



## Practice makes perfect: Preparing students for computer-based testing



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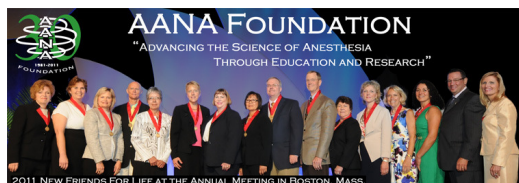
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  - The speaker has no ongoing financial relationship with the manufacturers of any product mentioned here.
2. Any recommendations made here are my personal opinions.
  - They are based on educational experience, consultation with colleagues, and published research.
  - This research was conducted as a dissertation for the author's doctoral degree at Wayne State University, Detroit, Michigan.
  - The author is a member of the National Certification Examination Committee of the NBCRNA.
  - The opinions expressed herein do not reflect the policy or views of the University of Detroit Mercy, Wayne State University, or the NBCRNA.

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## Outline

- Background- why test on computer?
- Research results:
  - Does practice in computer testing help prepare RNAS for the NCE?
- Program improvement:
  - What approaches can we take to successfully & ethically prepare RNAS for Boards?

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## Why we test;

How does the Cert Exam determine one is fit to be a CRNA?

- Testing for job selection
  - Civil service tests (China, 1100 BCE)
- Testing knowledge
  - Written exams in academic settings (Jesuits, 1500 CE)
- Validity
  - -We use exams (and documented clinical performance) to make an important decision- who should be a CRNA.
  - We have to be sure that these decisions are based on the best possible measurement tools- tests which are reliable and valid.
    - Test mode effect- students should succeed or fail based on knowledge, not on extraneous factors (“construct-irrelevant variance”)
      - test anxiety
      - unfamiliarity with mode of test administration

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## Background

- How do you get to be a nurse anesthetist?
  - Registered Nurse license
    - Protect public, mandatory
    - NCLEX-RN (**Computer-adaptive test**)
  - Certified Registered Nurse Anesthetist
    - Voluntary, evidence that one has attained skills beyond basic nursing practice
    - Graduate degree & Nat'l Certif. Exam (**computer-adaptive**)
- Yet we gave 100% paper exams during graduate education for nurse anesthetists (!)
  - Can we use tests not only to assess knowledge, but also as better Cert Exam practice, by increasing test-taking skills?

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## Computer-based testing (CBT)

(Wainer 1990)

- Many testing programs have migrated to CBT
  - GRE, USMLE, ASVAB, NCE, NCLEX-RN, ACT, SAT, MCAT, LSAT
- Score equivalence between test forms (Paper, CBT) has been studied extensively.
  - In the aggregate, they are comparable. But any one student may be disadvantaged in a particular test mode.
- Few studies could be identified that examined the value of practice in CBT
  - these were uncontrolled or incomplete
  - **No** studies have examined practice in CBT for RNAS

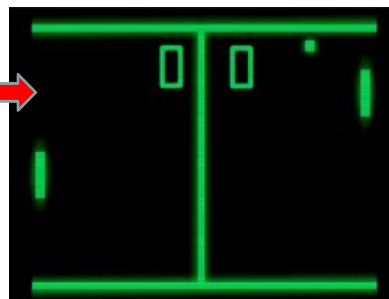
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*“Practice is the best of all instructors” -Publius Syrus*

Is there value in practicing for computer tests?

- The SEE “has three objectives: (NBCRNA 2009)
  1. to provide information to students about their progress...;
  2. to provide information to program directors on how well their programs are preparing students...; and
  3. to prepare students for the Certification examination experience”
- Is CBT the same as paper testing? (Is ping-pong the same as pong?)



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## What does the research show?

- The jury is still out. Results depend on the population and other factors.
  - Seven studies showed higher scores in Paper testing than CBT
  - Nine studies showed higher scores in CBT
  - Ten studies (which include three meta-analyses) showed equivalence.
- It seems that, for certain examinees, computer testing *is different*.

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## How does computer-testing differ from paper and pencil?

