Data Science and the Learning Journey in Higher Education

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Global Trends in Higher Education

**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

**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

**Developments in Technology**
- **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

Horizon Report 2018
Agenda

• Definitions of big data, machine learning and artificial intelligence
• New Basics of Complex Systems Research
• AI and the Learning Journey
• Dynamic Learning Analytics for Assessment
• Personal Learning – Collaboration – Problem Solving Framework
Definition: Big Data

Volume
- Data at Rest: Terabytes to exabytes of existing data to process

Velocity
- Data in Motion: Streaming data, milliseconds to seconds to respond

Variety
- Data in Many Forms: Structured, unstructured, text, multimedia

Veracity*
- Data in Doubt: Uncertainty due to data inconsistency & incompleteness, ambiguities, latency, deception, model approximations

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Google Images
Definition: AI and ML

**Artificial Intelligence**
- Any technique which enables computers to mimic human behavior

**Machine Learning**
- AI techniques that give computers the ability to learn without being explicitly programmed to do so

**Deep Learning**
- A subset of ML which makes the computation of multi-layer neural networks feasible

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Data Science Process

- Raw Data Collected
- Data is Processed
- Clean Dataset
- Exploratory Data Analysis
- Models & Algorithms
- Make Decisions
- Communicate, Visualize, Report
- Data Product

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Google Images
Human-to-Machine Shaping AI in Challenge Reports

User Performance

Rule-based Adaptation

Performance Space Variables

Interaction Events

Interaction Summaries

Reports

Expert Input

Machine Learning

Domain Models

Original Image
Analytics Target Range

- **Raw data**
  - Descriptive Analytics
  - Diagnostic Analytics
  - Predictive Analytics
  - Prescriptive Analytics

- **Analytics effort**
  - What happened?
  - Why did it happen?
  - What will happen next?
  - What should I do?

- **Post analytics human effort**
  - Decision Support
  - Operational Decision Automation

- **Impact**
  - Strategic Decision Support
  - Operational Decision Automation

**Data** → **Decision** → **Action**
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Thinking About Complexity & Six New Basics

- New aspects of reality emerge locally from a surrounding and interpenetrating global complexity
- Multifaceted open ecology: multiple causes, indirect feedback, nonlinearity and chaos
Complex Systems as Transdisciplinary Multidimensional Landscapes

- **Time** (e.g. historical preconditions, longitudinal data, recurring patterns and autocorrelations)
- **Space** (e.g. network topologies, neighbor effects, socioeconomic geographies)
- **Scale** (e.g. neurons to sociopolitical communities)
- **Dynamics** (e.g. unique behavioral profiles even under highly similar conditions)
New Basics 1 & 2

• Nonlinearity
  – *Output is not proportional to input*; the cause of some response by the system is not the simple sum of the stimuli

• Feedback loops
  – *Information is recycled*, connecting the current state to past states of the system
New Basics 3 & 4

• Openness
  – The system accepts “inputs from” and “outputs to” a larger external environment

• Memory
  – Impacts on the current state of the system are carried forward into future states of the system
New Basics 5 & 6

• Nested relationships
  – Components may themselves be complex

• Emergent properties
  – Properties of the whole system need a new level of analysis and representation from that of the components.
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1. Identifying, recruiting and admitting students
2. Attending to the intentions and goals of each student
3. Offering knowledge on demand in authentic settings
4. Supporting learning via dynamic feedback
5. Developing global networks for life-long economic advancement
Adaptive, personalised learning supporting a student’s journey, executed at a global scale

Strategic Alignment

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Developing Talent

- **Market Understanding**
  Curtin generates profiles of in demand skills in the market, tracks education trends, and reacts accordingly

- **Personalised Recommendations**
  Student and market information are used to aid course selection and align student expectations

- **Community Engagement**
  Curtin’s market knowledge is reflected in its outward facing marketing and community engagement
Personalization at Scale

- **Personalised Support**
  Support services use interaction history to learn from interaction and become tailored to individuals.

- **Proactive Retention Management**
  Students with high attrition risk are identified early and receive targeted preventative interventions.

