EATP Conference 28 September 2016, Lisbon

Turbulent Times -

Our Industry Put to the Test

Marten Roorda
CEO, ACT + ACT Next
Something better change!

“Something's happening and it's happening right now. You're too blind to see it. Something's happening and it's happening right now. Ain't got time to wait”
Horace Mann (1796-1859)

The father of American public education: “Education is the great equalizer of the conditions of men”
The Akademeia of Athens: Plato, Aristotel and Socrates
Classroom in 1650, during Netherlands’ Golden Age
Classroom in 1850, well ordered
Classroom, around 1970, familiar face
Computers enter the classroom
A bit of testing history

1845: Standardized testing in education started by Horace Mann, in Boston, Massachusetts

1905: Alfred Binet introduced norm-referenced standardization for aptitude testing

1914: Frederick J. Kelly introduced multiple choice

1936: Automatic test scanner for m.c., IBM 805

2016: .....???
ATP Conference 2015

- “Seems to be working”
- DIF vs. personal interest
- Mass processing (scanner)
- Standard error of measurement (FP, FN)
- We make artifact, then ask psychometrician to fit model
- Standardized testing: punishing and artificial!
Issues and failures

- Long turnaround of test scores
- Issues with CBT
- IP theft, security breaches, cancelations
- We don’t communicate well
- Testing becomes political (CCSS)
- Standardized test, standardized experience
In the meantime…

Waves of **Digital Disruption**

1995+
- Music
- Photography
- Video rental
- ...

2010+
- TV
- News
- Travel
- Recruitment
- ...

2015+
- Retail
- Healthcare
- Finance
- Automotive
- Education
- ...

...
Threats to our industry

• People want personalization, not standardization
• Opt-out movement, test-optional
• Demographics
• Politics in general
• Billionaires, celebs…
• Emerging technology
Young Gari Kasparow recommends a chess computer…
...is beaten by a chess computer, IBM Deep Blue, 1997
IBM Watson wins at Jeopardy, 2011
ALPHA wins simulated air combat from experts, 2016
Google Deepmind ‘Alphago’ beats Lee Sedol at go, 2016
The drivers for change

- Technology push
- Equity, access
- Poor system output (ROI)
- International competition
Trends and infrastructure affecting ed-tech
Investment in ed-tech by venture capital

- $5.4 trillion – size of global education sector in 2015 (World Bank, IBIS Capital estimates)
- $6.54 billion invested by VCs in ed-tech in 2015 – vs $2.42 billion invested by in 2014

2010 – 2015 largest ed-tech investment categories
- School operations, $736 million
- Teachers needs, $480 million
- Curriculum products, $387 million
- Other, $700 million
# 2010 – 2015 Investment Summary

<table>
<thead>
<tr>
<th>INVESTOR</th>
<th># EDTECH DEALS 2010–2015</th>
<th>% OF FUND FOCUSED ON EDTECH</th>
<th>AVERAGE EDTECH DEAL SIZE</th>
<th>SAMPLE U.S. K-12 EDTECH INVESTMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kapor Capital</td>
<td>163</td>
<td>25%</td>
<td>$100K - $250K</td>
<td>Allovue, ClassDojo</td>
</tr>
<tr>
<td>Learn Capital</td>
<td>60</td>
<td>100%</td>
<td>Seed (&lt;$500K) Core ($2M - $10M) Later ($15M)</td>
<td>AltSchool, BloomBoard</td>
</tr>
<tr>
<td>GSV Capital</td>
<td>50+</td>
<td>30%</td>
<td>$5M - $10M</td>
<td>Clever, Newton</td>
</tr>
<tr>
<td>500 Startups</td>
<td>43</td>
<td>N/A</td>
<td>N/A</td>
<td>Remind, Ubooly</td>
</tr>
<tr>
<td>NSVF “Seed” Fund*</td>
<td>40+</td>
<td>100%</td>
<td>$150K</td>
<td>MathChat, eSpark Learning</td>
</tr>
<tr>
<td>Social + Capital Partnership</td>
<td>24</td>
<td>~15%</td>
<td>Seed (&lt;$250K) Series A ($3M - $5M)</td>
<td>Brilliant.org, InstaEDU</td>
</tr>
<tr>
<td>Rethink Education</td>
<td>22</td>
<td>100%</td>
<td>$5M - $10M</td>
<td>Engrade, Elevation</td>
</tr>
<tr>
<td>New Markets Venture Partners</td>
<td>16</td>
<td>67%</td>
<td>$500K - $2M</td>
<td>Kickboard, PresenceLearning</td>
</tr>
<tr>
<td>Reach Capital</td>
<td>11</td>
<td>100%</td>
<td>$250K - $2M</td>
<td>Zeal, Tynker</td>
</tr>
<tr>
<td>Catamount Ventures*</td>
<td>11</td>
<td>50%</td>
<td>$2.5M</td>
<td>MasteryConnect, TenMarks</td>
</tr>
<tr>
<td>Owl Ventures</td>
<td>6</td>
<td>100%</td>
<td>$5M</td>
<td>DreamBox Learning, Newsela</td>
</tr>
</tbody>
</table>
Most valuable ed-tech companies (April 2015)