- Harder to cope with:
  - No skip/No change (items can't be flagged, reviewed, changed)
  - Judging progress, managing time
  - Noise distractions (keyboards, coming and going)
  - Freaking out at The Wall (Question #101)
- Students must juggle test AND computer anxiety
  - With computer anxiety, more thoughts related to the task of manipulating the computer (consuming resources in working memory).
  - If the examinee is near the margin of acceptable performance, they may fail.
  - Practice with computers decreases computer anxiety.

Smith &amp; Caputi, 2007; Chua, Chen, &amp; Wong, 1999

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## Why test on computer?

<b>Advantages</b> ...for examinees	... For administrators
Convenient <u>scheduling</u>	All the above plus...
<u>Quicker</u> to complete (2-edged sword; they may rush through too quickly)	<u>Better exam security</u>
<u>Easy navigation</u> (but hard to keep time)	Easier administration
<u>One item/screen = Less distracting</u>	Richer test results (easy item analysis, time /item, ...)
Quick accurate precise <u>scoring</u>	Innovative items
<u>Quick notification of results</u>	

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## Why avoid computer testing?

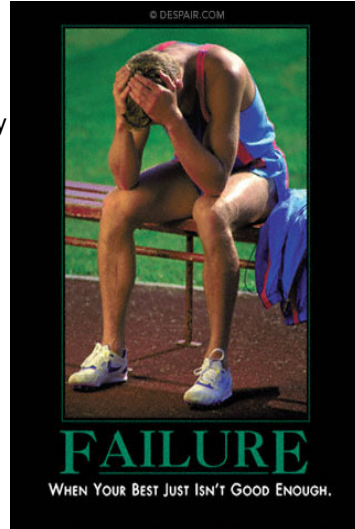
<b>Disadvantages</b> ...for examinees	...for administrators
Fear that <u>computer anxiety</u> may degrade performance	High-stakes programs <u>costly</u> (whether paper or CBT)
Fear that gender, ethnic, cultural, or language groups may be <u>disadvantaged</u>	<u>Had to increase item bank size in response to over-exposure, or threats of cheating</u>
<u>Prefer to review or change previous items</u> , skip items	

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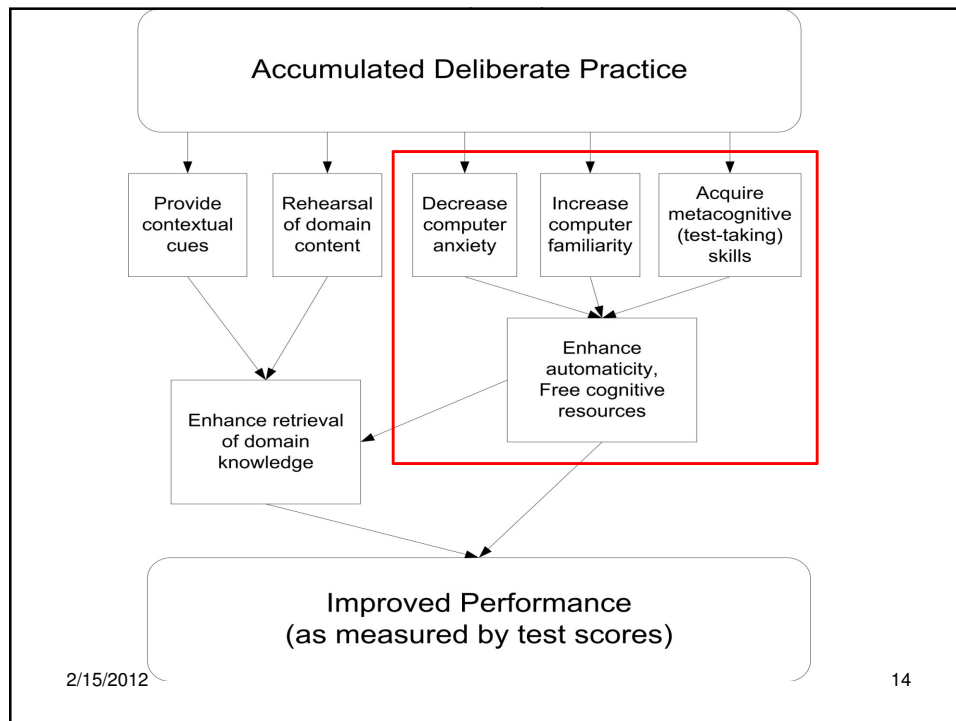
# Test-mode effect & Anxiety

- Testing effect: Practice retrieving knowledge may be the best way to promote long-term retention.
  - Learners need corrective feedback (especially immediate feedback)
- Test-mode effect: Certain students do better (or worse) on paper or computer testing
  - Many factors have been studied as possible contributors to this testing mode effect:
    - race, gender, ethnicity, general computer familiarity, test anxiety, computer anxiety, prior exposure to computer testing, and interface (e.g. font, legibility, and item review)
- Reducing test anxiety improves test scores and GPA (Hembree, 1988)



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## How does previous research help predict the results?

