Using "Big Data" Learning Analytics

Or How I learned to identify students
"falling off the growth chart" and evaluate
competency learning curves

Clinton Pong, MD
Tufts Medical School/Cambridge Health Alliance

Conference on Medical Student Education
February 9-12, 2017 • Anaheim, CA

STFM
SOCIETY OF TEACHERS OF
FAMILY MEDICINE

Disclosures

- none

Audience poll

- Students
- Residents
- Allied Health Prof
- IT/Tech-related
- Community Preceptors
- Clinical faculty
- Course directors
- Other

Broad Street cholera outbreak (1854)

What do you notice?

Learning Outcomes

1) Describe components of learning analytics relevant to LCME/ACGME for EPA and competency development

2) Analyze competency learning curves (CLC) for trends

3) Analyze competency measures and identify areas for improvement and faculty development

Analytics | CLC | Horizon

1) Learning Analytics for Smarties

Describe components of learning analytics relevant to LCME/ACGME for EPA and competency development

Analytics   CLC   Horizon

Medicine is DATA. Medicine is BIG

- Big Data
- Analytics
- Learning analytics

- Examples in medicine:
  - Vital signs → Growth chart
  - Lab tests → "Quad screen"
  - EKGs / EEGs → e-Read
  - Clinical calculators → Prediction of clinical outcomes

- Examples in education:

Big Data

Google

| Late 90s | 2000s | On the Horizon |

What we have

- Volume
- Velocity
- Variety
- Value

What we want

- Digestible
- Easy to use
- Includes all sources
- Useful and actionable
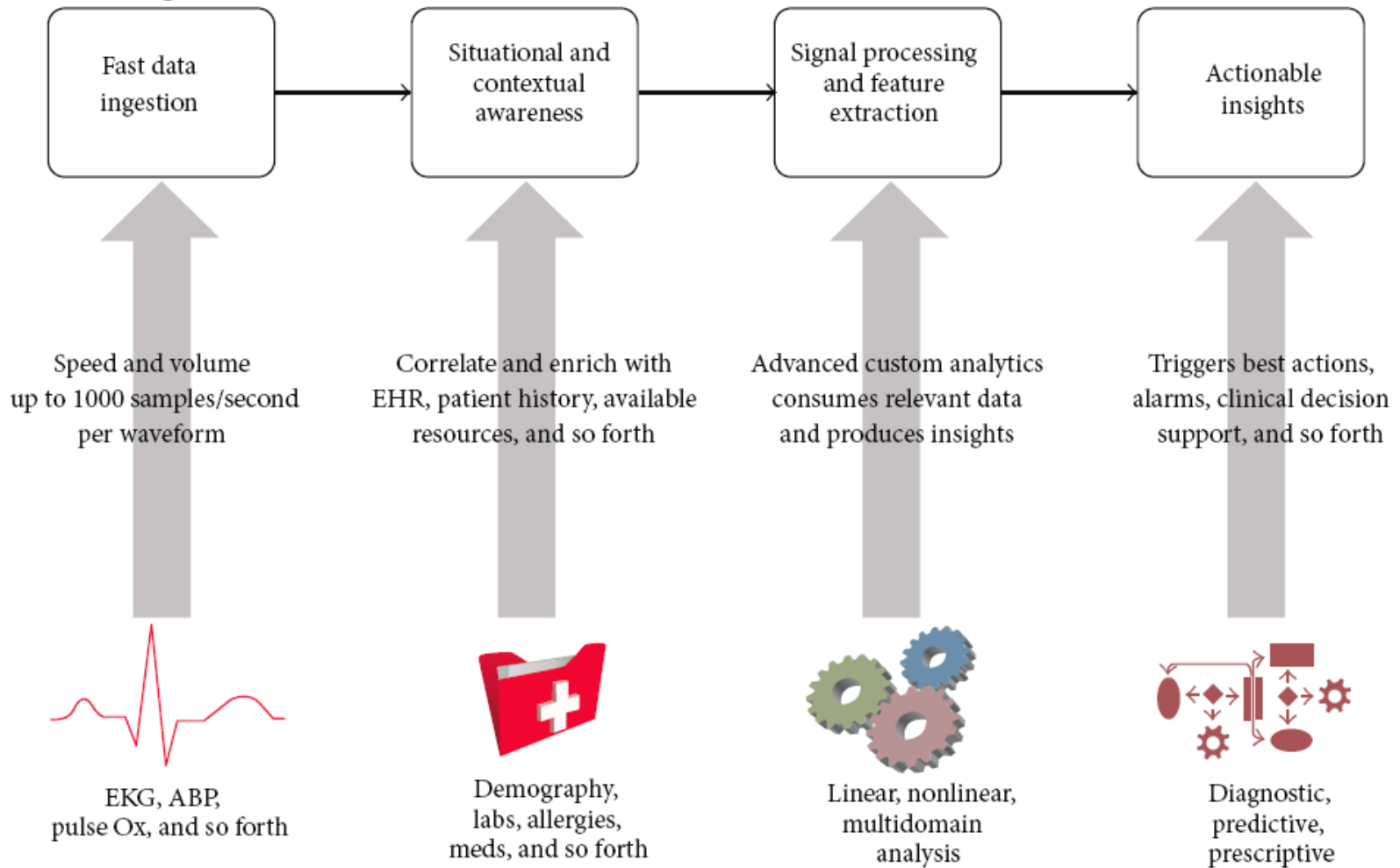
(Laney 2001)

Big Data Analytics in Healthcare

Fast data ingestion	Situational and contextual awareness	Signal processing and feature extraction	Actionable insights

Speed and volume up to 1000 samples/second per waveform

Correlate and enrich with EHR, patient history, available resources, and so forth

Advanced custom analytics consumes relevant data and produces insights

Triggers best actions, alarms, clinical decision support, and so forth

EKG, ABP, pulse Ox, and so forth

Demography, labs, allergies, meds, and so forth

Linear, nonlinear, multidomain analysis

Diagnostic, predictive, prescriptive

FIGURE 1: Generalized analytic workflow using streaming healthcare data.

(Belle 2015)

Topics from the *NMC Horizon Report > 2016 Higher Education Edition*

TRENDS, CHALLENGES, AND TECHNOLOGIES FOR HIGHER ED

TRENDS

SHORT-TERM IMPACT
> Growing Focus on Measuring Learning
> Increasing Use of Blended Learning Designs

MID-TERM IMPACT
> Redesigning Learning Spaces
> Shift to Deeper Learning Approaches

LONG-TERM IMPACT
> Advancing Cultures of Innovation
> Rethinking How Institutions Work

2016   2017   2018   2019   2020

CHALLENGES

SOLVABLE
> Blending Formal and Informal Learning
> Improving Digital Literacy

DIFFICULT
> Competing Models of Education
> Personalizing Learning

WICKED
> Balancing Our Connected and Unconnected Lives
> Keeping Education Relevant

NEAR-TERM 1 year or less
> Bring Your Own Device
> Learning Analytics and Adaptive Learning

MID-TERM 2-3 years
> Augmented and Virtual Reality
> Makerspaces

FAR-TERM 4-5 years
> Affective Computing
> Robotics

DEVELOPMENTS IN TECHNOLOGY

(Johnson 2016)

Big Data Analytics

- Descriptive analytics
  - Summarizes
  - ~80% of business analytics

- Visual analytics
  - Storytelling with graphs and charts to make insights consumable, comprehensible, and actionable.