<table>
<thead>
<tr>
<th>Company (US Only)</th>
<th>Value ($ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pluralsight</td>
<td>1,000</td>
</tr>
<tr>
<td>Udacity</td>
<td>1,000</td>
</tr>
<tr>
<td>Instructure</td>
<td>554</td>
</tr>
<tr>
<td>Lynda.com</td>
<td>46</td>
</tr>
<tr>
<td>Coursera</td>
<td>367</td>
</tr>
<tr>
<td>Open English</td>
<td>350</td>
</tr>
<tr>
<td>Sympoz</td>
<td>339</td>
</tr>
<tr>
<td>D2L</td>
<td>330</td>
</tr>
<tr>
<td>Lumos Labs</td>
<td>265</td>
</tr>
<tr>
<td>Clever</td>
<td>247</td>
</tr>
<tr>
<td>Edmodo</td>
<td>236</td>
</tr>
</tbody>
</table>

Current unicorns (June 2016)
- TutorGroup, China
- Age of Learning, US

Previous unicorns
- Pluralsight
- Lynda.com

http://hackeducation.com/2015/12/23/trends-business
Top 2015 in deals

1. Social Finance ($1 billion)
2. Earnest ($275 million)
3. HotChalk ($230 million)
4. Social Finance ($200 million)
5. TutorGroup ($200 million)
6. Lynda.com ($186 million)
7. Hujang.com ($157 million)
8. Udacity ($105 million)
9. 17zuoye and AltSchool (tied with $100 million each)
10. Xiaozhan Jiaoyu ($84 million)
11. General Assembly ($70 million)
12. Udemy ($65 million)
13. Yuaniku ($60 million)
14. Civitas Learning ($60 million)
15. NetDragon Education ($52.5 million)
16. Genshuixue and Varsity Tutors (tied with $50 million each)
17. Coursera ($49.5 million)
18. Knewton ($47.25 million)
19. Ortbotix and Duolingo (tied with $45 million each)
20. LittleBits ($44.2 million)
And the testing industry?

- Amount invested in ed tech in 2015 equals our combined ATP revenues – small industry
- For-profits (mainly ed publishers) suffer from unpredictable, political assessment markets
- Not-for-profits can do long-term investment, but only a few are large enough to afford pure R&D
- Where will the money come from? Operational margin? Foundations? Governments? VC?
- If we had the money, do we have the vision?
## Industry-level value chain

<table>
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<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Association Boards, credentials</td>
<td>Courses, materials</td>
<td>Suppliers, Admin. systems</td>
<td>Training &amp; Development institutes</td>
<td>Tutoring, test prep</td>
<td>Certification/Licensure</td>
</tr>
</tbody>
</table>
Innovative disruption – forces on the value chain

1. Share
   1. Free, spare capacity, open source (TAO), open educational resources

2. Skip
   2. Automation (ALG, AI scoring), digitalization (warehouse, logistics), online proctoring (test centers)

3. Integrate
   3. Adaptive learning (learn+assess), backward/forward integration

4. Simplify
   4. Usability vs. high quality, ‘good enough’, apps, low-end disruption

5. Enable
   5. Professional tool (canned psychometrician), invention, make your own, high-end disruption
Firm-level value chain: add value where? What’s core?

|----------------------|-----------------|------------------|--------------|---------------|---------|-----------|

From products to services: add value where?

