

# Using Big Data and Analytics to Improve Learning and Education

George Siemens

CIDER

February 10, 2016

# The history of learning analytics

“The world is one big data problem”

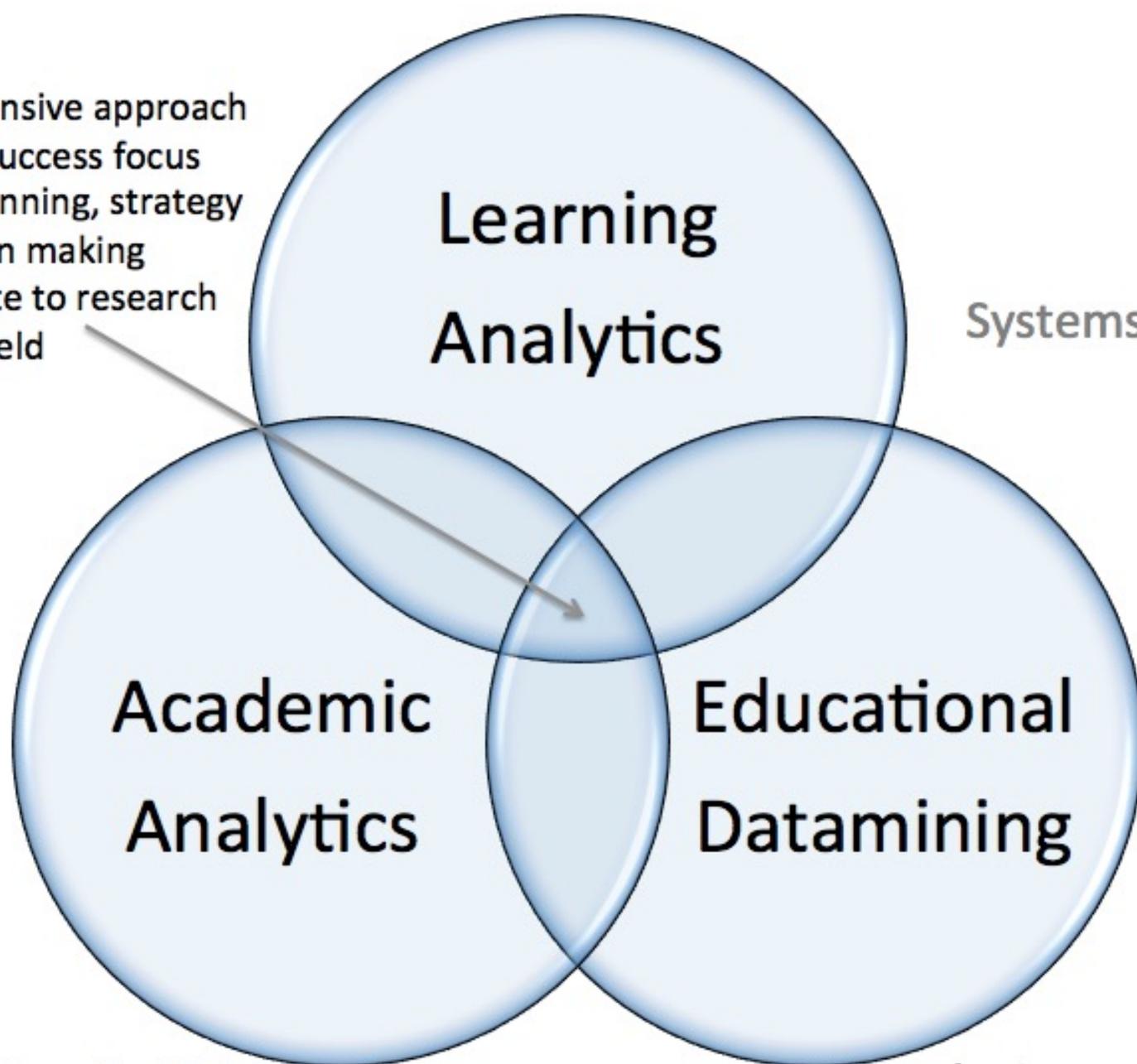
*Gilad Elbaz*

Learning analytics is the measurement, collection, analysis, and reporting of data about learners and their contexts, for the purposes of understanding and optimizing learning and the environments in which it occurs.

*LAK11 Conference*

**All share:**

- Data-intensive approach
- Learner success focus
- Assist planning, strategy & decision making
- Contribute to research base of field



Systems & wholes

Organizational efficiency,  
strategy, and decision making

Reducing components,  
analyzing relationships

**Technique:** Baker and Yacef (2009) five primary areas of analysis:

- Prediction
- Clustering
- Relationship mining
- Distillation of data for human judgment
- Discovery with models

# Current state and future trends: A citation network analysis of the learning analytics field.

Dawson, S., Gašević, D., Siemens, G., & Joksimovic, S. (2014, March). In *Proceedings of the Fourth International Conference on Learning Analytics And Knowledge* (pp. 231-240). ACM.

# Paper classification

Schema from Info Systems (6 categories)

## 1. Evaluation research

– (e.g. case study empirical)

