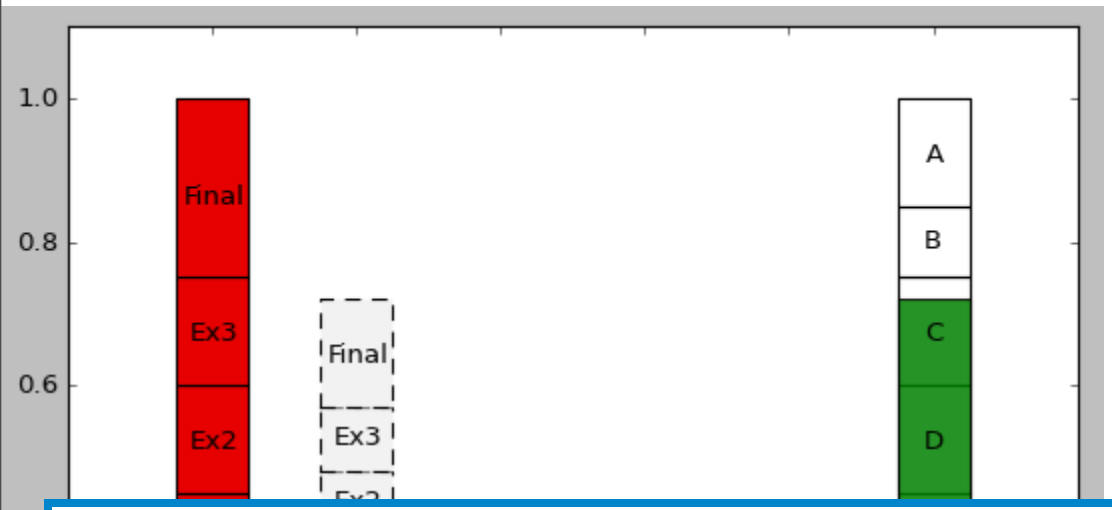

Next Steps: Preparing for Exam 2

It's Only a Matter of Time Until Exam 2! Find out how to plan your time accordingly

You told us that you spent 2 hours studying for exams. However, you didn't get the grade you wanted with this amount of studying. It looks like for exam 2, more hours studying are necessary to bring up that grade. Most professors recommend you study 6-10 hours.

Don't do it all at once—break up these hours and do a little studying each day. Start studying about a week before the exam and do a little every day.

In many cases, exams are scheduled around the same time. You told us that you are co-enrolled in Math 215. Do they have exams the same week as physics? If so, you should start planing your study time so you are able to dedicate enough time to all of your exams.