<table>
<thead>
<tr>
<th>Off-the-shelf Products</th>
<th>Customize Augment Localize</th>
<th>Test devt. as a service</th>
<th>Validation Accredit.</th>
<th>Assessment techn.</th>
<th>Services</th>
<th>Consult. Training</th>
</tr>
</thead>
</table>
John Fallon, CEO Pearson:

There will continue to be a market for a long time to come for high-quality courseware.

It will be paid for if it demonstrates real value.

Ed. technology: that investment has to be funded from somewhere.
Uberization of testing?

• Uberization: redistribution of authority to first-hand users
• Teachers and students take over control?
• People own their data, make them portable?
• Create a market place instead?
Megatrends in testing, ATP Keynote 2004

- *Learning and testing become one*
  Personalized learning, adaptive learning
- *Competence measurement*
  Performance assessment, non cognitive skills
- *Monitoring development*
  Learning progression, formative assessment
- *Authentic and realistic*
  Games, simulations, virtual reality
Megatrends in testing, ATP Keynote 2004 (2)

- **Stealth testing**  
  Integration, micro assessments, analytics

- **Computer becomes companion**  
  Tutor agent, artificial intelligence, practice & prep

- **Just-in-time tests**  
  Micro credentials, badging, license-on-demand

- **Globalization**  
  Interoperability standards, open source
Translate those into modern terms for 2028:

<table>
<thead>
<tr>
<th>Fixed</th>
<th>Adaptive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive</td>
<td>Holistic</td>
</tr>
<tr>
<td>Wait</td>
<td>Real-time</td>
</tr>
<tr>
<td>Artificial</td>
<td>Authentic</td>
</tr>
<tr>
<td>Intrusive</td>
<td>Stealth</td>
</tr>
<tr>
<td>Impersonal</td>
<td>Interactive</td>
</tr>
<tr>
<td>One-time</td>
<td>Just-in-time</td>
</tr>
<tr>
<td>Stand-alone</td>
<td>Open</td>
</tr>
</tbody>
</table>
Adaptive

Generations of assessment

Summative → Formative → Adaptive → Stealth
Adaptive learning: tailoring learning experiences to the needs of individual students, enabled by technology and by measurement (vs. personalized learning)

- DIF is good: interest!
- Profiling, patterns
- Diagnostic, misconceptions
- (Semi)-automatic
- Recommendations
- Learning pathways
- Connects learning and testing
- Feedback loop
Adaptive

- Adaptive learning solutions differ along…

  - Degree of learner control
  - Frequency of learner model update
  - Resolution of learner model
  - Range of components
  - Degree of instructor involvement
  - Scale of the feedback loop
Adaptive