## 2. Validation research

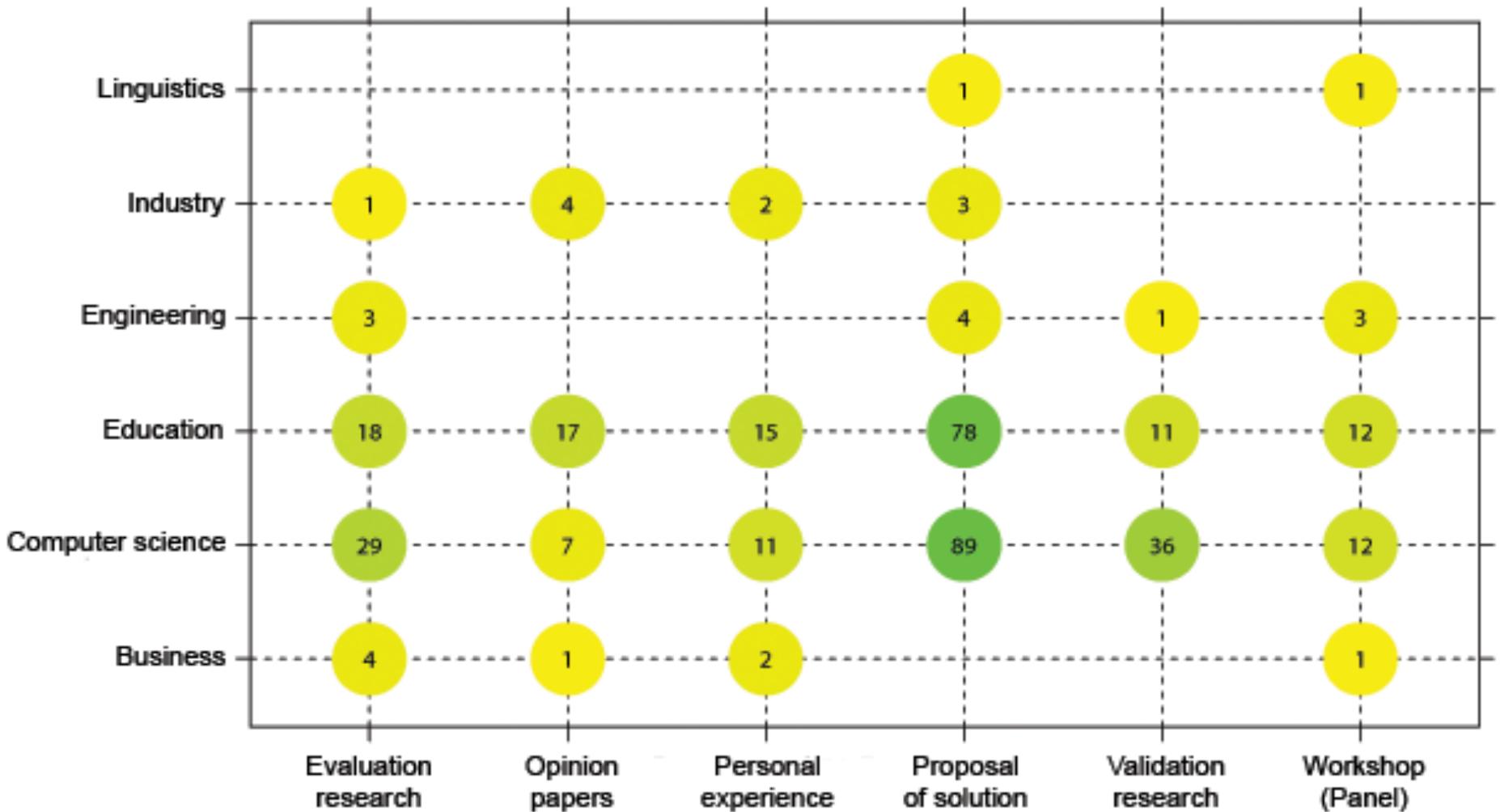
– (e.g. testing theory/ method/ solution empirical)

Glass, R.L., et.al, 2002. Research in software engineering: an analysis of the literature. Information and Software Technology 44, 8, 491-506

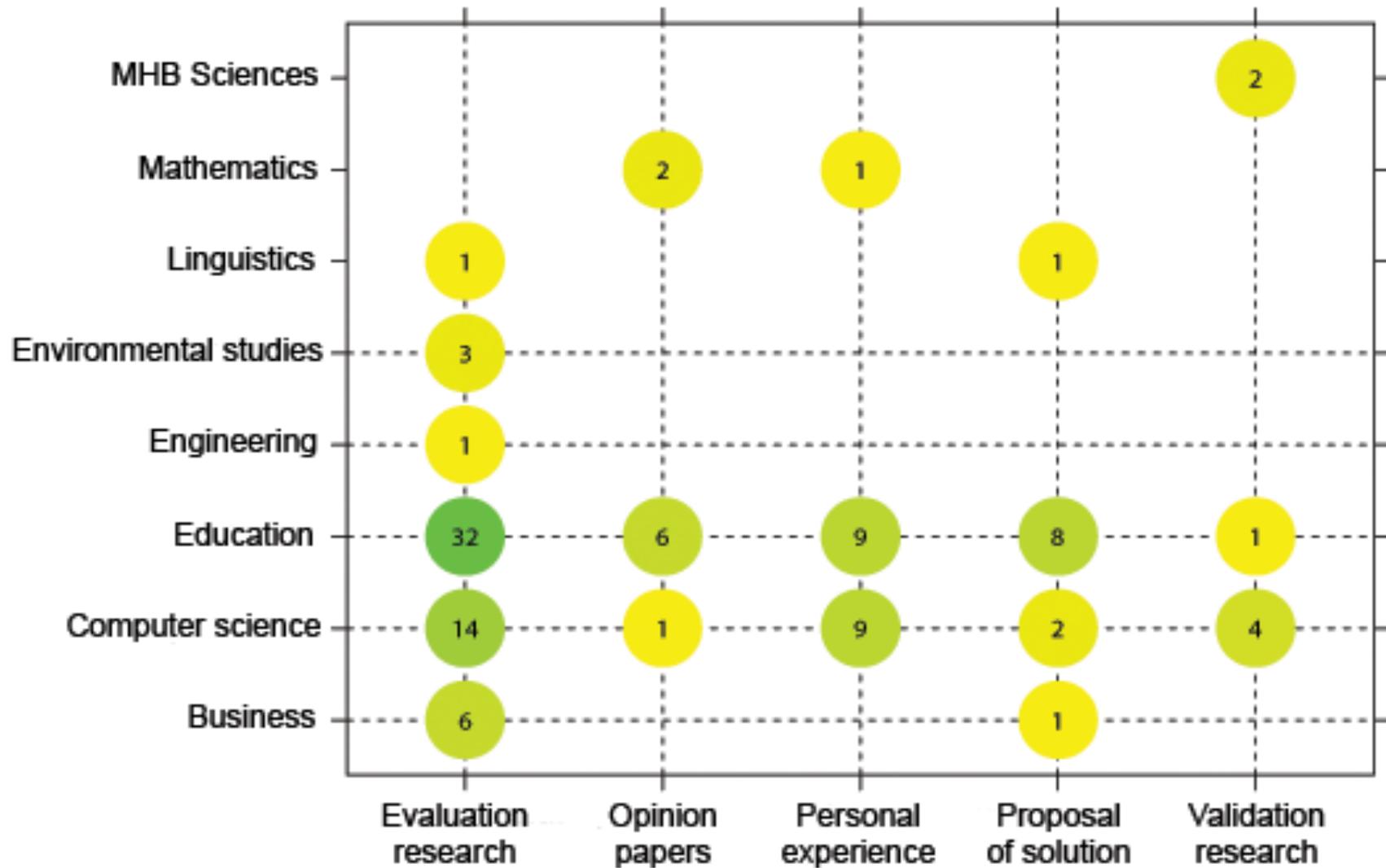
# Paper classification

3. Solution proposal  
(solution/ technique to address an issue)
4. Conceptual proposal  
(e.g. frameworks)
5. Opinion  
(well its my opinion/argument)
6. Experience  
(Let me tell you a story)
7. Panel/workshop