- Comparative analytics
  - Benchmarking
  - Monitoring
  - Tracking performance or process health indicators

- Prescriptive analytics
  - Prescribes courses of action
  - i.e. IEP & coaching plans

- Predictive analytics
  - Study recent and historical data using:
    - Statistical
    - Modeling
    - Data mining
    - Machine learning
    - Etc.
  - Future performance measures

Learning analytics interprets data "on behalf of students in order to assess academic progress, predict future performance, and spot potential issues."

"Data are collected from <u>explicit student actions</u>, such as completing assignments and taking exams, and from <u>tacit actions</u>, including online social interactions, extracurricular activities, posts on discussion forums, and other activities that are not directly assessed as part of the student's educational progress."

Enhancing Teaching and Learning Through Educational Data Mining and Learning Analytics

An Issue Brief
U.S. Department of Education

(U.S. Department of Education, 2012)

Learning analytics systems apply models to answer such questions as:

1. When are students ready to move on?
2. When are students falling behind/at risk for drop out?
3. What grade is a student likely to get w/o intervention?
4. What is the best next course?
5. Should a student be referred for help?

- ACGME Milestones
- Remediation
- Elective/ Selective
- Workshops
- Faculty Development

(U.S. Department of Education, 2012)

MedEd has a "steep learning curve"

- Learning curve*
  - Visual representation of performance
- Experience curve*
  - Learning Curve
  - + deliberate practice
  - + feedback
- **Competency Learning Curve (CLC)****
  - Experience curve
  - + Big Picture
  - + Big Data

MASTERY ACHIEVED
You know it

NAÏVELY CONFIDENT
You think you know, but still don't know what you don't know

CLUELESS
You don't know what you don't know

DISCOURAGINGLY REALISTIC
You know what you don't know

http://drvidyahattangadi.com/live-your-life-by-accelerating-your-learning-curve/#.WJOmctIrKJA
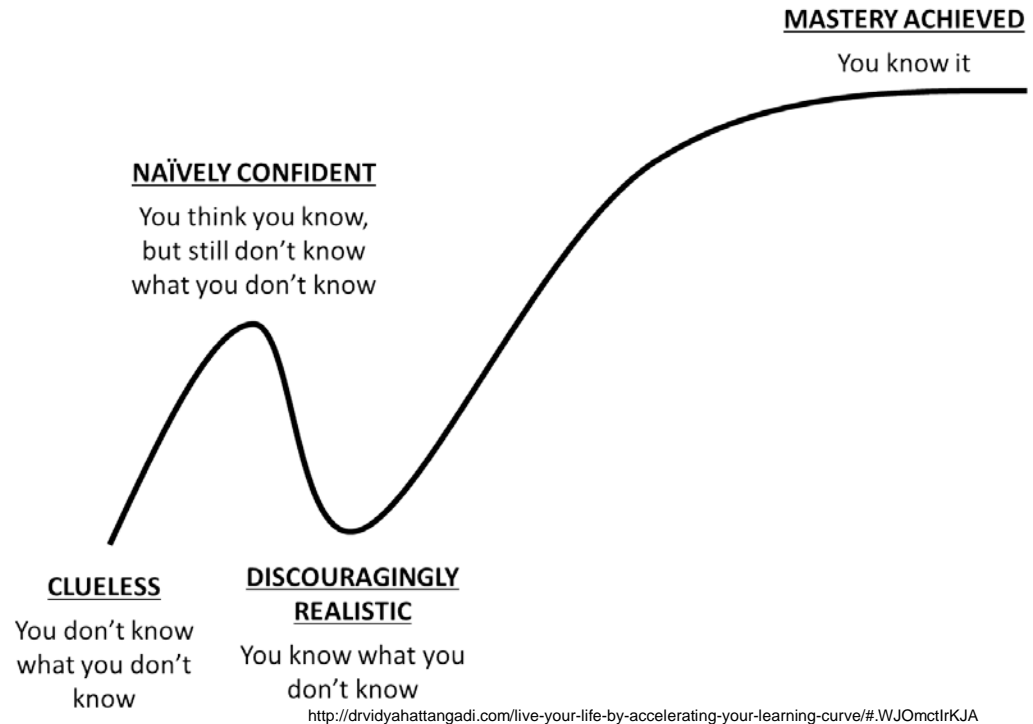
*(Pusic 2012, 2015)
*Novel concept, (?!Pong 2018)

2) Competency Learning Curve (CLC)