- Adaptive learning is dynamic …
Adaptive
Adaptive Criterion or construct

Adaptive Learning

Learning Measurement
### Holistic ACT Holistic Framework

<table>
<thead>
<tr>
<th>Category</th>
<th>Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core Academic Skills</strong></td>
<td>- English Language Arts</td>
</tr>
<tr>
<td></td>
<td>- Mathematics</td>
</tr>
<tr>
<td></td>
<td>- Science</td>
</tr>
<tr>
<td><strong>Cross-Cutting Capabilities</strong></td>
<td>- Technology and Information Literacy</td>
</tr>
<tr>
<td></td>
<td>- Collaborative Problem Solving</td>
</tr>
<tr>
<td></td>
<td>- Studying and Learning</td>
</tr>
<tr>
<td></td>
<td>- Thinking and Metacognition</td>
</tr>
<tr>
<td><strong>Behavioral Skills</strong></td>
<td>- Acting Honestly</td>
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<td></td>
<td>- Maintaining Composure</td>
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<tr>
<td></td>
<td>- Socializing with Others</td>
</tr>
<tr>
<td><strong>Education &amp; Career Navigation</strong></td>
<td>- Getting Along Well with Others</td>
</tr>
<tr>
<td></td>
<td>- Sustaining Effort</td>
</tr>
<tr>
<td></td>
<td>- Keeping an Open Mind</td>
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<td></td>
<td>- Self Knowledge</td>
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<td></td>
<td>- Environmental Factors</td>
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<tr>
<td></td>
<td>- Integration</td>
</tr>
<tr>
<td></td>
<td>- Managing Career and Education Actions</td>
</tr>
</tbody>
</table>
Holistic
ACT Holistic Framework

- Framework
- Mapped to standards
- Make actionable
- Granular on an item level
- Connect to adaptive learning
Real-time

- Model growth, progressions
- Immediate feedback
- Really formative
- Fully adaptive
- Constant data flow
- In the cloud
Authentic

- Simulations
- Games
- Virtual reality
- Real-life experience
- Holodeck (Star Trek)
- Collaborative
- Multiple data types
Stealth

- Non-intrusive
- Continuous
- Hidden in a game
- Or in a learning system
- Multiple data sources
- Flexible stop rule
- With adaptive learning
- Or just observation
- Intelligent agent
Interactive

- Blended learning
- Chatbot
- Tutor agent
- Voice assistant
- Test prep or practice
- AI runs in background

INQ ITS: Rex, their own virtual inquiry coach
Just-in-time

- Skills and achievement gaps
- Non-traditional courses
- Non-degree education
- Certificates
- Digital badges
- Portfolios
- Micro-credentials
- Assess existing competencies
Open

- Open standards (IMS)
- Open source
- Open educational resources
- Open frameworks
Artificial intelligence (AI)
Big data, broad data, small data

- Secondary data, like response time
- Data from log files
- Data from sensors
- Eye tracking, body movement, facial expression
- Unstructured data from chat, social media, etc.
- Data from (serious) gaming and virtual reality
- Data from user interfaces (keyboard, voice, brain)
- Background data from questionnaires
- Large memory resources, like Wikipedia or the Web
Artificial neural networks

- Resembles human nervous system
- The nodes resemble the neurons
- Parameters (multiple input data), tuned by algorithms
- Goal is optimization and pattern recognition
- Different models, like network psychometrics and Bayesian
- Multiple hidden layers: deep learning
Machine learning

- The machine learns - artificial intelligence
- Enables to recognize patterns in complex data
- Enables discovery of “hidden insights”
- Enables reliable, repeatable decisions
- Growing volume and variety of data
- Increased processing power
- Supervised vs. unsupervised
- Reinforcement Learning
- Deep Neural Networks (Deep Learning)
Machine learning

ML Examples

• Recommend items to online shoppers
• Deliver information most likely of interest
• Help experts identify trends or risks in order to improve diagnoses and treatments
• Identify potentially fraudulent behaviors and flag
• Help process language, voice assistant
Artificial intelligence techniques for assessment

- Machine learning and deep learning
- Recognition of speech, (eye) movement, expressions
- Recognize (error) patterns or user’s preferences
- Natural language processing
- Profiling
- Optimization of psychometrics
Use of AI in assessment

- Automated item generation
- Diagnostics, error pattern recognition
- AI scoring
- Combining diverse data, unstructured data
- Create optimal learning pathways
- Operate chatbots
- Test security, online proctoring to proctorless
- In fact, each and every aspect of our process
Will Machine Learning Consume Psychometrics?