# Paper classification (LAK)



# Paper classification (Journal)



# Paper classification

Dominated by computer science (LAK)

Greater number of education researchers in journals

- Reflection of special issues
- Reflection of priority sites for publications

Largely conceptual and opinion publications

# Methods classification

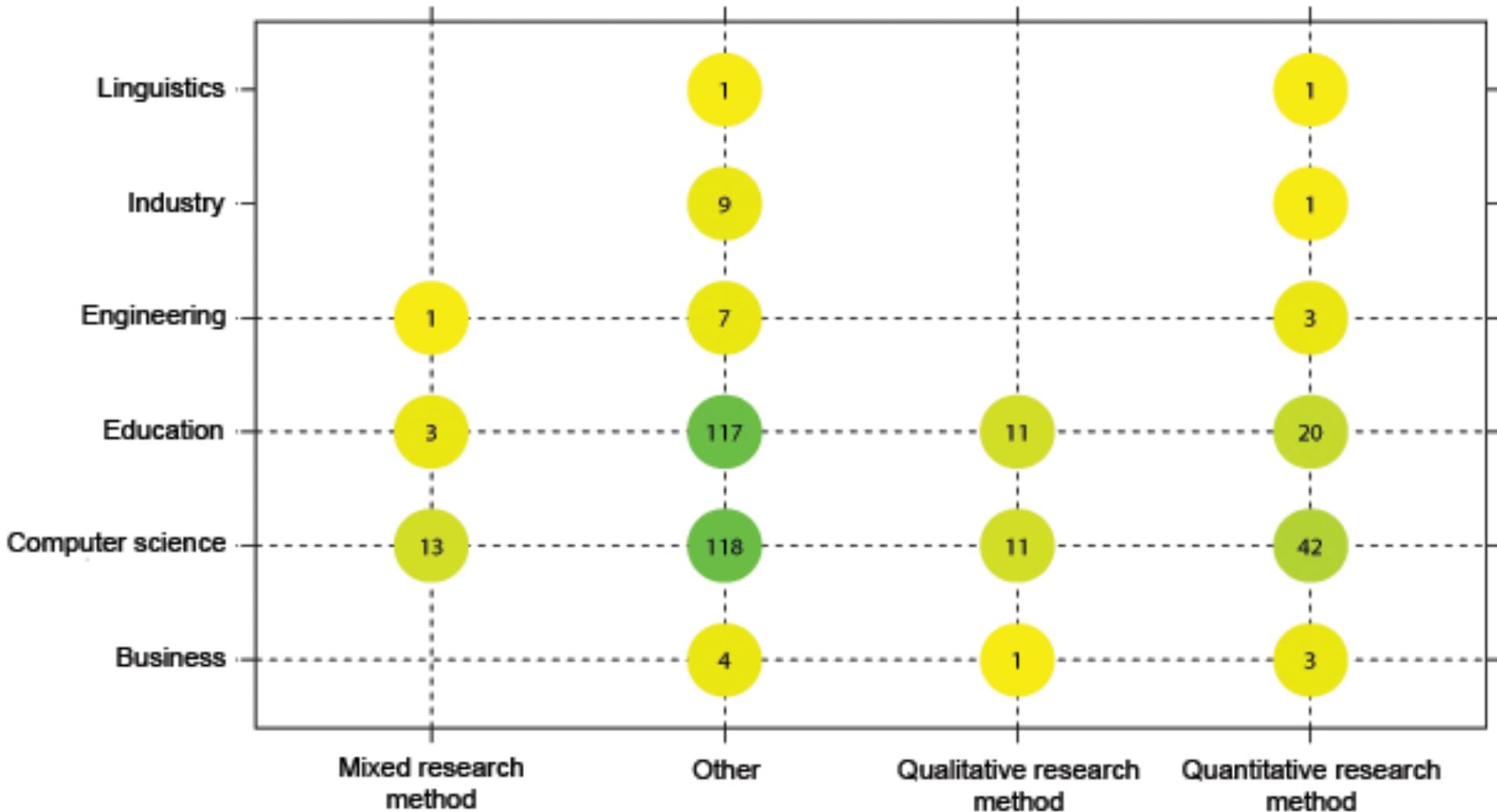
Qualitative

Quantitative

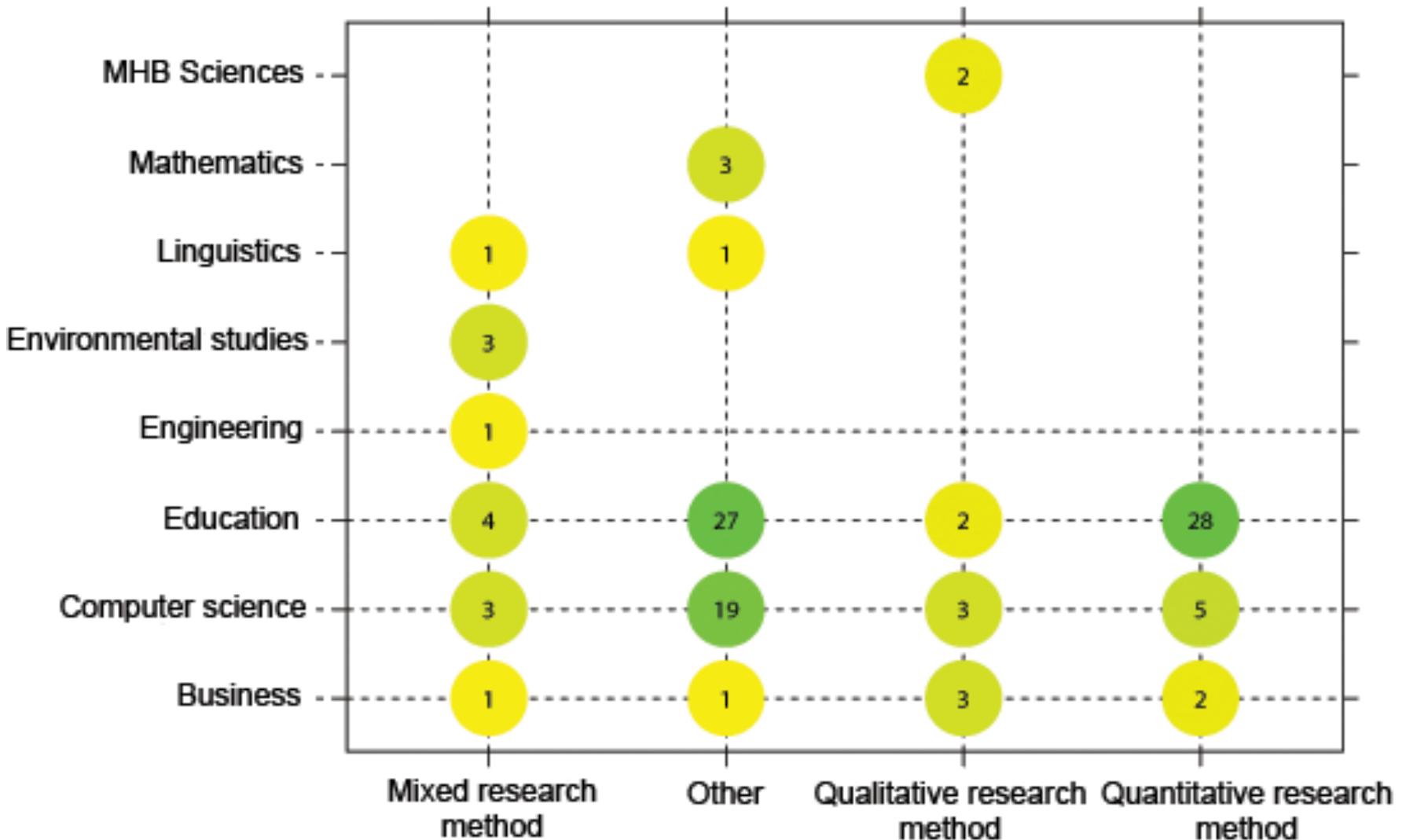
Mixed methods

Other

# Methods classification (LAK)



# Methods classification (Journals)



# What will LA do for learning science & education

Add a new research layer

Personalization

Optimization (move from negative orientation)