Analyze competency learning curves for trends

Analytics   **CLC**   Horizon

ACTIVE LEARNING PROCESSES

SCRIPT

Set goal, select, and sequence | Practice

COMPLEX SKILL

Set goal, select, and sequence | Practice

BASIC SKILL

Set goal, select, and sequence | Practice

PRODUCTION SET

Perform, compile

PRODUCTIONS
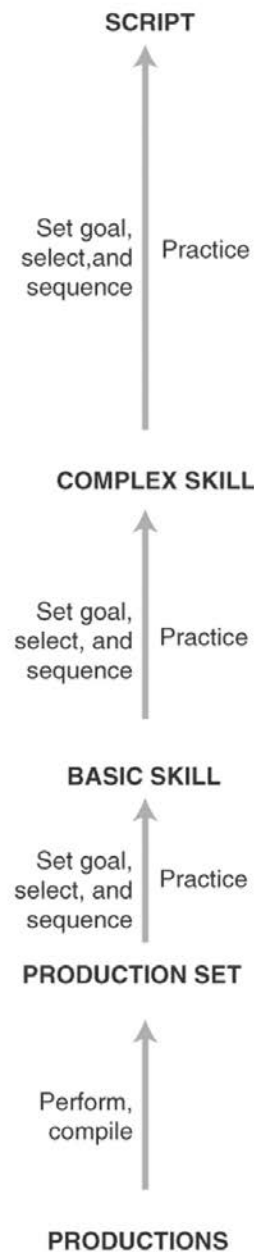
ORGANIZATIONAL STRUCTURE OF COMPETENCIES

COMPETENCY DOMAINS

COMPETENCIES

COMPETENCY SUBCOMPONENTS
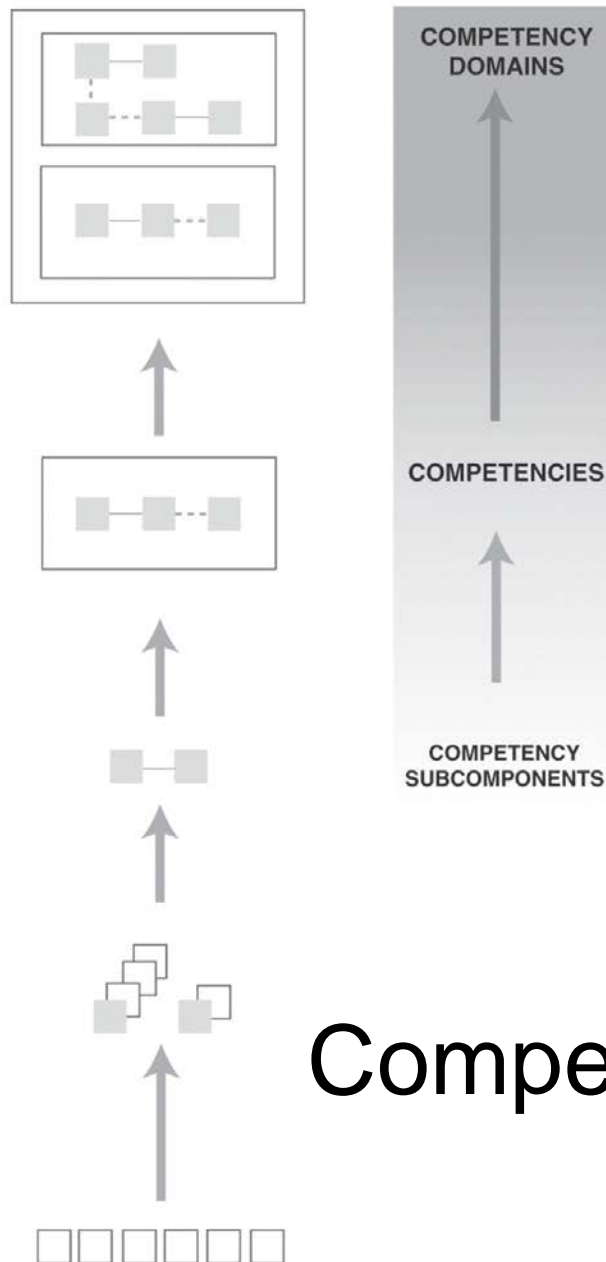
Preclinical Competence

Competency

Checklist components

Competency-Based MedEd

(Swing 2010)

Student Dashboard "Radar"

- Exit Learning Outcomes
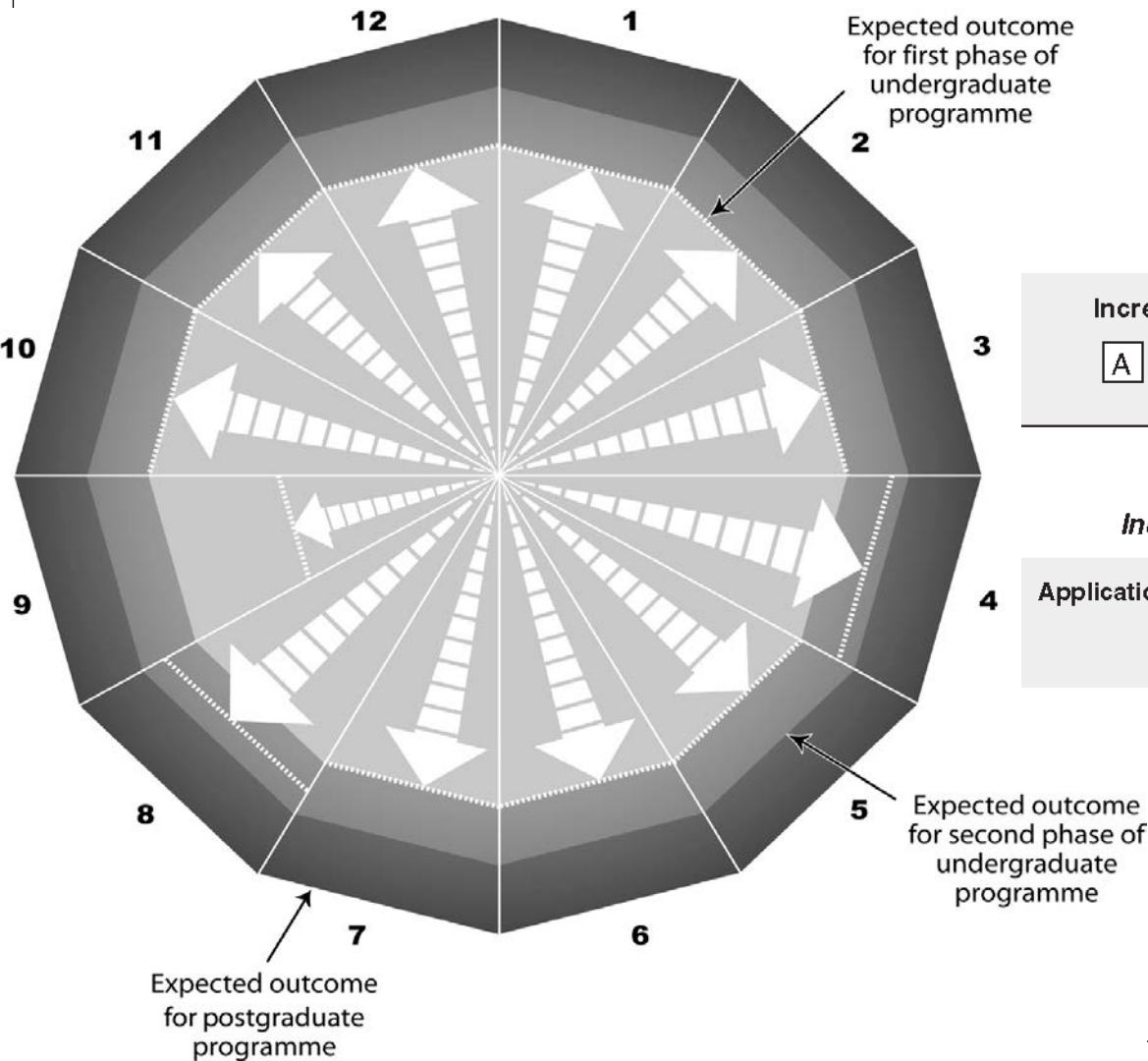
(Harden 2007)

Ex: Competency Assessment

Increased Utility

Application (to medical practice)