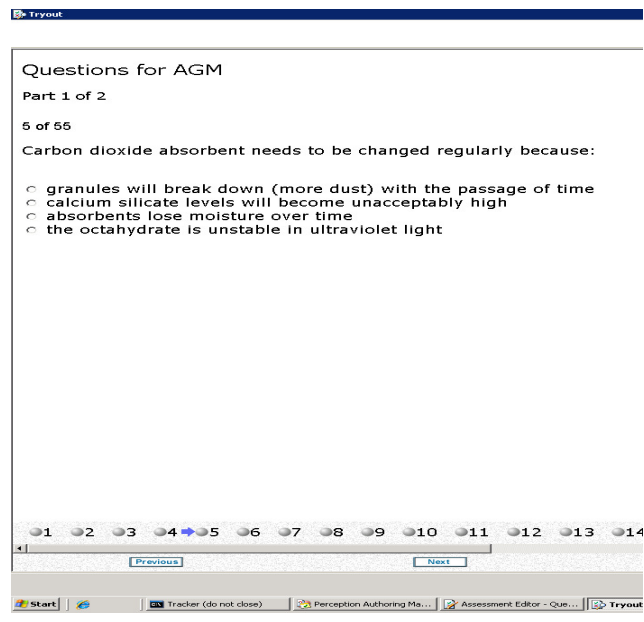
- *Performance is better if...*
  - tests are frequent
  - tests are spaced in time
  - practice is serious (high stakes, motivated)
  - time spent practicing is vast
  - practice resembles testing situation
    - don't practice for Tour de France on a stationary bike at the gym.
  - enough practice to attain automaticity
  - enough practice (right type?) to lessen computer anxiety
- Can we use tests not only to assess knowledge, but also as better Cert Exam practice, by increasing test-taking skills?

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## What we hoped to gain by computer-testing at UDM

- Implemented in 2005.
  - 20-25 hourly and final exams in all ANE courses over 27 months.
  - Includes graphics, alternative item types
  - Face-to-face, proctored
  - Secured browser, NOT Blackboard (can't google answers)
  - NOT adaptive (all get same items in random order with distractors shuffled).



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## Faculty goals

Goal	Rationale/Example
Environmental considerations	Aligned with efforts to make all aspects of educational administration paperless
Decrease costs	<ul style="list-style-type: none"> <li>•Less paper &amp; duplication costs</li> <li>•Automated correction saves faculty time</li> <li>•Low cost (software was available on campus)</li> </ul>
Customer satisfaction	<ul style="list-style-type: none"> <li>• Quicker/better feedback</li> <li>• First-attempt pass rates on the Cert Exam are tracked by applicants, students, alumni, and accreditors as a key quality outcome, which builds program reputation.</li> </ul>
Academic integrity	Better security
Instructional advantages	<ul style="list-style-type: none"> <li>•Quicker/better <u>feedback</u></li> <li>•Easy <u>item analysis</u></li> <li>•<u>Build bank for cumulative exams?</u></li> <li>•<u>Better preparation for cert exam?</u></li> </ul>

## Research Questions

1. Controlling for academic ability, will practice in computer testing while in school be associated with higher scores on the National Certification Examination for Nurse Anesthetists (NCE) than a comparison group who primarily had experience with paper tests?
  2. Do the demographic characteristics of individuals (gender, age) make a difference in test score?
  3. What is the economic cost of instituting and maintaining computer-based testing activities?
- Other criteria such as student satisfaction with the CBT program will be evaluated.

