A TALE OF TWO LEARNERS
optimizing anesthesiology residency training for the new culture of digital natives

larry chu, md
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ANESTHESIA INFORMATICS AND MEDIA LAB

Stanford Medicine | Anesthesiology, Perioperative and Pain Medicine
Stanford University Department of Anesthesia • Agency for Healthcare Research Quality
International Anesthesia Research Society, National Institutes of Health

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empathy

noun

The ability to step into the shoes of another person, aiming to understand their feelings and perspectives, and to use that understanding to guide our actions.
the two sigma paradox

Average Student
in Tutorial
>98% control

Average Student
in Mastery
>84% control

SUMMATIVE ACHIEVEMENT SCORES

1:1 Tutorial
1:30 Mastery
1:30 Conventional

THE 2-SIGMA PROBLEM: THE SEARCH FOR METHODS OF GROUP INSTRUCTION AS EFFECTIVE AS ONE-TO-ONE TUTORING. BLOOM, B.S. EDUCATIONAL RESEARCHER, VOL 13, NO 6 (JUN-JUL 1984) PP. 4-16
NEW TOOLS—SAME GOALS
EFFECTIVE LEARNING BY DESIGN
CHALLENGE FOR TEACHERS
UNDERSTAND NEW INSTRUCTIONAL TECHNOLOGIES
**UDL - Universal Design for Learning**

<table>
<thead>
<tr>
<th><strong>AFFECTIVE NETWORKS:</strong> THE <strong>WHY</strong> OF LEARNING</th>
<th><strong>RECOGNITION NETWORKS:</strong> THE <strong>WHAT</strong> OF LEARNING</th>
<th><strong>STRATEGIC NETWORKS:</strong> THE <strong>HOW</strong> OF LEARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Checkmark] Stipulate interest and motivation for learning</td>
<td>![Checkmark] Present information and content in different ways</td>
<td>![Checkmark] Differentiate the ways that students can express what they know</td>
</tr>
<tr>
<td><strong>More ways to provide Multiple Means of Engagement</strong></td>
<td><strong>More ways to provide Multiple Means of Representation</strong></td>
<td><strong>More ways to provide Multiple Means of Action and Expression</strong></td>
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</tbody>
</table>

UDL provides a blueprint for creating instructional goals, methods, materials, and assessments that work for everyone—not a single, one-size-fits-all solution but rather flexible approaches that can be customized and adjusted for individual needs.

http://www.cast.org/our-work/about-udl.html#.Vte894RGdMZ
EMPATHY FOR LEARNERS
WHO ARE TODAY’S ANESTHESIA LEARNERS?
high adoption of computer technologies

- Novice
- Somewhat Knowledgeable
- Knowledgeable
- Very Knowledgeable
- Power User

- 2010
- 2011
- 2012
- 2013
- 2014
mobile and data-connected generation of learners

- iPhone
- Android Phone
- Other

<table>
<thead>
<tr>
<th>Year</th>
<th>iPhone</th>
<th>Android Phone</th>
<th>Other</th>
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<tbody>
<tr>
<td>2010</td>
<td>50%</td>
<td>0%</td>
<td>9%</td>
</tr>
<tr>
<td>2011</td>
<td>54%</td>
<td>4%</td>
<td>21%</td>
</tr>
<tr>
<td>2012</td>
<td>75%</td>
<td>2%</td>
<td>24%</td>
</tr>
<tr>
<td>2013</td>
<td>75%</td>
<td>2%</td>
<td>25%</td>
</tr>
<tr>
<td>2014</td>
<td>76%</td>
<td>3%</td>
<td>104%</td>
</tr>
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</table>
anesthesia residents are heavy adopters of tablet devices

2010: 4.6%
2011: 11.5%
2012: 32.5%
2013: 72.2%
2014: 71.5%
residents believe tablets under-utilized in their education

- Strongly agree that "a mobile device such (e.g. iPad) would enhance my ability to learn in a meaningful way"
- Strongly agree that "mobile devices (e.g. iPads) are under-utilized in anesthesia education"
residents believe tablets enhance multiple educational uses

- Enabling opportunities for learning to occur more frequently
- Increasing the convenience for learning
- Increasing opportunities for learning outside of the hospital
- Increasing opportunities for learning in the OR

Scores:
- Unimportant
- Of Little Importance
- Mod. Important
- Important
- Very Important
preference for learning new clinical procedure

- Intraoperative Teaching
- Videos
- Flashcards
anesthesia residents seek help first from online sources

...where do you typically go first for help?
anesthesia resident are not content creators, they’re consumers

Larry Chu, MD
Associate Professor of Anesthesiology | Lchu@stanford.edu

Medicine | Education | Future of Medical Education | April 21-23, 2017
THOUGHTFUL USE OF EDTECH
WHAT ARE THE UNIQUE AFFORDANCES YOU SEEK?
screen-based simulation increases feeling of preparedness

PROJECT
10 month online elearning curriculum designed to prepare anesthesia interns for residency training. Launched in 2009. Now deployed at 23 schools nationwide.