A → A

Increased Proficiency

Increased Accomplishment

A → **A**
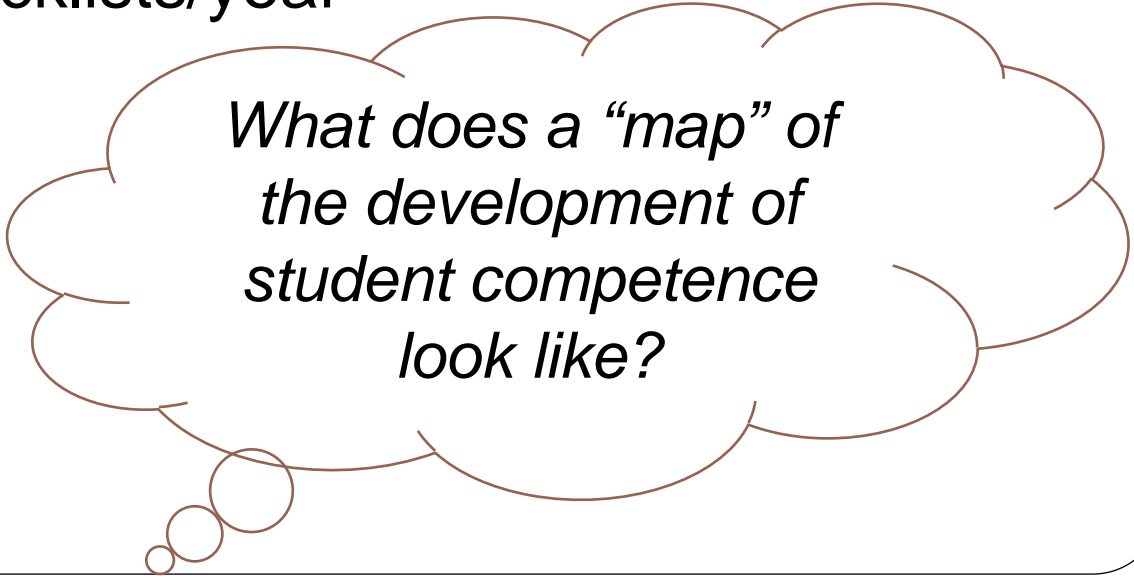
- **Information Mastery**
  - ❑ Can formulate PICO (patient, intervention, control, and outcome) question
  - ❑ Identifies patient-oriented evidence
  - ❑ Lists evidence-based information sources (Dynamed, BMJ, Cochrane)
  - ❑ Accesses evidence to answer a clinical question in real time

Self → **Partner** → **Preceptor**

Beginner → *Competence*

Competency-based Apprenticeship in Primary Care (CAP) @Tufts

- Competency-Based Checklists
  - 50 in total
  - 26 mandatory $\rightarrow$ 28 $\rightarrow$ 30
- n = 180-200 students,
- p = ~90-100 pairs w/ 90-100 preceptors
- C = 10,000 checklists/year
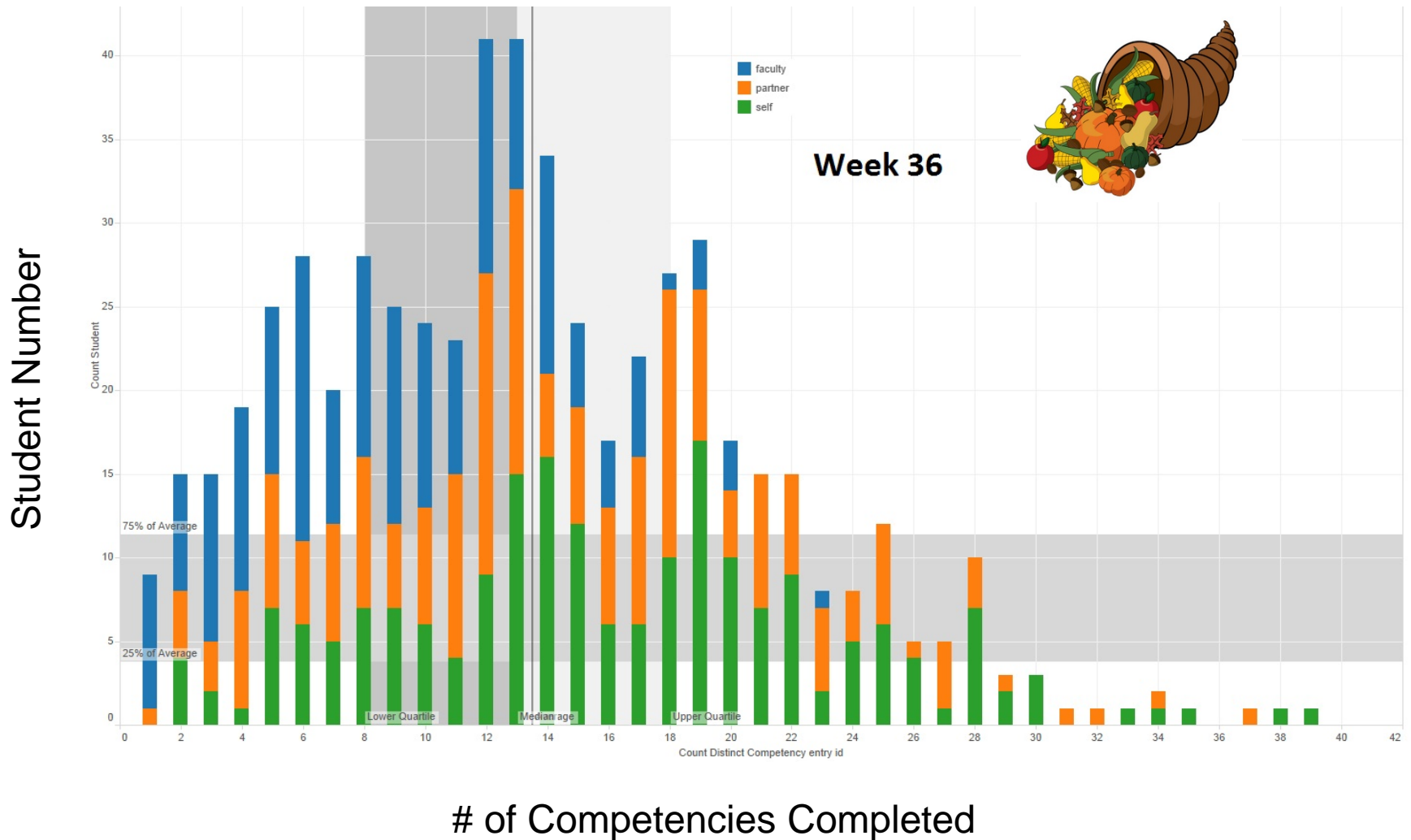
- Sound familiar?
  You know nothing,
  John Snow!

What does a "map" of the development of student competence look like?