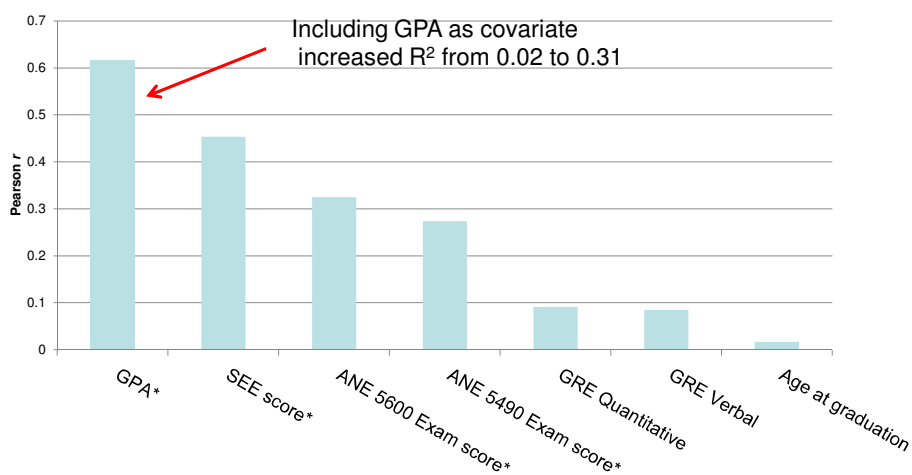
## Method

- **Sample**
  - 205 graduates' records available at one university site
    - 75 with Computer testing practice (2007-09)
    - 75 in comparison group (paper testing; pre- 2007)
      - matched on gender, age, and GPA
      - No difference in # first-attempt failures
    - Power was sufficient to detect difference between groups of 22 points (ES = 0.46)
- **Case-Control design**
  - no random assignment to groups
  - historical controls from intact groups
    - To do a prospective study would have required randomized students for actual tests into paper or computer testing groups. Fairness??
- **Statistical analysis**
  1. ANCOVA
    - Cert Exam score BY Group [Computer, Paper] WITH GPA (covariate)
  2. GPA-blocked ANOVA

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## Covariate chosen by correlation of academic measures with NCE score



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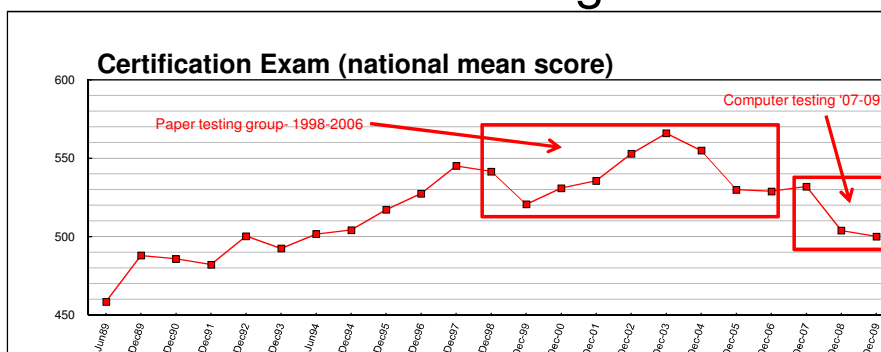
## Groups were matched on GPA, age, gender

Variable	Paper <i>M (SD)</i>	Computer testing <i>M (SD)</i>	<i>p</i>
GPA	3.64 ± 0.18	3.60 ± 0.19	.175
Age at graduation	33.2 ± 5.58	32.3 ± 5.18	.326
GRE Verbal	435 ± 65.6	451 ± 82.9	.198
GRE Quant	503 ± 94.4	518 ± 117	.413
GRE Anal. Writing	3.93 ± 0.62	4.03 ± 0.59	.565
ANE 5490 Exam 1 (%)	92.1 ± 5.31	88.4 ± 5.06	.000*
ANE 5600 Exam 1 (%)	90.3 ± 6.29	90.0 ± 6.78	.846
SEE score	396 ± 34.7	391 ± 33.3	.359
NCE national average	543 ± 15.0	518 ± 14.1	.000*

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## NCE scores decreasing 2003-09



- No way to know *why* scores lower more recently.
- Raw proficiency scores ( $\phi$ ) used to avoid potential artifact from scaling and equating