Organizational insight

Improved decision making

New models of learning

Increase competitiveness

Improve marketing/promotion/recruitment

# Learning analytics is about learning

# Once size fits all does not work in learning analytics

**FACULTY**

—  
**CORE  
CONTENT**

↓  
**LEARNER**

**PERIPHERAL  
LEARNERS**

**EXTERNAL  
EXPERTS**

**FACULTY**

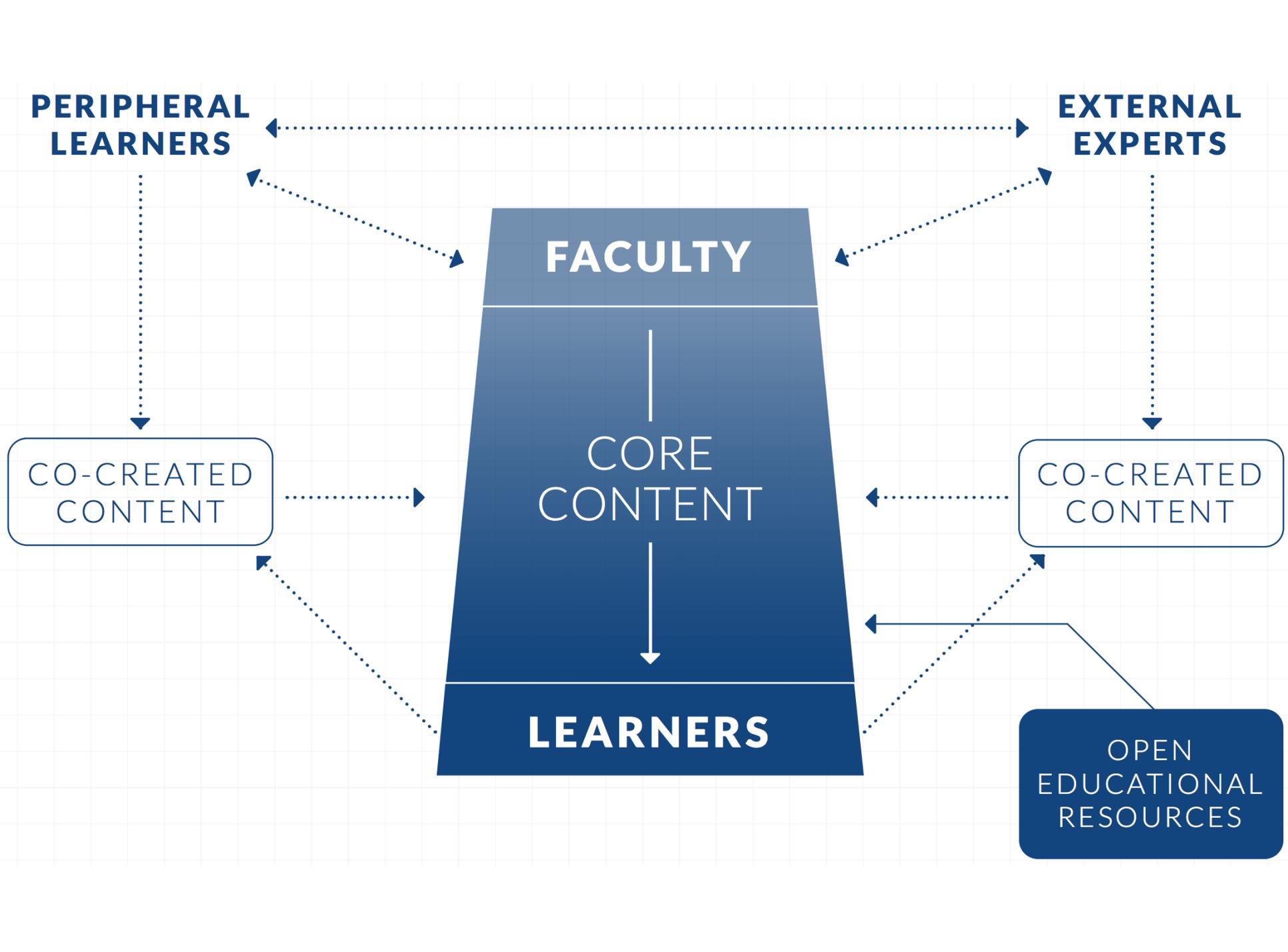
CORE  
CONTENT

**LEARNERS**

CO-CREATED  
CONTENT

CO-CREATED  
CONTENT

OPEN  
EDUCATIONAL  
RESOURCES

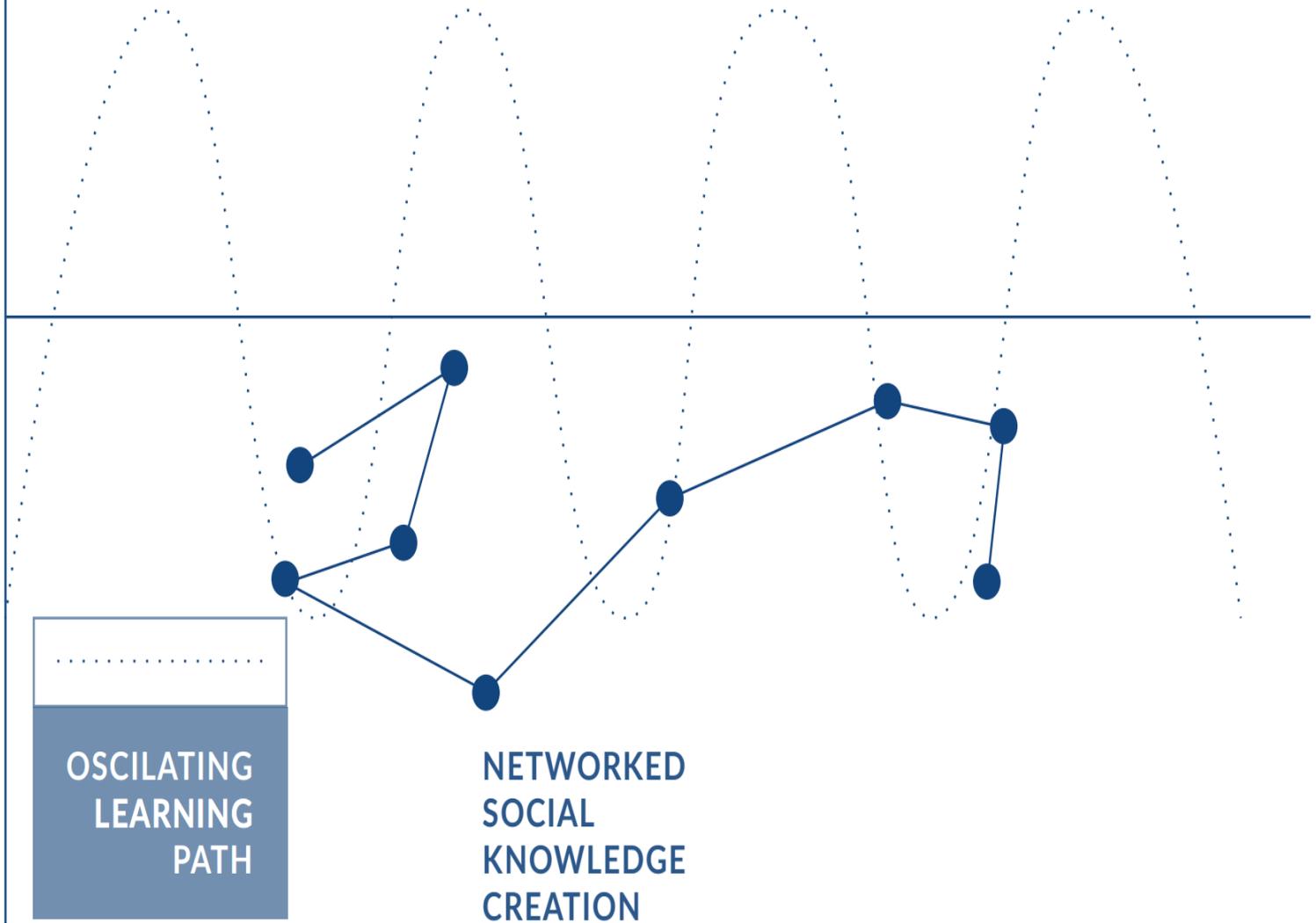


→ Lecture/content → Activities → Assessment → Credential

LINEAR INSTRUCTION TIMELINE

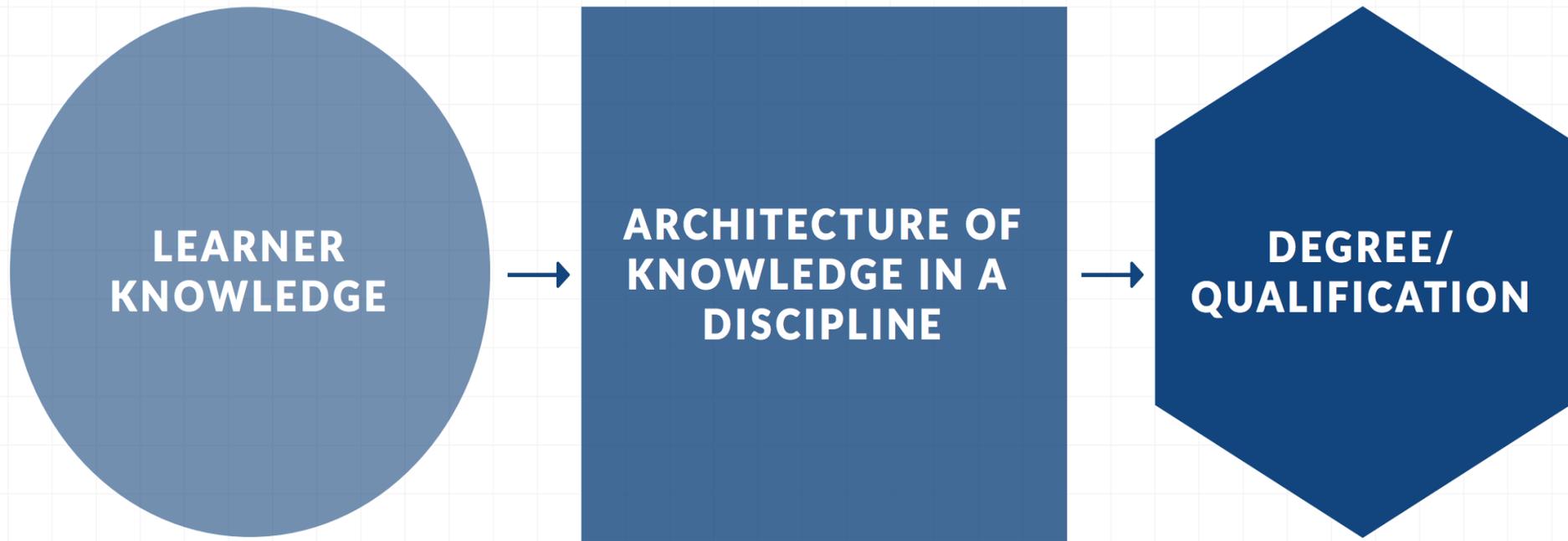
Traditional  
Sequential  
Course

Connective  
Knowledge

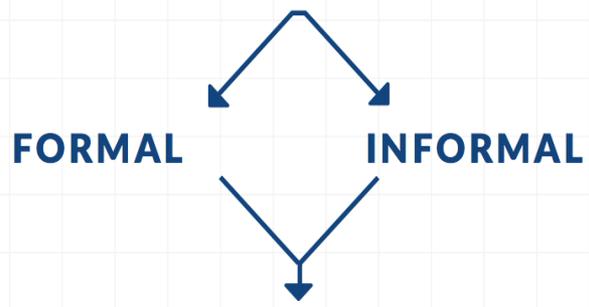


OSCILATING  
LEARNING  
PATH

NETWORKED  
SOCIAL  
KNOWLEDGE  
CREATION



**DEVELOPED THROUGH**



**PERSONAL  
KNOWLEDGE  
GRAPH**

**INTELLIGENT DATA  
SEMANTIC AND LINKED**



# KNOWLEDGE DOMAINS

# PERSONAL KNOWLEDGE GRAPH

NURSING



82%

COMPUTER SCIENCE



65%

LANDSCAPING



38%

# Parallel developing partners: Adaptive and personalized learning

Platform	Publisher
Knewton	Pearson
Smart Sparrow	McGraw-Hill
Desire2Learn	adaptcourseware
LoudCloud	CMU OLI
Intel One-to-One	Intel content ecosystem

Knowledge development, learning, is (should be) concerned with **learners understanding relationships**, not simply memorizing facts.

i.e. naming nodes is “low level” knowledge activity, understanding node connectivity, and implications of changes in network structure, consists of deeper, coherent, learning

TYPE OF ANALYTICS	LEVEL OR OBJECT OF ANALYSIS	WHO BENEFITS?
Learning Analytics	<b>Course-level:</b> social networks, conceptual development, discourse analysis, “intelligent curriculum”	Learners, faculty
	<b>Departmental:</b> predictive modeling, patterns of success/failure	Learners, faculty