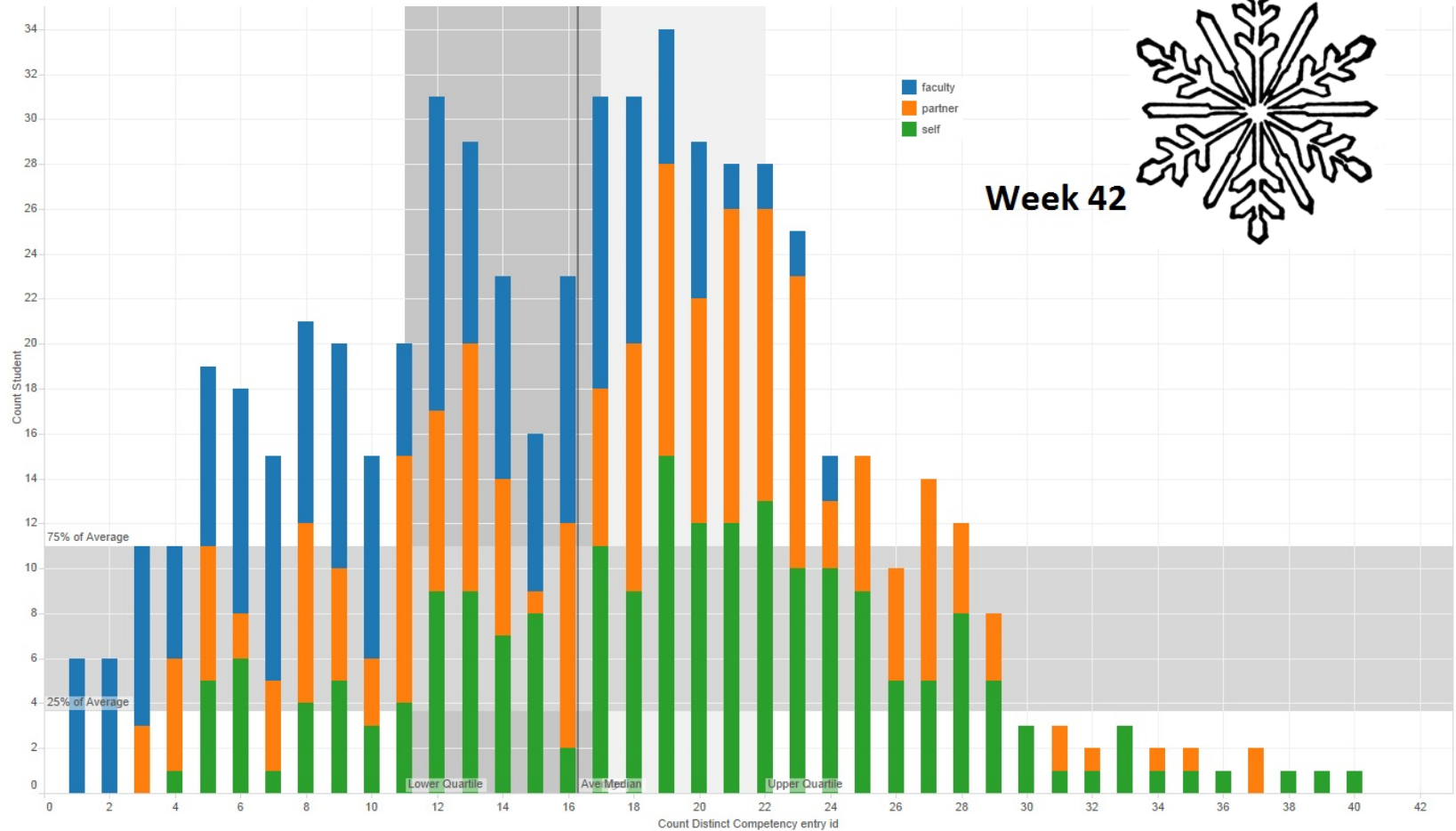# MS1 x4 sessions
(before summer break)