What we provide

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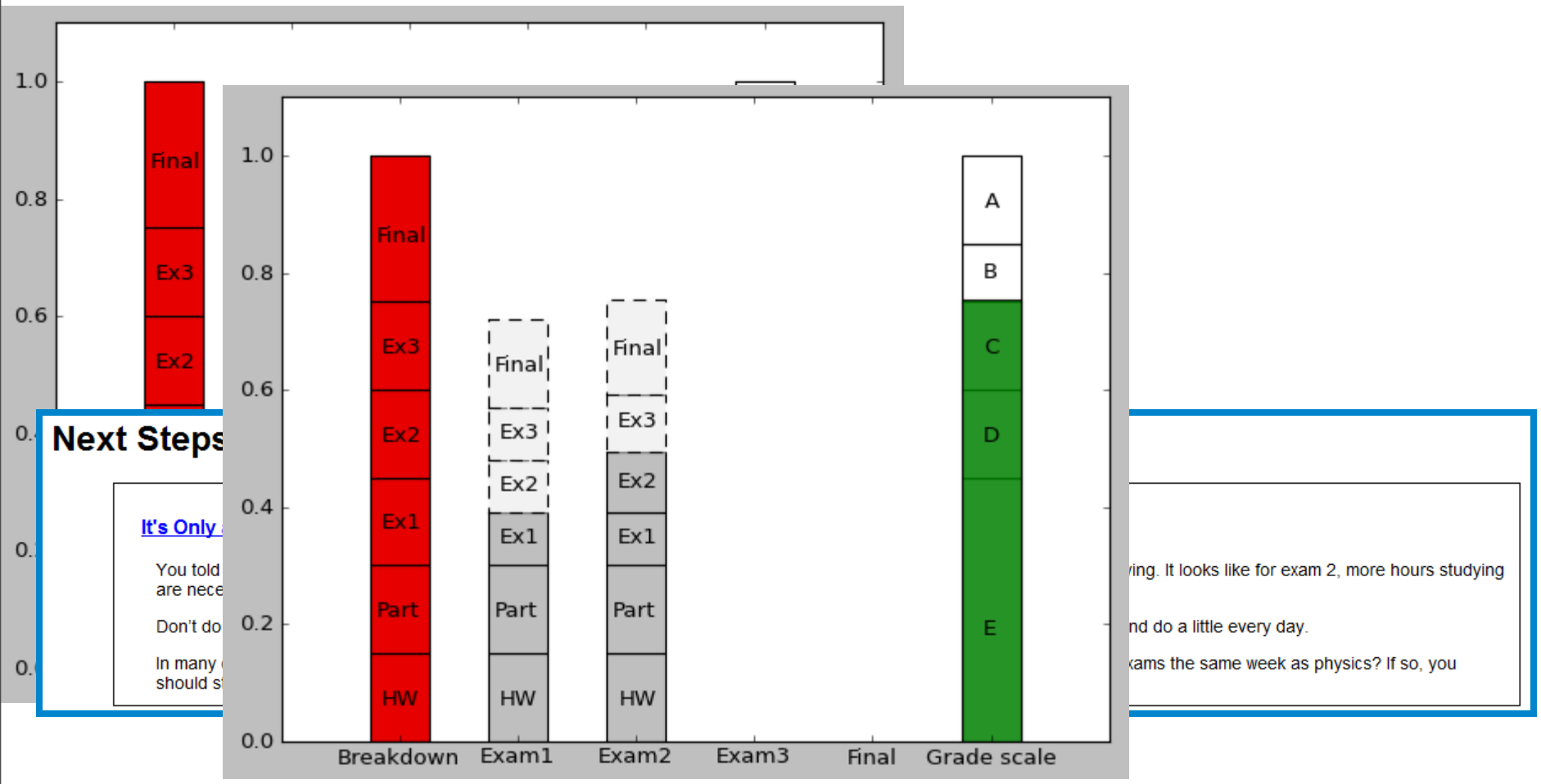

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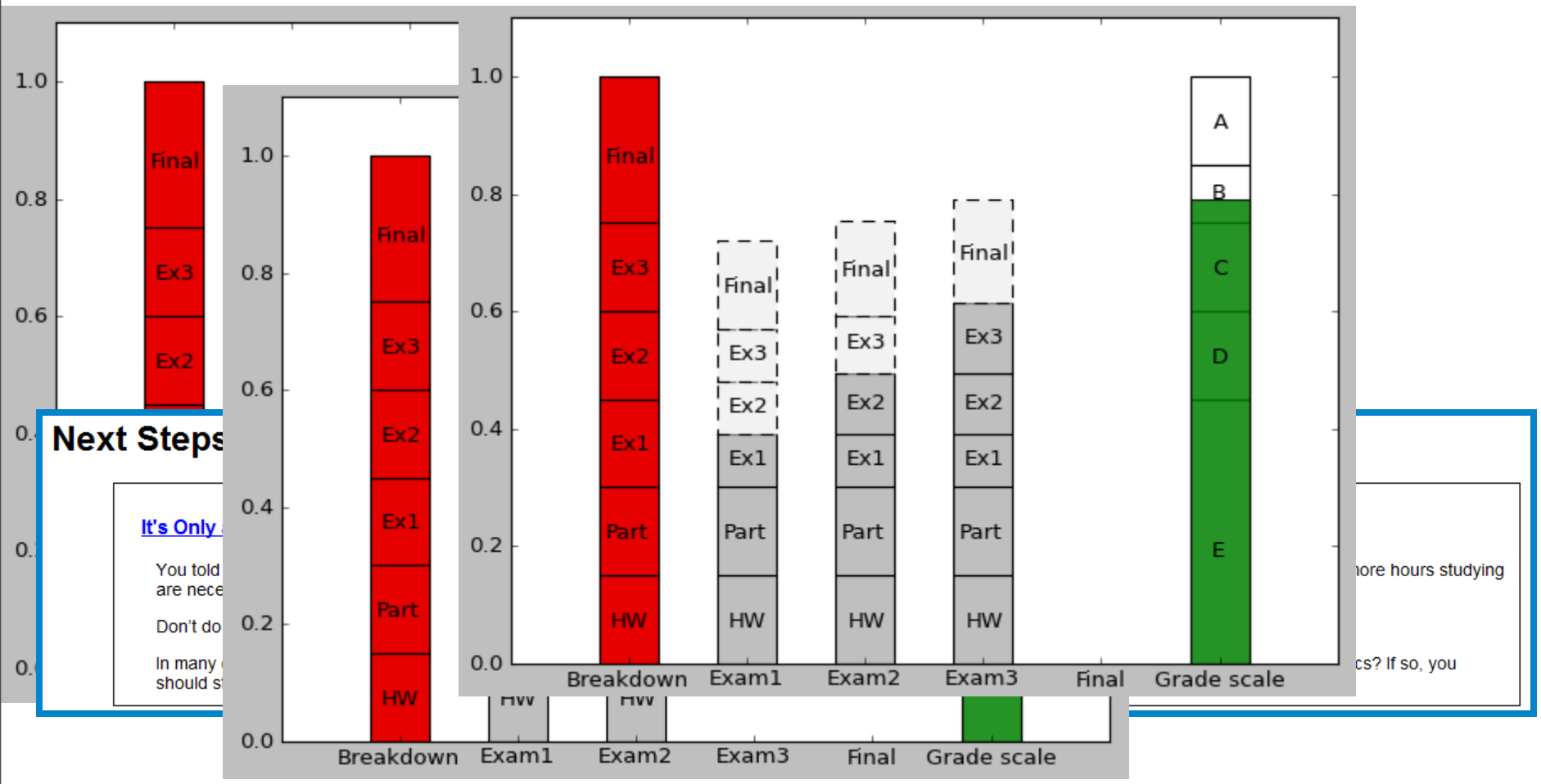