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## Results

### 1. NCE scores unaffected by age or gender

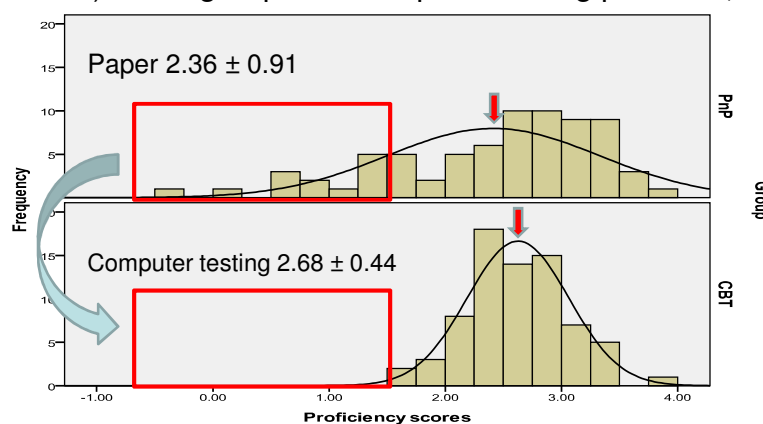
	Test	Value	<i>p</i>
Age	Linear regression	$F(1, 201) = 0.061$	.805
Gender	<i>t</i> test ( $n=201$ )	NCE score (males)=539, (females)=534.	.51

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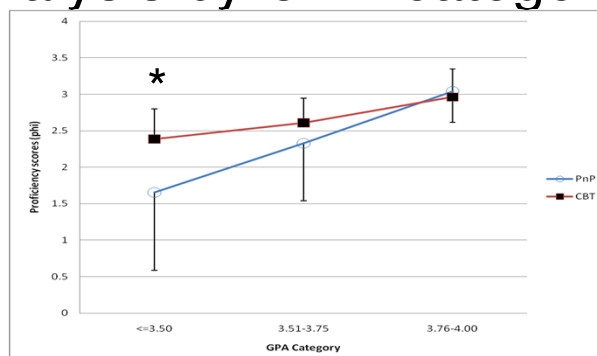
### 2. NCE scores higher in computer testing group than paper test group

- Mean proficiency score (adj. mean  $\pm$  SD) was higher (ES 0.52) in the group with computer testing practice ( $P < .01$ )



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### 3. Analysis by GPA category



- NCE score (both groups) increased with higher GPA ( $p < .001$ ), but the interaction was significant (indicates different effect of computer practice in some of the GPA categories)
  - NCE scores were the same for students with GPA 3.50 and above (good students do well regardless of any obstacles or advantages)
  - NCE scores were significantly **higher in the computer practice group in those students with GPA < 3.50** (\*  $p = .02$ ) (ES 1.1)

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### 4. Direct Cost of CBT

- Direct costs \$2,300/year (net)
  - Software lease (EZExam) ~\$3.5 K/yr
  - Paper & copying savings ~\$1K
  - Net cost:
    - \$1.43 per student per exam
    - Compares to \$0.65 with PnP
- These costs amortized over PA & NA students only ( $n \sim 70$ ). If more groups of students used this software, the cost per student per exam would be less.

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<h1 style="font-size: 2em; margin: 0;">Indirects</h1>	<b>Indirect Benefits</b>
	<ul style="list-style-type: none"> <li>•<b>Time</b> <ul style="list-style-type: none"> <li>•<b>Faculty time correcting examinations</b></li> <li>•<b>Class time saved for instruction</b></li> </ul> </li> <li>•<b>Environmental impact- less paper waste</b></li> <li>•<b>Learning benefits</b> <ul style="list-style-type: none"> <li>•<b>immediate feedback</b></li> <li>•<b>better preparation for computer-adaptive National Certification Examination</b></li> </ul> </li> <li>•<b>Better testing</b> <ul style="list-style-type: none"> <li>•<b>easier, immediate item analysis</b></li> <li>•<b>build item banks</b> for re-use in later examinations, comprehensive examinations, or remediation</li> <li>•<b>enhanced security</b></li> </ul> </li> <li>•<b>Hardware savings</b> <ul style="list-style-type: none"> <li>•<b>Avoid costs of examination answer sheet scanning</b></li> </ul> </li> </ul>
	<b>Indirect Costs</b>
2/15/2012	<ul style="list-style-type: none"> <li>•<b>Learning, maintaining, or troubleshooting software</b> <ul style="list-style-type: none"> <li>-Faculty time</li> <li>-Information Technology staff time</li> </ul> </li> </ul>