Academic Analytics	<b>Institutional:</b> learner profiles, performance of academics, knowledge flow	Administrators, funders, marketing
	<b>Regional</b> (state/provincial): comparisons between systems	Funders, administrators
	<b>National and International</b>	National governments, education authorities

Learner success

Use of school resources/services

At-risk learners (predictive capacity)

Help-seeking behavior

Alerts

Intervention

Learner dashboard

Path of concept development

Real-time analytics



<http://www.itap.purdue.edu/learning/tools/signals/>



# Open Learning Initiative

Transforming higher education through the science of learning.

<http://oli.cmu.edu/>

Figure 1. Degree Compass

The screenshot displays the APUS OneStop website interface. On the left, a sidebar provides detailed information for BIOL 1010: Principles of Life, including its description, prerequisites, and class section details for Spring Semester 2011. The main content area features a 'Courses You Should Consider' section with a list of related courses and their ratings. On the right, there are sections for 'My Courses' and 'RODP' (Request of Degree Plan).

### BIOL 1010: Principles of Life

**Course Description:** A course for non-science majors. Topics covered include scientific methodology, the nature of living organisms, cell structure and function, cell chemistry and division, nature of heredity and gene action, the theory of evolution and principles of ecology. BIOL 1010 will not serve as a prerequisite of upper level biology courses.

**Note:** To add any of the sections below to your class schedule, return to the main OneStop window, click on the "Web Self Service" tab, then "Student", then "Registration", then "Add or Drop Classes". You'll also want to make note of the CRN for the course you wish to register for as this will make finding the class in the registration system easier.

#### Spring Semester 2011

**Class Section: 01**

Class CRN: 1135  