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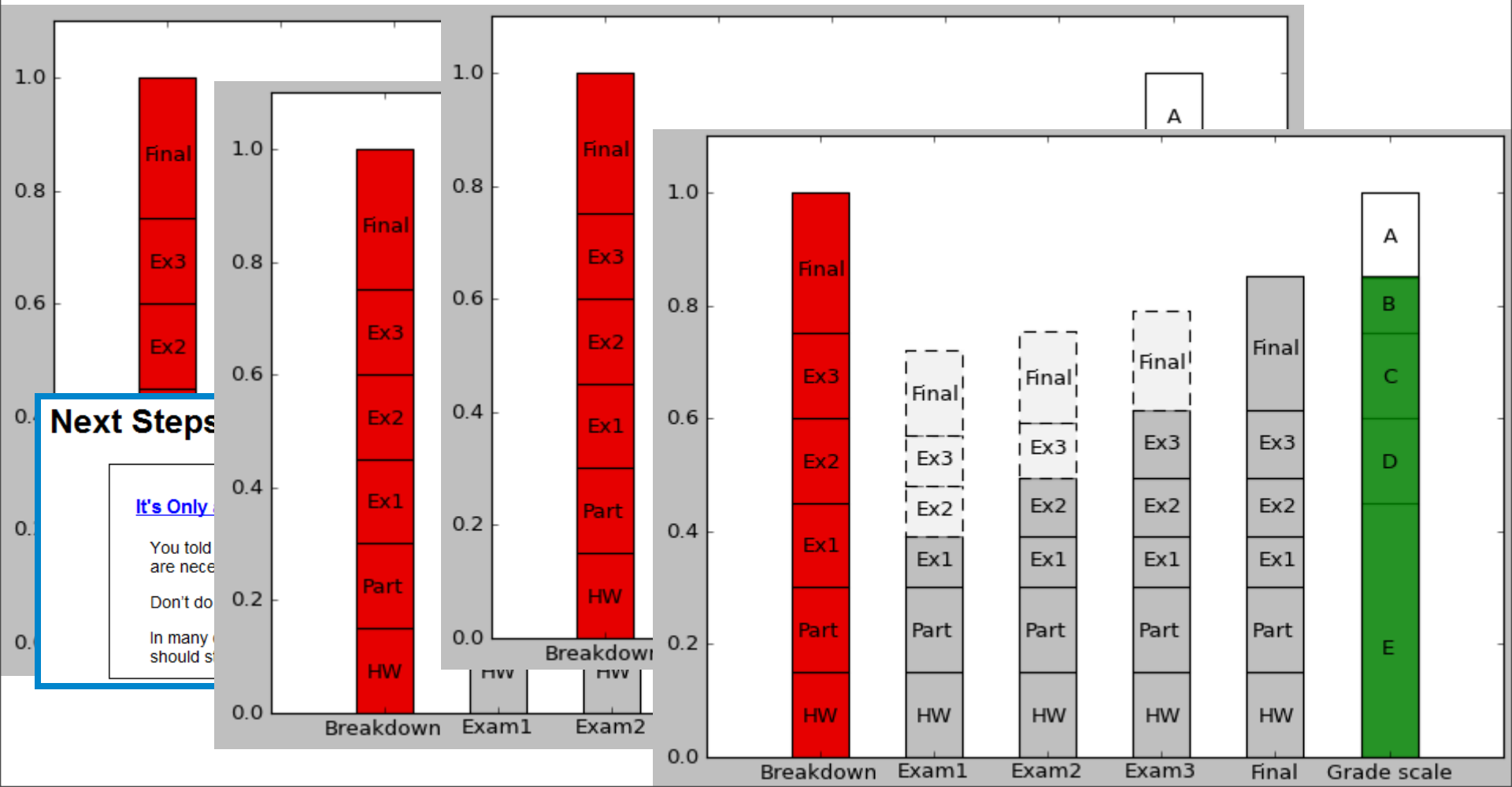