## 5. Student satisfaction

- **Hate no skip/no change**
  - “Maybe I'm old school, but ...the main reason I like pencil/paper is because if someone suffers from test anxiety, sitting and writing, skipping questions and being allowed to come back to those questions as ‘test nerves’ settle down, helps build overall confidence during the exam.” ...“Inability to look back through all questions at the end of an exam is a great disadvantage.”
- **...but I know it will help me**
  - “Going into the first computerized exam I was extremely nervous, especially knowing you cannot go back into other sections. However I have become used to it.” “...I am sure it will help me in the future.” ...“Since we take almost all of our examinations on computers, I don't think that computerized testing will even play into anxiety for the Certification Exam.”

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## 5. Student satisfaction

Advantages cited by students	Times mentioned
Immediate score and question feedback; Learning benefit of immediate review of wrong answers	73
Increase computer familiarity, and decrease computer or test anxiety	12
Good preparation for National Certification Examination	12
Like CBT better than PnP, ergonomic benefits	8
Learn no skip/no change	4
Easy to use test software	4

- Students generally liked computer-based testing,
- By far, the benefit of CBT most often cited was immediate feedback

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## Student dissatisfaction

Disadvantages cited by students	Times mentioned
<u>No skip/no change</u> (inability to review and change answers to previous questions)	27
Technical problems (test <u>software crashes</u> )	25
<u>Learning new test-taking skills</u>	15
Computer anxiety related to technical problems	6
No disadvantages	5
Other (Like PnP better; Like essay/short answer better than multiple-choice; Like learning from review of whole PnP test better)	4

- While students are uneasy with the need to learn new test-taking skills, they recognize that doing so is likely to be good preparation for the NCE
- The most-often cited disadvantages are no skip/no change, and technical problems.

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## Alternative explanations of results

- Systematic bias
  1. **Comparable academic ability** in the two groups cannot be assured without random allocation.
  2. The **curriculum may have changed** in subtle ways that produced higher scores for more recent students.
    - No gross changes in curriculum or faculty occurred
  3. Finally, the **difficulty of the NCE test form may have been higher in the past**, making it more likely that recent scores would be higher.
    - Not very likely; national average first-attempt score on NCE has decreased from 560 (2002) to just above 500 (2009)

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## Conclusions?

1. Cert Exam scores were positively correlated with measures of academic ability (graduate GPA, SEE score). Gender or age did not affect score.
2. Controlling for GPA, the Computer-testing group had higher scores on the Cert Exam than the Paper group overall (effect size 0.52; about 25 scaled score points)
3. Subgroups
  - Students with GPA > 3.5 were not helped or hurt by CBT practice.
  - Students with graduate GPA < 3.5 with practice in computer testing had higher Cert Exam scores than those without (effect size 1.1; about 50 scaled score points)

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## Conclusions?

5. Student reactions to computer-based testing were generally positive.
  - Advantages:
    - immediate scoring and feedback
    - good preparation for the NCE
  - Disadvantages
    - inability to review and change previous answers
    - need to learn new test-taking skills
    - technical problems with the software
4. Direct costs of testing were low, and there were substantial indirect (non-economic) benefits

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What approaches can faculty take to effectively and ethically prepare RNAS for Boards?



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## Ethics of test prep

- Student ethics
  - “**More Arrests in SAT Cheating Investigation**” (*NY Times* Nov 22, 2011)
  - **Test banks stolen from publisher** [Sept 2011]
    - “To faculty customers utilizing an Evolve test bank product: Recently, it’s come to our attention that **one of our Evolve test banks... was pirated and made for sale via an online auction site**. This action, which is an unfortunate problem affecting all publishers, is illegal. Copyright infringement is a felony and as such this current situation has been referred to the Elsevier legal department for action.”
- Faculty ethics
  - Don’t divulge test content, or teach to the test
  - Uphold clear standards for academic conduct to students
  - Design fair, reliable, and valid tests, which allow only students with sound knowledge base to progress