Week 12
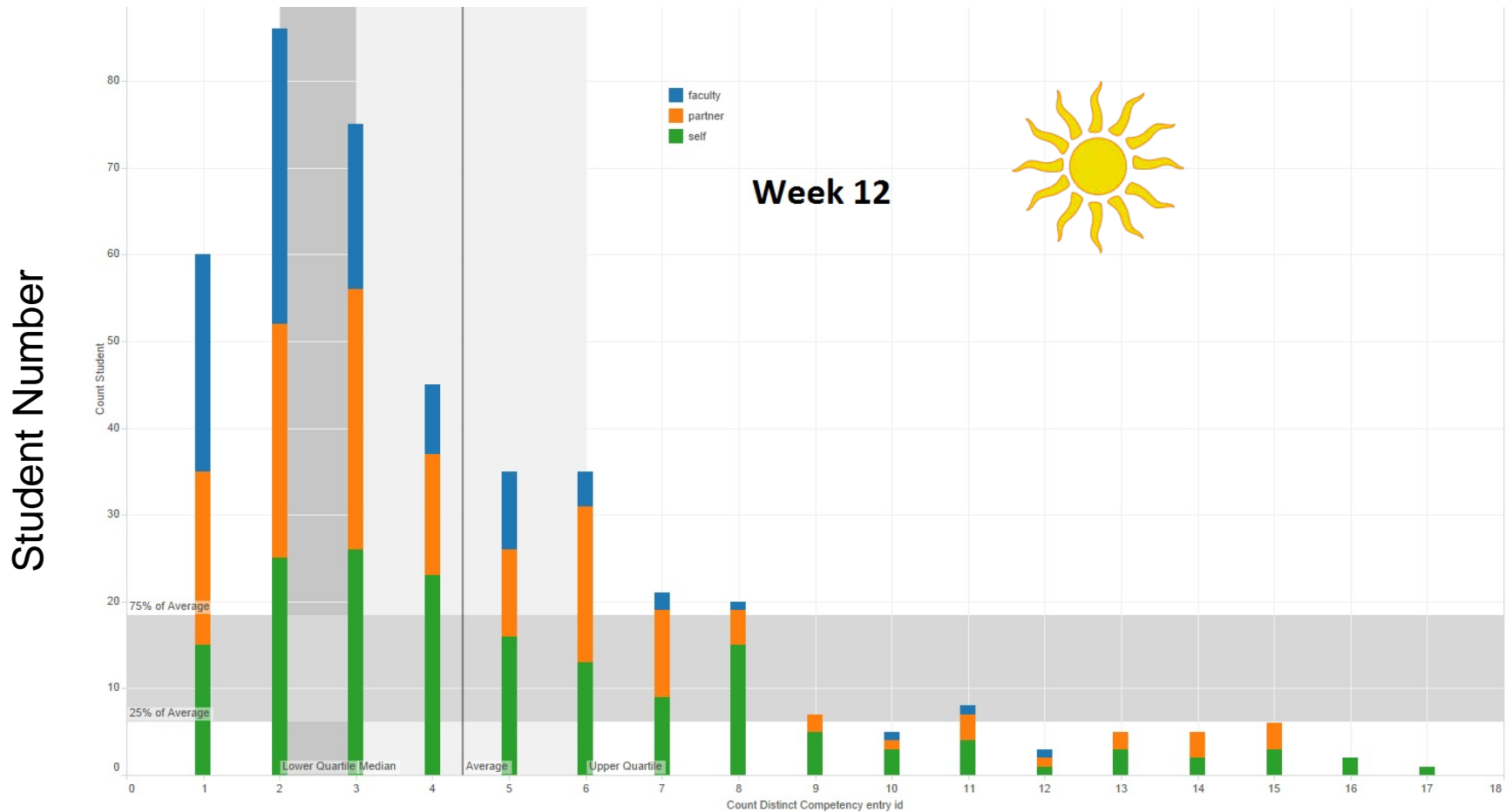
Student Number

# of Competencies Completed

Before Thanksgiving

After winter break

Week 42

Student Number

# of Competencies Completed

Pass = 28 competencies

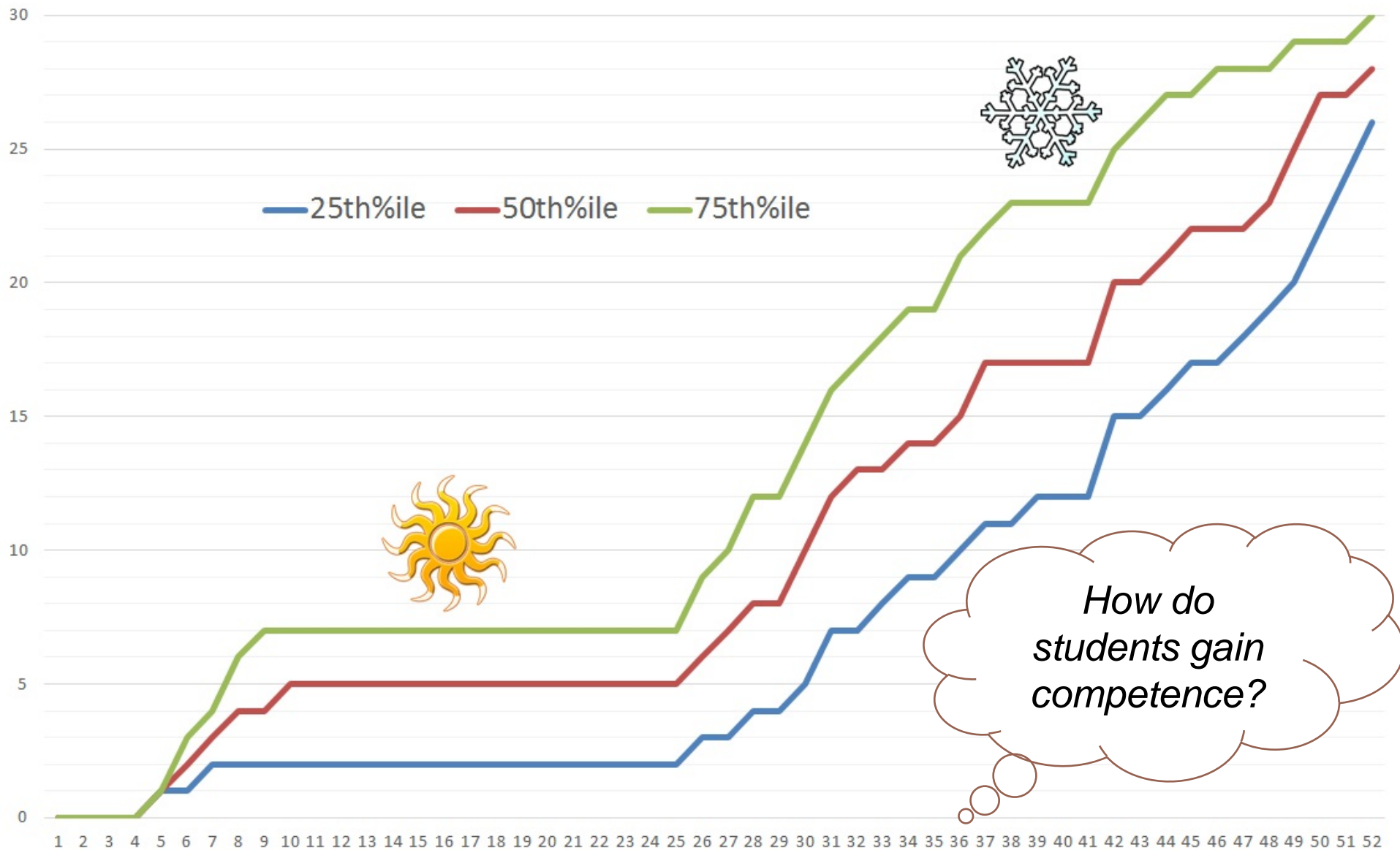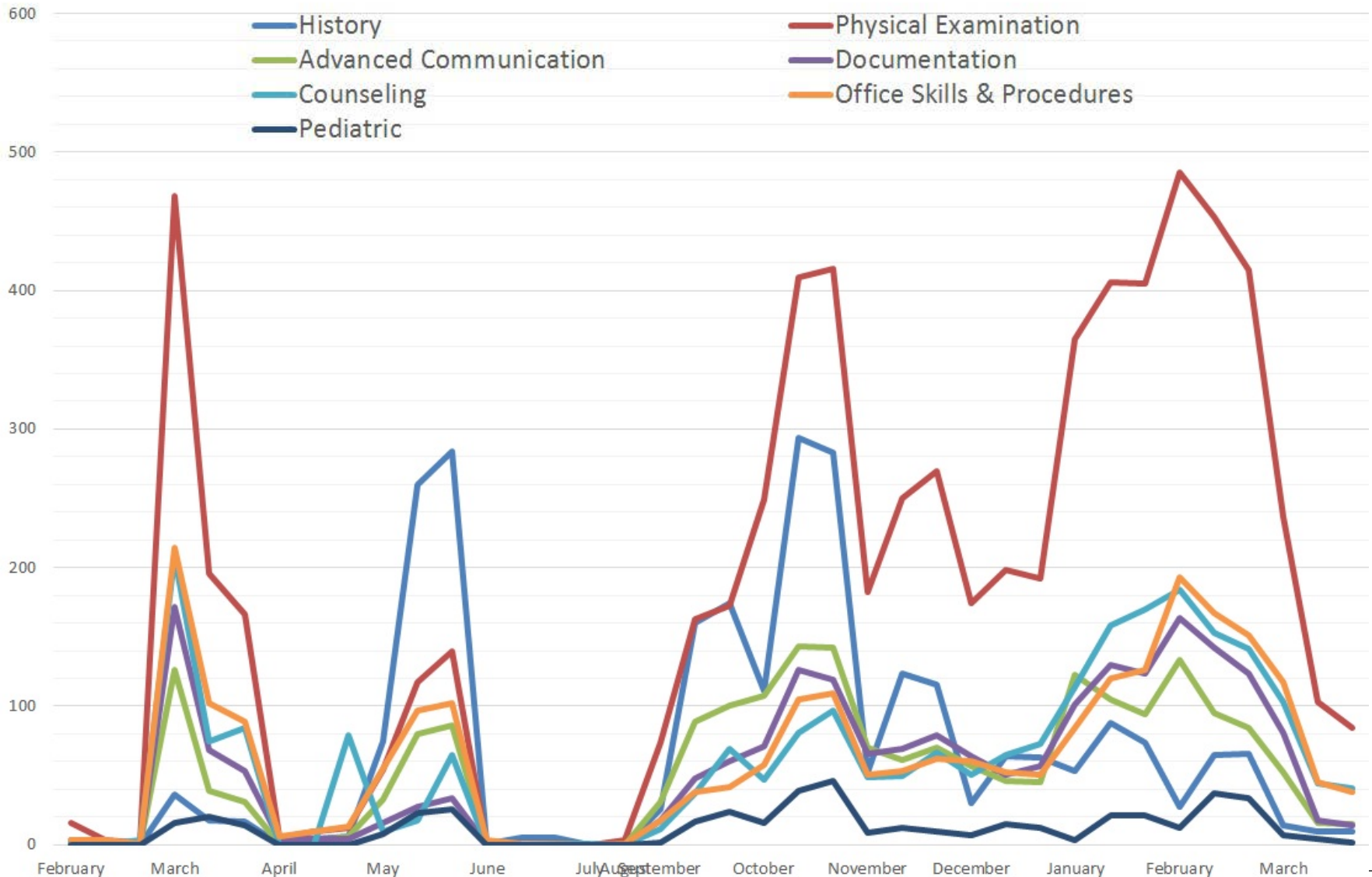# of