RESULTS
Post-curriculum quiz scores improved by an average of 24% each month (p<0.0001), self-assessed preparedness scores improved by 72.2% (p=0.02) after completing the online course. Mean AKT-1 scores were 14% higher in the START cohort (86.2%ile nationally) vs. historical control (75.8%ile national) (p=0.03).  
how might we scale experiential learning?

“Net Gen learners are experiential, prefer to learn by doing rather than being told what to do. This enables them to better retain information and use it in creative, meaningful ways.”

Oblinger and Oblinger, Is it Age or IT, First Steps Toward Understanding the Net Generation, 2005
How can we engage today’s residents through experiential learning using video?

Framework: First-person POV video games.
ethercast

INDUCTION OF GENERAL ANESTHESIA
BRING LEARNING TO SCALE
ROLE OF CURATION AND PERSONALIZE LEARNING
1400 Anesthesia Learners
48/133 Programs = 36% US
1 Australia
1 South Africa

2014: 1400/3517 = 40% US
2015: 1471
Majority of current residents are millennial learners, incorporating new technologies and fast, mobile delivery of information.

Accustomed to mobile, online learning from grade school through medical school, expecting similarly sophisticated teaching modalities in residency.

Learnly was created to meet this need for a time-shifted, place-shifted method of learning that strategically promotes an incremental model of studying (vs. cramming) to prepare residents for high stakes educational milestones.
UNIQUE AFFORDANCES

340+ online learning modules, organized around anesthesia basic sciences. Learnly is not marketed as a board review course.
UNIQUE AFFORDANCES

- Daily trigger email
- Short online reading
- Knowledge Assessment Questions
Introduction to Lesson

Monday, September 8, 2014

Ventilators: Classification: Flow Generation vs. Pressure Generation

James M. Hunter, Jr., MD
Assistant Professor of Anesthesiology and Surgery
University of Alabama at Birmingham

Learning Objectives:

After completing this lesson the learner will be able to:

1. Describe the flow patterns in flow-targeted and pressure-targeted mechanical breaths.
2. Contrast how changes in lung compliance and chest wall compliance affect airway pressure during pressure-targeted breath.
3. Contrast how changes in airway resistance affect airway pressure and tidal volume in a flow-targeted breath.
4. Explain how pressure support differs from pressure control.

What would you do?

A 52-year-old woman is slow to awaken after general anesthetic transported to the PACU and mechanical ventilation with volume-targeted ventilation is chosen. The patient is "fighting the ventilator" and becoming agitated. Evaluation reveals that the patient is attempting to provide support. How might the choice of mechanical breath type affect inspiration? How would changing to pressure-targeted ventilation change the patient's response? Would changing to pressure-targeted ventilation change the patient's response? Would changing to pressure-targeted ventilation change the patient's response?

Affective Networks:

The Why of Learning

Engagement

For purposeful, motivated learners, stimulate interest and motivation for learning.
Positive Pressure Breaths

The flow pattern of a mechanical breath is determined by parameters controlled by the ventilator and duration.

This chapter describes the common types of positive pressure breaths:

- volume-control
- pressure-control, and
- pressure support.

Each of these breath types is useful in the operating room. For example, pressure support can aid the patient’s inspiratory efforts.

Check your understanding!

- List the parameters that can be controlled by the ventilator in delivery of a positive pressure breath.

Move on to the next section!
Question 1
Marked out of 1.00
Flag question
Write a personal note

How is most blood carbon dioxide transported?

Select one:
- A. As carbaminohemoglobin
- B. As bicarbonate ion (HCO₃⁻)
- C. As dissolved CO₂
- D. As carbonic acid (H₂CO₃)

Question 2
Marked out of 1.00
Flag question
Write a personal note

Which of the following is NOT a determinant of mixed venous oxygen content?

Select one:
- A. Hemoglobin
- B. Arterial oxygen content
- C. Oxygen consumption
- D. Partial pressure carbon dioxide
- E. Cardiac output
WHO’S USING LEARNLY?