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## Barriers to designing effective board prep

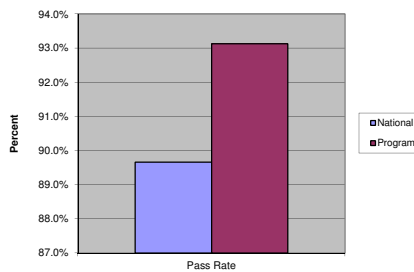
- Faculty tend to have been great students
  - It’s hard to relate to students who struggle. You just haven’t had those problems yourself.
  - On the other hand, faculty are probably good test-takers, and have insights to share
- I have my own biases about what works
- I tend to nibble at the edges and react to recent events.
  - It is hard to design a coordinated approach when board failure is rare, and each seems unique.

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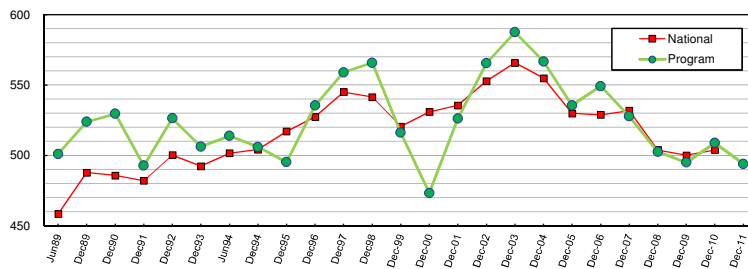
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# One program's dashboard...

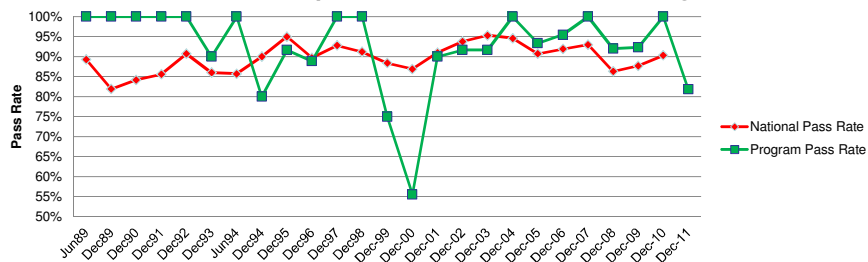
**First attempt Pass rate**  
UDM Nurse Anesthesia 1989-2011