Competencies Completed
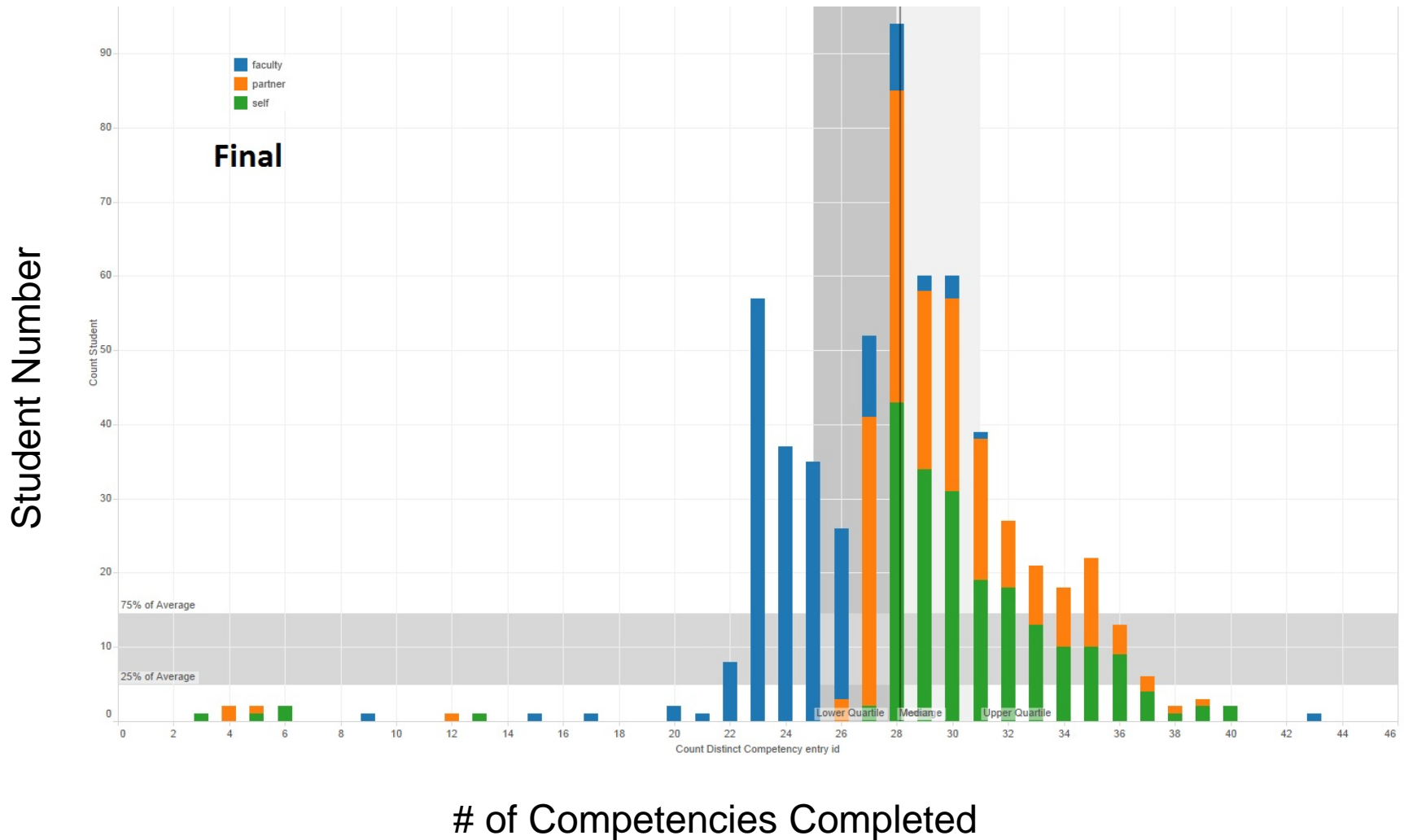
TOCA: Competency Learning Curve
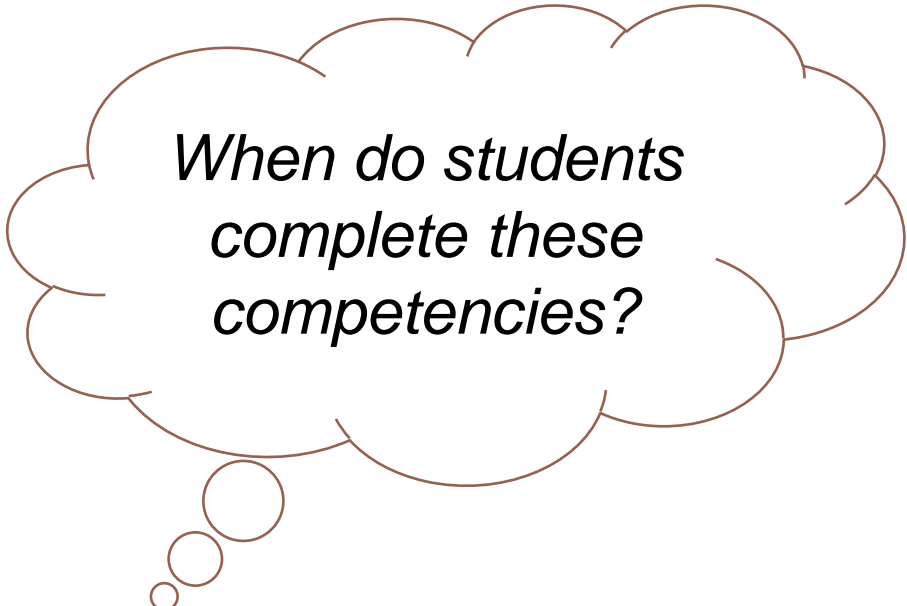
Anticipated order of progression…
History → PE → Communication → Documentation → Counseling → Office Skills/Procedures