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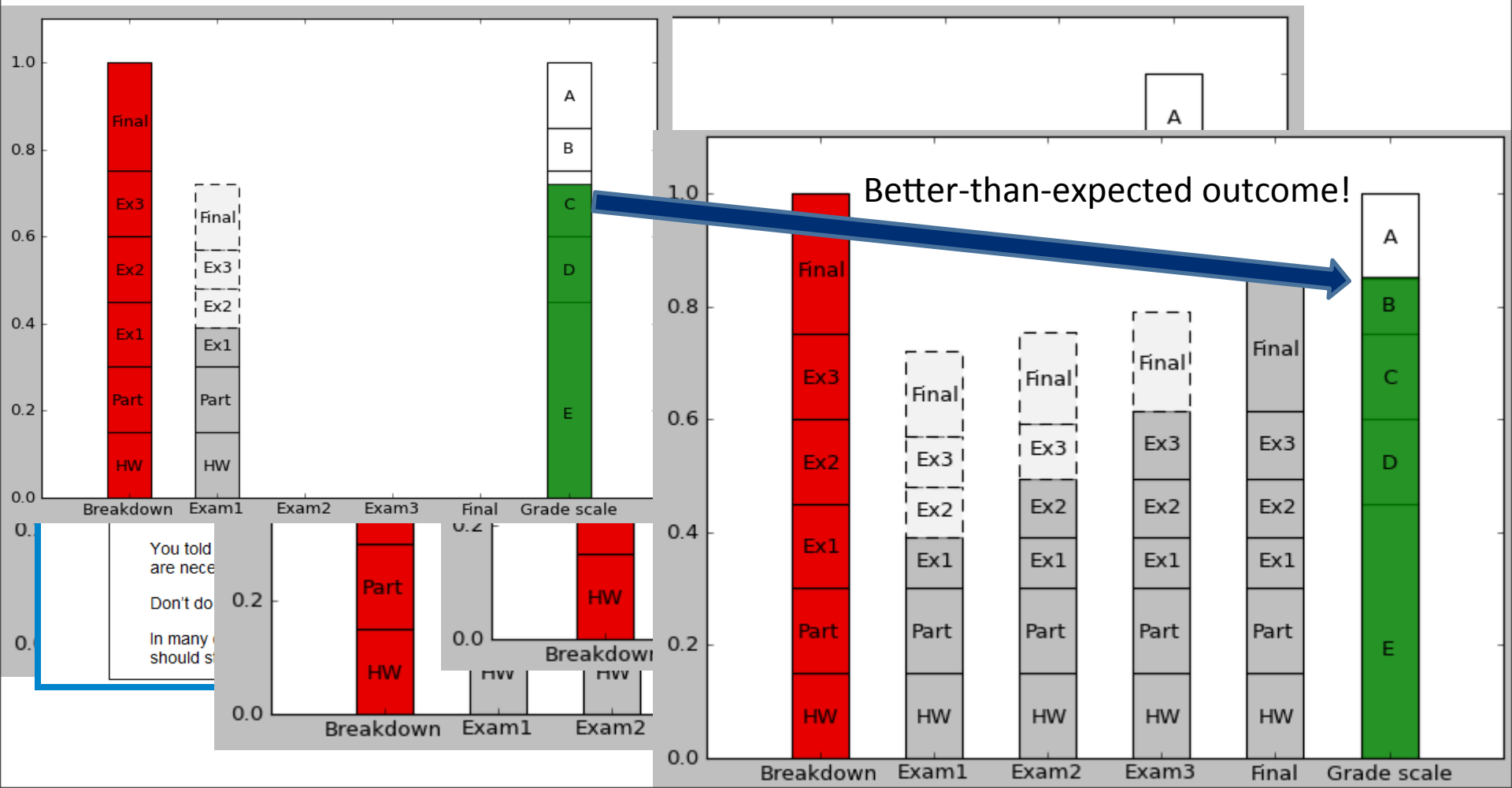