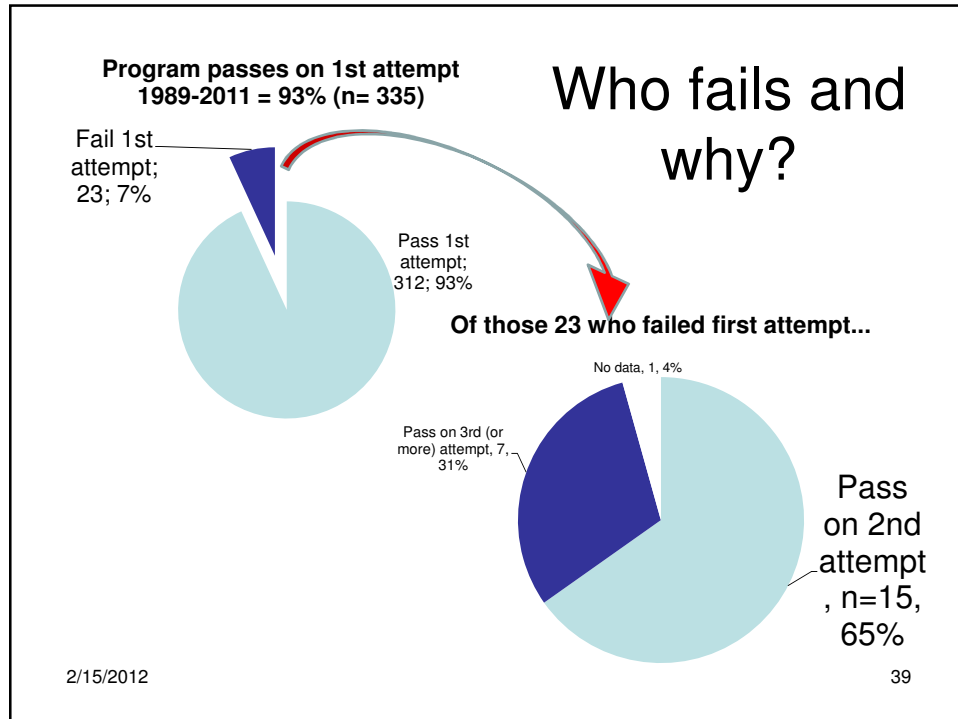
**Certification Exam (mean score)**



**NCE First attempt Pass Rates- National and Program**



- **National Pass rates**
  - Range ~82-95% (median 90%)
- **Program**
  - Range 56-100% (median 93%)
  - ***But why not 100% every year?***



## Who fails and why?

- Failed 1<sup>st</sup> attempt- 7% (23/335)
  - “Hands and arms went numb... all of a sudden none of the questions made any sense... drove through a snowstorm to get there”
  - Of these 23, more than 2/3 passed on 2<sup>nd</sup> attempt (usually within a month).
  - What happened to make them pass so quickly?
    - This is a funny pattern if results are only affected by knowledge base.
    - Did they get smart all of a sudden? Discover better study techniques?
    - **No. They conquered anxiety.**

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## A coordinated board preparation system addresses...

1. Content review
2. Resource management
  - Schedule in senior year should allow time for board study, or at least be structured so they aren't ready to drop dead by the time they receive their diploma
  - Wellness; Physical and Mental
3. "Test wise-ness"
  - Less Test anxiety
  - Better Study skills
  - Better Test-taking skills
    - Practice in computer testing
    - Cumulative exams (not just topic-limited hourly's)

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## So what do we do?

- Month 1 (27 month curriculum)
  - **Sept 2010** (for Class of Dec 2012)
  - Present "Test-Taking Skills & Study Skills"
  - 1-2 hours
  - Why?
    - Many of them are bright enough to have floated through UG while barely studying; never had to buckle down when faced with a true academic challenge. And now they're in the big leagues (grad school)

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## So what do we do?

- Month 1 to 15 (of 27)
  - **Sept 2010-Dec 2011**
  - Majority of classes are in first 15 months, integrated with increasing clinical (the last 12 months are primarily clinical)
  - Computer-based testing throughout, in all anesthesia courses

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## So what do we do?

- Month 15 of 27 (**Dec 2011**)
  - Comprehensive test #1- end of junior year
    - assembled from our item banks.
    - Must pass with 80% (one retake allowed)
      - They can still progress to next term if they fail
      - Thinking about changing that, but have not because they take it plenty serious.
    - Why?
      - Student self-assessment, and curricular assessment
      - get them used to a wide variety of questions (like the NCE); all their other tests are pretty restricted in topic (hourly exams that only cover the last month or so).

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## So what do we do?

- Month 20 of 27 (**May-Aug 2012**)
  - Board review course
    - 1st session is repeat of “Test-Taking Skills & Study Skills”
    - followed by an hour on Cert Exam stats (program, national) and advice on how to do well.
      - We talk a LOT about overcoming test anxiety.
    - The rest of the class is mostly practice in answering test questions (we think they are weak there).
  - All MUST take SEE (no minimum score)

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## So what do we do?

- Month 23 of 27 **Aug 2012**
  - Comprehensive test #2. Same as Comp exam #1 EXCEPT this one has “teeth”;
    - MUST pass with 80% (one remediation allowed).
    - CANNOT progress to next term (graduate) if they do not pass in two attempts.
      - » I’m really not looking for a new reason to dismiss, but they have to take this seriously to benefit from it
  - Why?
    - more practice in a high stakes comprehensive test
    - assess their learning, and predict their board score
    - \*\*\*get them to study earlier than the final few months\*\*\*.

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## So what do we do?

- Month 24 to 27 **Sept-Dec 2012**
  - Counsel those identified as high risk

	Correlation with NCE score
SEE	.75
Comprehensive exam score	.74
Cumulative GPA in program	.61

- Encourage to take boards as soon as possible after graduation
  - Practically, they need no encouragement on that score. Most cannot work before passing boards and medical staff credentialing.

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# Questions?



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