CAP Competencies (2016)

Most Utilized Competencies

- History
  - HPI
  - Social History
- Physical Examination
  - Vital Signs
  - Pulmonary exam
  - Abdominal exam
  - HEENT exam
  - CV exam
  - Neck exam
  - Eye & Fundoscopic exams
  - Extremity exam

- Advanced Communication
  - Establishing Rapport
- Documentation
  - Updating the Med list
  - SOAP Note
- Counseling
  - Information Mastery

When do students complete these competencies?

Key CAP Competencies (2016)
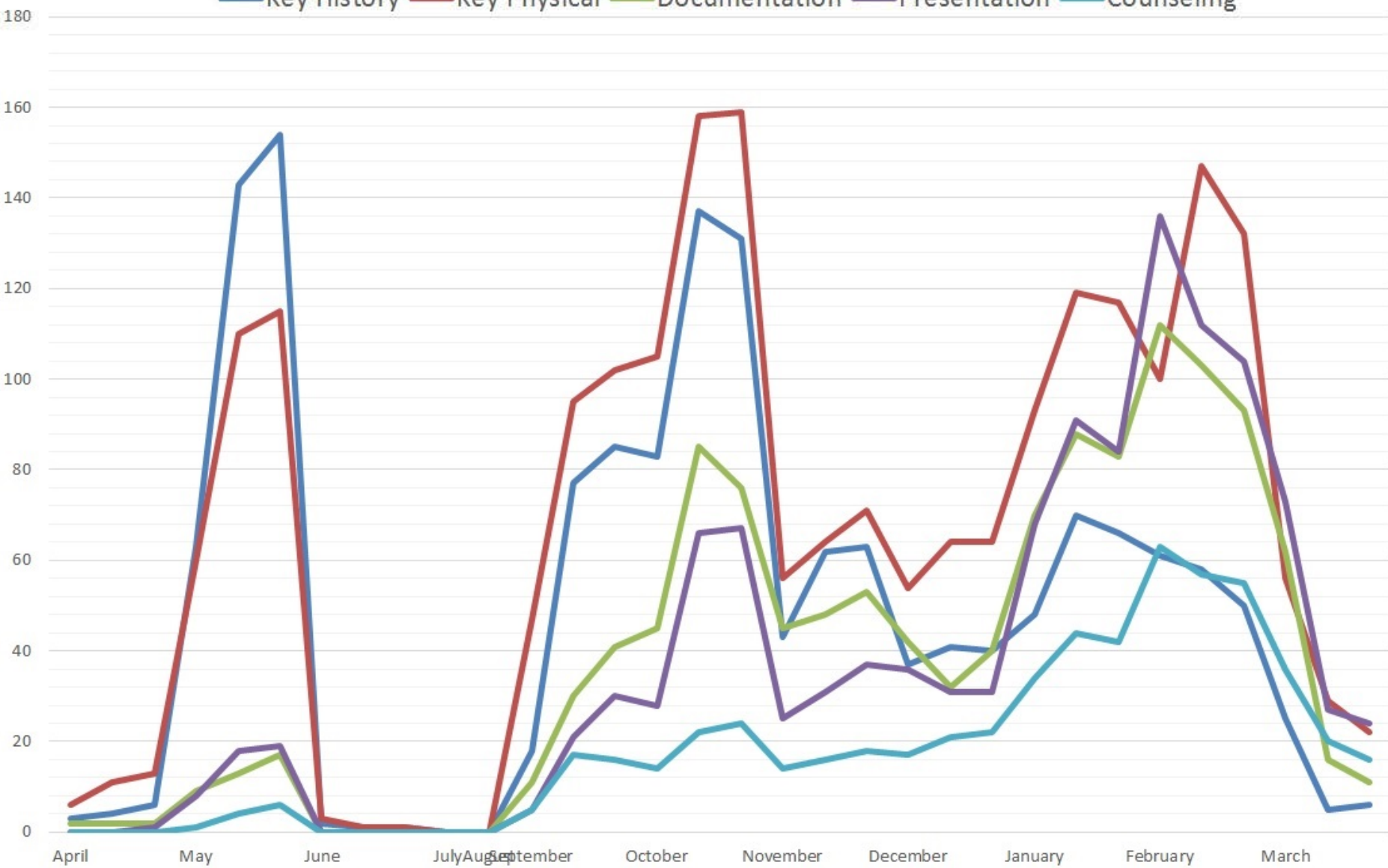
3) Next Steps

Analyze competency measures and identify areas for improvement and faculty development

Analytics   *CLC*   **Horizon**

Areas of Lowest Competence
(by incomplete TOCA count)

- History
  - Cultural History
- Physical Examination
  - Pelvic exam (FEMALE)
- Advanced Communication
  - Explaining lab results
  - Geriatric assessment
  - Communicating with a consultant
  - Explaining a new medication to the patient
  - Cross cultural communication
- Prenatal care
- Pediatric care
- Office Skills & Procedures
  - Office procedures (EKG/venipuncture/imms/POC tests)
  - Skin tag removal
  - Wart destruction
  - Peak flow

Reasons

- Cultural competency
- Patient population
  - Lacking Peds/OB/♀/geriatrics
- Team-based care for office procedures
  - not done by the preceptor
- ? Other ?

Action Plan

- Reflective writing on culture and medicine
- Field trips (swapping pediatric pairs with adult medicine pairs)
- Interprofessional education – streamline student documentation of learning in a Community of Practice
- Student skills workshops
- Faculty development on TOCA & Big Data
- Dashboard/Radar

http://rba-africa.com/rba-spreads-with-south-african-communities-of-practice/

SOAPY note: Y=Your Action Plan

- *What goals do you have?*

- *What is feasible?*
- *What is your next step?*

http://rba-africa.com/rba-spreads-with-south-african-communities-of-practice/

References

- Belle A, Thiagarajan R, Soroushmehr SM, Navidi F, Beard DA, Najarian K. Big Data Analytics in Healthcare. Biomed Res Int. 2015;2015:370194. Review. PubMed PMID: 26229957;

- Ronald M. Harden (2007) Learning outcomes as a tool to assess progression, Medical Teacher, 29:7, 678-682

- Johnson, L., Adams Becker, S., Cummins, M., Estrada, V., Freeman, A., and Hall, C. (2016). NMC Horizon Report: 2016 Higher Education Edition. Austin, Texas: The New Media Consortium

- Laney, D. Meta Group. 2001. February. 3D Data Management: Controlling Data Volume, Velocity, and Variety. [url http://blogs.gartner.com/doug-laney/files/2012/01/ad949-3D-Data-Management-Controlling-Data-Volume-Velocity-and-Variety.pdf] accessed 2/2/17.

- Pusic MV, Kessler D, Szyld D, Kalet A, Pecaric M, Boutis K.Experience curves as an organizing framework for deliberate practice in emergency medicine learning. Acad Emerg Med. 2012 Dec;19(12):1476-80

- Pusic MV, Boutis K, Hatala R, Cook DA. Learning curves in health professions education. Acad Med. 2015 Aug;90(8):1034-42.

- Swing SR; International CBME Collaborators.. Perspectives on competency-based medical education from the learning sciences. Med Teach. 2010;32(8):663-8.

- U.S. Department of Education, Office of Educational Technology, Enhancing Teaching and Learning Through Educational Data Mining and Learning Analytics: An Issue Brief, Washington, D.C., 2012.

STFM
SOCIETY OF TEACHERS OF FAMILY MEDICINE