Instructor: Finley, Mack  
Credit Hours: 3  
Time: 08:00 am - 08:55 am  
Days: MWT  
Campus: Austin Peay SU, Main Campus  
Location: Sundquist Science Complex E106A  
Instructional Method: Conventional Methodology  
Start Date: 13-JAN-11  
End Date: 06-MAY-11  
Capacity: 99  
Seats Open: 98  
Seats Filled: 1

#### Courses You Should Consider:

**BIOL1010 - Principles of Life**  
Description & Prerequisites: Course Description: A course for non-science majors. Topics covered include scientific methodology, the nature of living organisms, cell structure and function, cell chemistry and division, nature of heredity and gene action, the theory of evolution and principles of ecology. BIOL 1010 will not serve as a prerequisite of upper level biology courses.

BIOL1011 - Principles of Life Lab	★★★★☆	<a href="#">View Sections</a>
BIOL1010 - Principles of Life	★★★★☆	<a href="#">View Sections</a>
GEOL1041 - Physical Geology Lab	★★★★☆	<a href="#">View Sections</a>
BIOL2011 - Human Anat and Phys Lab	★★★★☆	<a href="#">View Sections</a>
GEOL1040 - Physical Geology	★★★★☆	<a href="#">View Sections</a>

[See more suggestions...](#)

Filter:

These suggestions are courses in which other students similar to you have made successful progress in your program of study. You should always consult your advisor when planning your schedule.

#### My Courses

**AP Austin Peay Online**  
Wherever you go, there we are.

**APOnline**

Use this link to access your W1, W2, etc. APOne course sections.

**Note:** If you are planning to browse your course for longer than 30 minutes (or to take a quiz or post a forum topic), please use the direct login, <http://olearn.apus.edu> to avoid Onestop timing out your online course session.

#### RODP

Click here to access your RSO, RS1, etc. courses. (Requires log-in)