Measurement of impact

- In/out plus usage measures to determine engagement with E^2Coach
- Performance of students relative to historical prediction models
- Disparities on gender, SES, first-gen status
- This is a complex intervention, with many parts: which are key?
- Testing in fall using fractional factorial design
- Building on a legacy of rigorous testing in the public health community

Lessons learned

- Computer tailored communication provides a powerful, flexible model for **intervention engine**
- MTS adoption is practical
- It produces a rich suite of data for assessment and optimization

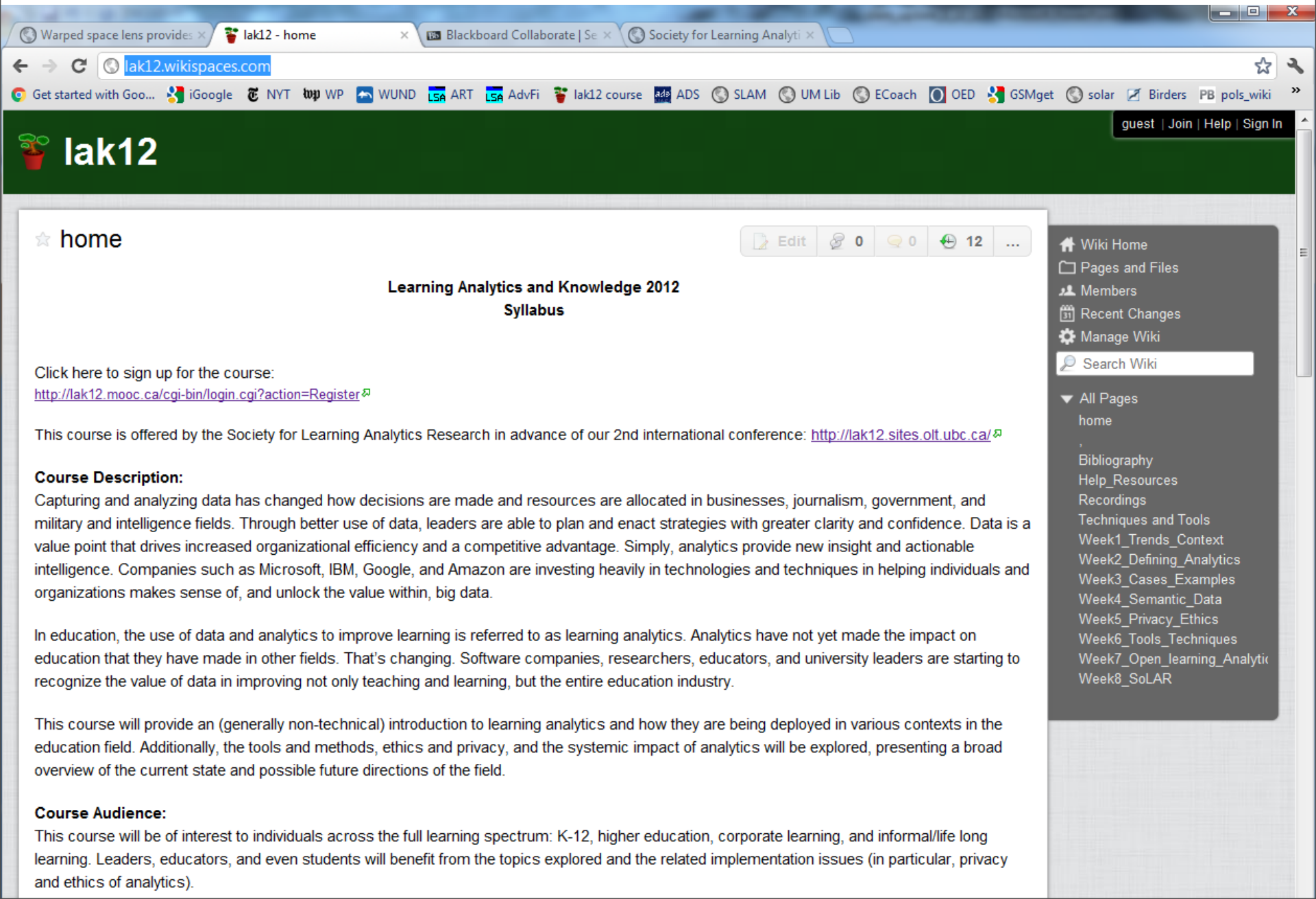
- This is not a technological problem, the real challenge is still in understanding
  - How to optimize response to detailed information about students? What do they have to do to succeed?
  - How to use normative information to motivate them to change?
  - How to better incentivize successful behaviors? How do we get them to change?