99% used learning technologies in college

59% completed an online course before
• **81% of residents** who have been using the course for at least 3 months **say that Learnly is more engaging than traditional study methods**

• **86% of residents** say Learnly is more engaging than traditional lectures
LEVEL OF ENGAGEMENT OVER 24 HOURS

# INTERACTIONS WITH LESSON

TIME OF DAY (HOURS)
37% of Learnly residents are regular users, compared with 7% average completion rate for MOOCs.

88% of Learnly residents say makes them feel more prepared for high stakes milestone exams.
98% of residents say they use STARTprep to learn and study at convenient times not possible with in-person courses.

Podcasts
Podcast episodes have been downloaded 2,604 times across eight countries.

Participation
1/3 or residents open daily course emails and 29% click through to the course.

Demographics
42% female
62% ages 25-30
45% on Facebook
22% 1st caregiver

Time Shifting
95% of residents rate STARTprep chapters as being good, very good or excellent.

Participation
86% of residents say STARTprep is more engaging than traditional lectures.

Mobile Learners
88% of residents say that STARTprep makes them feel more prepared for high stakes educational milestones.

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990 Residents
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92% of respondents say that Learnly helps them make better clinical decisions.

94% say Learnly helps them feel more prepared for daily cases.
Initial results show the program helps learners:

- **Feel more prepared for high stakes educational milestones**
- **Engages learners more** than traditional lectures and study methods
- Allows residents to **learn at times that are convenient** to their needs and lifestyles
- **Reveals strengths and gaps in residents’ knowledge** of the anesthesia basic sciences
Slow and steady wins the race! The key of [Learnly] is it cuts out the wasted time in figuring out what to study. Each day there is a set topic for review.
OUTCOMES (2013 COHORT)

- Failure Rate
  - Learnly: 0.8% (p<0.05)
  - National: 4%

Learnly vs National: Learnly has a significantly lower failure rate compared to the national average (p<0.05).
OUTCOMES (2013 COHORT)

<table>
<thead>
<tr>
<th>Activities</th>
<th>Failed</th>
<th>Pass</th>
<th>Top 10%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2,837</td>
<td>4,394</td>
<td>6,854</td>
</tr>
</tbody>
</table>

*p<0.08
OUTCOMES (2013 COHORT)

- Learnly: 15%
- National: 10%

Scored in “top 10%”
What psychological side effects may occur after ketamine administration?

Emergence reactions can include hallucinations, vivid dreaming, and hemodynamic and neurovegetative experiences.

Key Take-Aways:
- Ketamine is a noncompetitive antagonist at the NMDA receptor whereby it causes dissociative anesthesia by affecting the limbic system.
- Ketamine can be used in all possible administration routes. Ketamine is water soluble with a pKa of 7.5, which permits nonintravenous IV, IM, oral, IN and rectal administration. It is 10 times more lipid soluble than thiopental and can quickly cross the BBB barrier. It has an oral bioavailability of 20%.

Learning Objectives:
- After completing this lesson, the learner will be able to:
  1. Explain the molecular mechanism by which ketamine acts on the human nervous system.
  2. Describe the factors that influence the pharmacokinetics of ketamine.
  3. Identify the primary mechanisms by which ketamine is metabolized and excreted from the body.
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- Ketamine increases intraocular pressure (IOP); hence should be avoided in open eye procedures. The other drugs either have no effect or decrease IOP. Succinylcholine slightly increases IOP so many anesthesiologists choose to avoid it as well.

Which of the following drugs is MOST likely to increase intraocular pressure?

A. Propofol
B. Fentanyl
C. Ketamine
D. Vecuronium
AN ANESTHESIOLOGY LEARNING ECOSYSTEM

AFFECTIVE NETWORKS: THE WHY OF LEARNING

Engagement
For purposeful, motivated learners, stimulate interest and motivation for learning.

RECOGNITION NETWORKS: THE WHAT OF LEARNING

Representation
For resourceful, knowledgeable learners, present information and content in different ways.

STRATEGIC NETWORKS: THE HOW OF LEARNING

Action & Expression
For strategic, goal-directed learners, differentiate the ways that students can express what they know.
QUALITY OF LEARNING EXPERIENCE

ACKNOWLEDGE VULNERABILITY OF RESIDENTS
She asked me to sit for a few minutes and, shamefully, I hesitated. I had eight more patients to see before rounds and was already running behind.