**RODP Login Instructions**  
Login instructions are located on the RODP Online login page.



Athabasca University 

LANDING

UMBC

Check my activity



BILL & MELINDA  
GATES *foundation*



Predictive Analytics Reporting



Your location: Discussions > Assessment Discussion

## Assessment Discussion

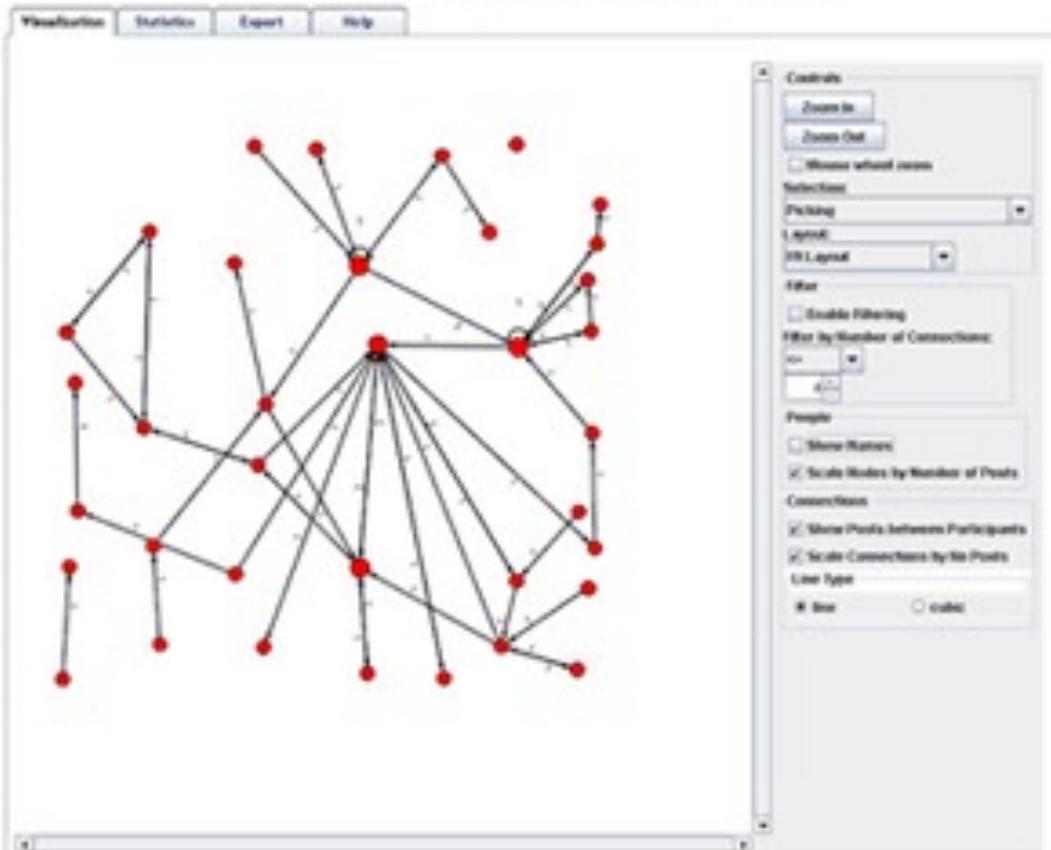
Description (click to expand)

Create Message

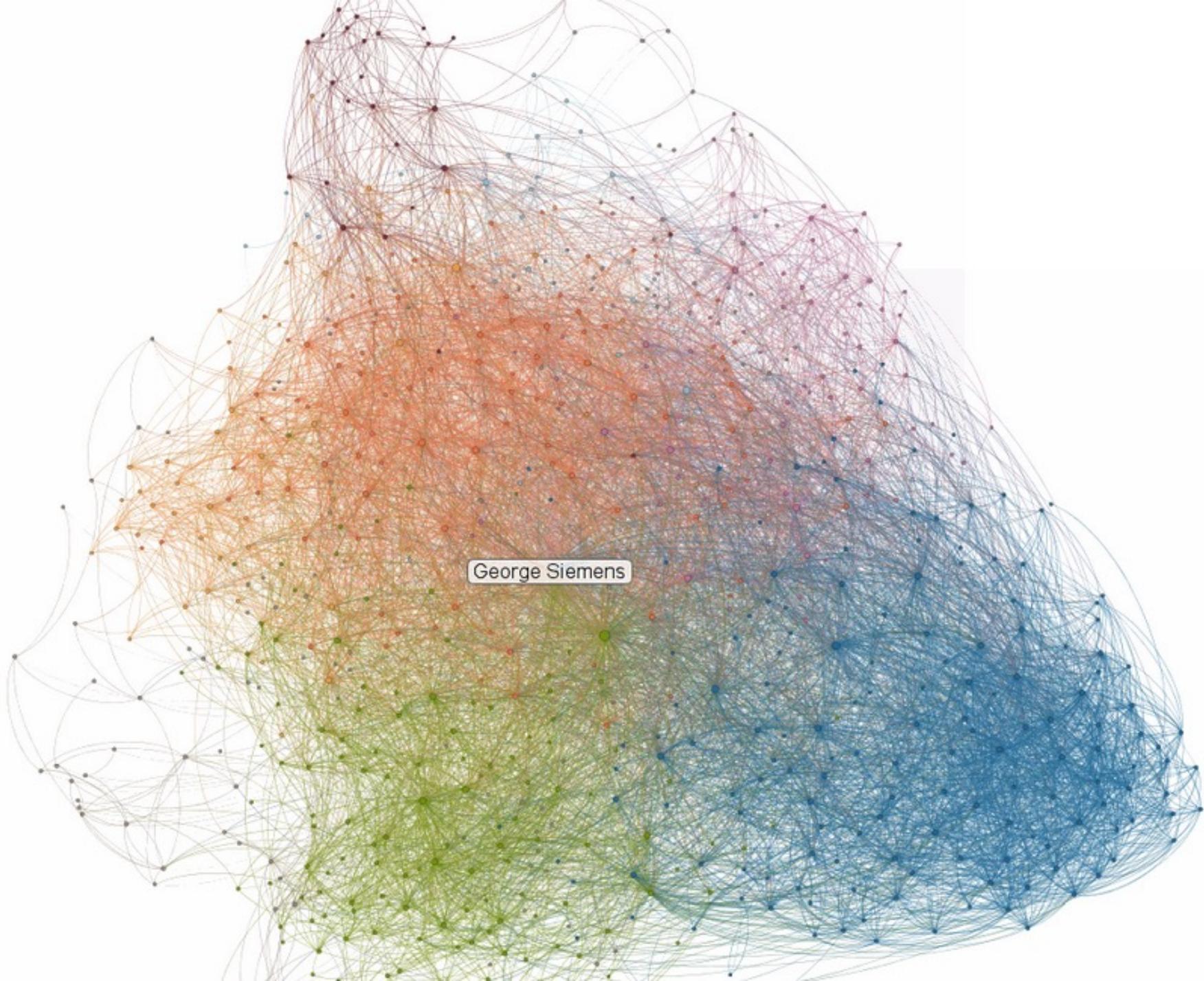
Expand All Collapse All

- Subject
- Exam Schedule %
- anatomy formative answers %
  - Re:anatomy formative answers %
- GL block quiz %
- GL quiz 7 question %
- BCA POEM - Formative %
  - Re:BCA POEM - Formative %
- Quiz question %
- Assessment Committee Meeting 10/08/09 %
  - Re:Assessment Committee Meeting 10/08/09 %
- formative quiz stats %
  - Re:formative quiz stats %
  - Re:formative quiz stats %
- formative quiz %
  - Re:formative quiz %
  - Re:formative quiz %
  - Re:formative quiz %

## Social Networks Adapting Pedagogical Practice (SNAPP)



<http://research.uow.edu.au/learningnetworks/seeing/snapp/index.html>



George Siemens

# The WHAT of learning analytics

**QUEST FOR FUNDAMENTAL UNDERSTANDING?**

**PURE BASIC  
KNOWLEDGE  
(BOHR QUADRANT)**

**USE-INSPIRED  
BASIC RESEARCH  
(PASTEUR QUADRANT)**

**APPLIED  
RESEARCH  
(EDISON QUADRANT)**

**CONSIDERATION OF USE?**

# Lack of data-informed decision making culture

Macfadyen, L., & Dawson, S. (2012). Numbers Are Not Enough. Why e-Learning Analytics Failed to Inform an Institutional Strategic Plan. *Educational Technology & Society*, 15(3), 149-163.