- **Personalised Communication**
  Learning materials are targeted at students based on learning progress and their intentions.
Emergent Curriculum

- **Adaptive Curriculum**
  Curricula are dynamic, adapting in real time to student needs and the external environment

- **Scalable Delivery**
  The latest technologies deliver content to all students & staff and allow near-real time feedback and decisions

- **Integration with Industry**
  Curricula are designed to deliver the competencies in demand and allow relevant work place learning
Dynamic Delivery

- **World Leading Pedagogy**
  Analytical research into student cognition and teaching method are used to define Curtin’s practices, and drive student self-awareness

- **Adaptive Assessment**
  Student evidence of learning is measured continuously, allowing targeted, dynamic assessment

- **Managed Outcomes Framework**
  Students are assessed against a granular framework, allowing for an iterative approach to learning
Global Networks

- **Strategic Employment**
  Market analysis and an unique assessment framework allow students to secure positions with high prestige employers

- **Alumni Communication**
  Alumni are engaged with information on market and industry trends and opportunities for further study

- **Targeted Recruitment into Research**
  Engagement in research is developed from specific analysis of history and student competency
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Challenge Based Learning

- Self-directed learning and social collaboration
- Promoted through problem-based learning
- In a technology-enabled and game-based learning environment
Measurement Targets

- Understanding big ideas - systems knowledge
- Dealing with time and scale
- Practice in decision-making
- Active problem-solving
- Concepts, strategies, & tactics
- Understanding processes beyond experience
- Practice & improvement over time
Assessment Plan

• CONTEXT
  – Observations of group members
  – *Designed domain-task-performance space*
  – Coordinated activity to construct and maintain a shared conception of an open-ended problem
  – Achieve some goal

• 3 KINDS OF MEASURES (learner inputs)
  – *Actions, Communications, Products*

• RESULTS
  – Evidence of higher order creative, critical thinking and communication skills
Interaction Traces = Evidence

• New *frameworks, concepts* and *methods* are needed for measuring what someone knows and can do based on game interactions and artifacts created during serious play.
Interaction Traces = Evidence

• Interactions and artifact creation processes create streaming data traces that provide evidence of performance and learning.
Evidence Centered Design

- Student Model
- Evidence Model
- Task Model
- Presentation Model
- Assembly & Delivery Methods
- Delivery Model
- Interpretation Method
- Observation Situations

Adapted from (Mislevy, Steinberg, Almond)
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PL-C-PS Domain Model

- **Personal learning:** acquisition of knowledge (e.g. new insights, capacities for thinking, acting and employing skills) that is evidenced for outside observers as well as an individual’s own reflection and metacognition.

- **Collaboration:** coordinated group activity resulting from continuous attempts to construct and maintain a shared conception of a problem (Roschelle & Teasley, 1995)

- **Problem solving:** cognitive processing directed at achieving a goal when no solution method is obvious (Mayer & Wittrock, 1996).
# Design Process Questions

## Personal Learning

1. How can the learner share their background, experience and initial thoughts?
2. How can the learner be exposed to and reconcile differing ideas and viewpoints?
3. How can the learner create a critically reflective response-artifact that articulates a new understanding at this point in time?
4. How can the learner communicate and celebrate the results thus far?

## Collaboration

1. How can the learner establish and maintain the group’s shared understanding of the problem?
2. How can the learner take appropriate action to solve the problem?
3. How can the learner help establish and maintain the team organization?

## Problem Solving

1. How can the learner explore and understand the problem?
2. How can the learner represent and formulate solution options?
3. How can the learner plan and execute appropriate actions?
4. How can the learner monitor and reflect on progress?
Social Learning Group Capacity

PL1
PL2
PL3
PL4

PL1
PL2
PL3
PL4

PL1
PL2
PL3
PL4

Social Learning Capacity
OECD Assessment Framework for Collaborative Problem Solving

...as a theater for individual action during online collaborative problem solving
Closing Remarks
Big Data & The Learning Journey

• Requires educational researchers, practitioners and policymakers to understand how insights can be gained from the use of new tools and approaches to learning, teaching, evaluation and research.
Eliciting High-Level Skills

- The rise of smart technologies is the foundation for several emergent challenges and opportunities for eliciting and validating the acquisition of high-level skills such as collaboration, creativity, critical thinking and communication.
Capacities for Learning Futures

• Create innovative content and delivery modes
• Provide personalized education at scale for the global education marketplace
• Continuously harvest analytics insights to improve learning and teaching, the student experience, and the enterprise.
Contact Information

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