Benefits of ML to Psychometrics
• Maximize the probability of learning for individuals
• Discover hidden insights in complex data sets

Challenges ML vs. Psychometrics
• Validity evidence may have a bit different emphasis
• Scoring models may change, not constant

Andrew Kyngdon, July 2016

Is it really necessary to summarize the rich source of data into a psychometric model designed many years ago for PBT, fixed forms? Wouldn't it be more productive to use Machine Learning models?
Cognitive science

• Causality vs. correlation
• Understand how the brain works
• Understand how people really learn & develop
• Learn how to train the machine
• How traits, abilities relate and depend (network)
Automate the testing process, beginning to end

- Automated item generation: math, ELA, reading
- Automated task modeling
- Computer adaptive testing, Computer adaptive tasking
- Automated test assembly
- Just-in-time CAT AIG
- Automated scoring
- Final picture: full assessment automation
Next generation assessment

There is much more to score!

- Group sessions
- Presentations
- Job interviews
- Chat sessions
- Task performances

...and on different scales, like creativity, collaboration, etc.
Next generation assessment

The Changing Nature of Educational Assessment
Randy Bennett, 2015

• 1st Generation – Accountability, Onetime, Standardized, Low-tech
• 2nd Generation – Innovative items, new constructs, AIG, AI scoring
• 3rd Generation – Cognitive principals, real environment, interactive, more integrated

One possible scenario:
continuous assessment but with clear distinction between summative and formative purpose
Next generation assessment

3 stages of development, 2012

1. Unorganized, decentralized
2. Standardized, norm-referenced
3. Individualized, criterion-referenced
Next generation assessment

Three stages of testing innovation

1. Digitalization – PBT to CBT, authoring system, portals, etc.
2. Traditional innovation – CAT, itembanking/IRT, new item types
3. Disruptive innovation – Machine learning, AI scoring, new data types
Next Generation Digital Learning Environment
(Educause, 2015)

5 domains of core functionality:
• Interoperability and Integration
• Personalization
• Analytics, Advising, and Learning Assessment
• Collaboration
• Accessibility and Universal Design

“Weaving together of standard formative assessments, adaptive learning technology, and learning analytics”
Next generation of assessment

Business Development/Strategy

Generations Management

Product Management

Research & Development
Next generation assessment

Geoffrey Canada:

“The high stakes is today”
Value proposition

- Use brand, authority
- Personalization
- Integration
- Help create insights
- Recommendations
- Learning pathways
- Make predictions
- Help practice and prep
- Certify, accreditation
## New business models

- Open source, open resource
- Platform play, marketplace
- Disrupt others
- Market share first
- Micro-services using data
- High margin service-adds
- Etcetera, use BMC
What can you do tomorrow?

- Diversify product portfolio
- Innovate, embrace edtech
- Connect to world of learning
- Empower the user, personalize
- Review value proposition, business models
- Core vs. non-core, buy/build
- Go for operational excellence
- Invest in excellent, impatient leaders

Disrupt the disruption! If you can’t beat them, join them. Integrate (or share, skip, simplify and enable) into adaptive learning

(examples: UPS & 3D printing, Uber & driverless)
Possible setbacks

- Political risk managed but not disappeared
- Slow technology adoption
- Real-world, high tech vs. large scale, high stakes
- Trust in AI, without human intervention?
- AI to become intangible, incomprehensible
- Innovator’s dilemma
How urgent is this?

- Disruption…
- Increased competition…
- Consolidation…
- Less funding…
- Product lifecycle…
- Capabilities…
- R&D time to market…

Start today creating the next generation of assessments (formative, adaptive, stealth). Your customers need it. If you don’t, you are at danger!
Intelligent voice of testing?

- Association of Test Publishers
- Education Technology Industry Network (ETIN, of SIIA, 200 members, 4 from ATP)
- ASU GSV (annual conference, 3500 attendees)
- International Association for Technology in Education (ISTE, 17,470 members, 15% edtech)
- Professional associations (AECT, AACE, eLearning Guild, IEEE TCLT, ITEEA, SALT, Educause)
Intelligent voice of testing?

- How will testing relate to (adaptive) learning?
- Who will be the intelligence voice of testing?
- Rebrand, reposition, rename?
- Connect, partner, merge?
- Conference: *Innovations* in testing?
Something better change!

Ready for change now? Start the conversation at this conference!

Gaining Advantage Through Assessment

Register