Dhruv Khullar, MD
MGH Resident
“So far, residency educational reform has focused on the quantity of hours worked, not necessarily improving the quality of time spent at work.”

Dhruv Khullar, MD
MGH Resident
STANFORD COURSEWORK

EDUCATION 281X - TECHNOLOGY FOR LEARNERS
ANES 204 - MEDICAL EDUCATION IN THE NEW MILLENIUM

LEARNING DESIGN & RESEARCH

NEJM FIRST AUTHOR
STARTPREP AUTHOR/EDITOR
TEACHING STARTPLUS
INSTRUCTIONAL DESIGN RESEARCH PUBLICATIONS

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CLINICAL VIDEO FOR NEW ENGLAND JOURNAL OF MEDICINE

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LAUNCHED NEW PODCAST
DOWNLOADED MORE THAN 16,000 TIMES IN 47 COUNTRIES
PLACING KNOWLEDGE INTO PRACTICE
CLINICAL ATTENDING STANFORD OPERATING ROOMS

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LECTURING ON MEDICAL EDUCATION

STANFORD COURSE ON MEDICAL EDUCATION IN THE NEW MILLENNIUM

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CUTTING EDGE TECHNOLOGY
OCULUS RIFT AT STANFORD TECHNOLOGY LABS

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LEADERSHIP ON A GLOBAL STAGE

MEDICINE X AND MEDICINE X | ED

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FUTURE OF MEDICAL EDUCATION | APRIL 21-23, 2017
**STARPrep: A 12 month multi-institutional episodic daily learning online mobile curriculum designed to prepare anesthesia residents for competency in the anesthesia basic sciences**

Chandrasoma J¹, Lynn Ngai², Traynor AJ³, Piehl E³, McFadyen G¹, STARTprep Working Group⁴, Chu LF¹

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**STUDY OBJECTIVES**

- To understand the extent to which a daily online curriculum can address the unique learning needs of today’s Millenial residents
- To measure which variables in an online course significantly affect residents’ performance on high stakes educational milestones
- To provide useful information to residency program directors to ultimately advance the teaching of anesthesia basics sciences in online, blended and in-person formats at their home institutions.

**METHODS**

- Stanford IRB approval 27444 was obtained to distribute the online curriculum and accompanying research instruments to 37 residency programs internationally.
- The course was first implemented in July 15, 2013 and ran everyday through June 22, 2013, for 204 residents from 13 original institutions participated.
- The course was implemented for a second time beginning in July 15, 2014, 1374 residents from 47 institutions are participating.
- Enrollment was voluntary and performance was blinded to home institutions.
- Students receive a daily email that prompts them to log into the Moodle LMS where they read a textual chapter written by a faculty expert, complete a set of interactive flashcards; and take a daily 5 question quiz. Supplemental resources such as audio podcasts and downloadable PDFs are also provided.
- System and learner improvement are evaluated.

**RESULTS**

- 31.7% residents from 55% residency programs across all regions of the U.S and all program sizes.
- 56% CA 1 residents, 12% CA 2 and 35% CA 3.
- 42% are females and 58% are males.
- 62% are between the ages of 21-30.
- 16% grew up outside the United States.
- 77% hold an undergraduate degree in the sciences.
- 23% serve as a primary caregiver for someone else.
- 59% expert learning technologies in collegemedical school.
- 39% completed an online course before.
- 41% own a Facebook account.
- 70% identify as a “saver” or “spectator” social media.
- 17% have a “Shifting” learning style on the Kolb Learning inventory.
- 46% have an “experiencing” learning style.

**Who is using STARPrep?**

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**DISCUSSION**

**STARPrep is more engaging than other modes of studying anesthesia basic sciences.**

- 81% of residents who have been using the course for at least 2 months say that STARPrep is more engaging than traditional study methods.
- 86% of residents say STARPrep is more engaging than traditional lectures.

**Most residents are “selective users” of STARPrep.**

- 47% were Selective Users, meaning that they use almost every available resource in sequencial order, residents
- 37% were Segmental Users, meaning that they use almost every available resource in sequencial order, residents
- 16% were Selective Users, meaning that they read every chapter, but use the other resources selectively. residents

**STARPrep is a novel 12 month multi-institutional episodic daily learning online mobile curriculum in use by more than 1300 U.S. anesthesia residents.**

**WORKING GROUP MEMBERS**

- Larry Chu, MD, Associate Professor of Anesthesiology, Stanford Medicine, lchu@stanford.edu

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ASSISTANT PROFESSOR
USC, DEPARTMENT OF ANESTHESIOLOGY