The future for tailored communication: an intervention engine

- At UM: expansion of BTE/WTE studies to other disciplines, across gateway STEM courses
- Going to the cloud to collaborate across institutional boundaries
- Developing an integrated system to support academic advising

- Tailored communication is a very generic tool
- Engine of a customized, interactive interface between students and relevant information and support, from orientation to graduation. A tool for informed connection.

Reminder about the SOLAR MOOC on Learning Analytics



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Week1_Trends_Context

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Week 1: Trends and context: why learning analytics? Why now?
Date: January 23 - 29

Introduction:
This week is an introduction into the trends and context that are driving learning analytics. Parts of this week overlap with week 2 where we focus on defining analytics (in its many versions) in education.

We live in digital times. And times of information abundance and growing complexity. The conversations that used to evaporate are now increasingly digitized, waiting for a clever algorithm for analysis. The potential of analytics to increase employee efficiency, match the right people to the right tasks, and to improve access to help resources is tremendous. Businesses and governments have taken advantage of new data-focused tools and techniques to improve organizational efficiency and gain a competitive advantage.

When applied to learning - corporate, higher education, K-12 - analytics raise similar concerns about the interplay between the value between transparent data silos and privacy and ethics. This course will explore learning and knowledge analytics, including analytics methods and models, systemic application, potential data sources, the "soft/human/non-quantifiable" aspect of learning, as well as privacy and ethical considerations in deploying analytics.

In week one, we will focus mainly on building some familiarity with the concepts (and language) of learning and knowledge analytics. We define learning analytics as: "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs".

Readings and videos:

- Baker, S.J.D., Yacef, K. (2009) The State of Educational Data Mining in 2009: A Review and Future Visions: http://www.educationaldatamining.org/JEDM/images/articles/vol1/issue1/JEDMVol1Issue1_BakerYacef.pdf
- Why the current interest in analytics in education?
  - Technology and the completion agenda:
  - http://www.insidehighered.com/news/2010/11/09/completion
- Untangling the social web-Economist:http://www.economist.com/node/16910031
- Marisa Mayer (Google), The Physics of Data:http://www.parc.com/event/936/innovation-at-google.html
- Industry partnerships: http://www-03.ibm.com/press/us/en/pressrelease/36384.wss
- Big data stupid decisions: http://www.youtube.com/user/OreillyMedia#p/c/2543D0F253DD85CF/25/LXDEwpbuwCs

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Bibliography
Help_Resources
Recordings
Techniques and Tools
Week1_Trends_Context
Week2_Defining_Analytics
Week3_Cases_Examples
Week4_Semantic_Data
Week5_Privacy_Ethics
Week6_Tools_Techniques
Week7_Open_learning_Analytic
Week8_SoLAR

lak12

Recordings

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Week 1:
Overview [Recording]

Week 2:
Ryan S.J.d. Baker [Recording]

George Siemens [Recording] [Slides]

Week 3:
John Campbell [Recording]

Week 4:
Dragan Gasevic [Recording]

Week 5:
Erik Duval [Recording] [Slides]

Week 6:
Shane Dawson

Recordings of all the sessions which have happened already are available here

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Week1_Trends_Context
Week2_Defining_Analytics
Week3_Cases_Examples
Week4_Semantic_Data
Week5_Privacy_Ethics
Week6_Tools_Techniques
Week7_Open_learning_Analytic
Week8_SoLAR