# ↓ TOP-DOWN

SYSTEM-WIDE



**COORDINATED  
TEAM**

Enterprise-Level  
Tools

Integration of  
Data Sources

Automated  
Discovery

Automated  
Interventions

Social Network  
Analysis

Quantified-Self

Server/LMS  
Stats

Language/  
Discourse  
Analysis



**INDIVIDUAL  
FACULTY  
MEMBER**

# ↑ BOTTOM-UP

CLASSROOM-LEVEL



**“BIG DATA”**

SIZE OF DATA SETS



**“SMALL DATA”**

TEAM/ORGANIZATIONAL IMPACT

INTEGRATED

LIMITED

**Sector Transformation**

- Data Sharing Capabilities
- Innovation
- Open Data
- Sector-wide Agility

**Organizational Transformation**

- Predictive Models
- Personalized Learning
- Measured by Impact & Organizational Strategy

**Organization**

**Students**

**Faculty**

**Experimentation**

- Drill Down Reports
- Sample Dashboards

- Students Dashboards
- Teaching Dashboards
- Bi Reporting Tools
- Cross-system Data Integration

**Aware**

- Basic Reports
- Log Data

BEGINNING

ADVANCED

MATURITY OF LEARNING ANALYTICS DEPLOYMENT

The HOW of learning analytics

## DATA SOURCES

Student Information Systems

Learning Management Systems

Use Of University Services

Student Cards

Social Media

Student Success Systems (CRM)

Any Interaction Between learner & institution

## DATA REPOSITORIES

## QUESTIONS PATTERNS SOUGHT

Course Sequencing

Social Networks

Preparedness

Important Teaching & Learning Variables

Pre-University Profiles

Help-Seeking Behaviors

## LEARNING ANALYTICS

Faculty  
Learner: Self-Awareness  
Learning Designers  
Personalization/Adaptation

## ACADEMIC ANALYTICS

Reporting (State, Organizational)

Admin • — Institutional Research  
• — Leadership

# ANALYTICS MODEL

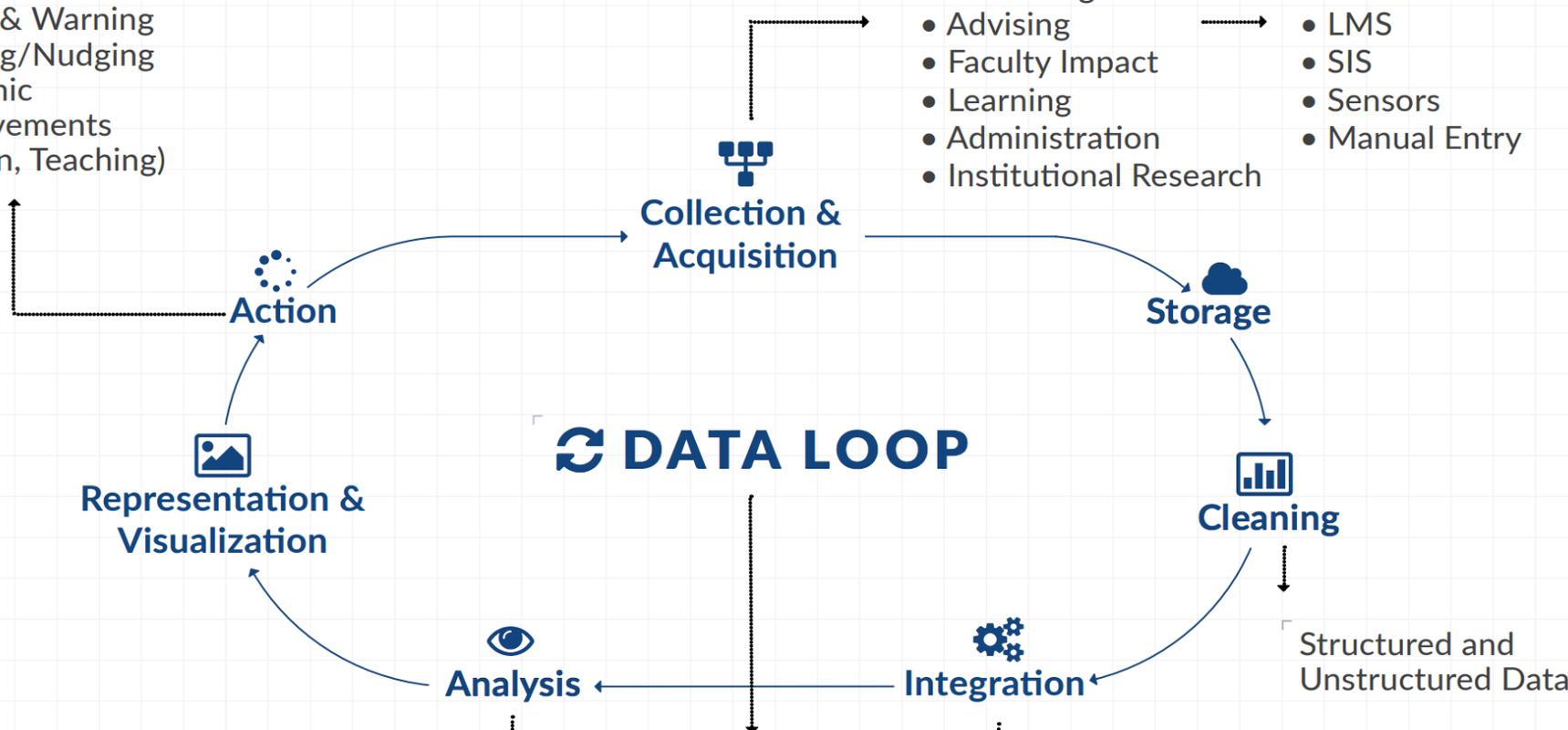
Intervention  
Optimization  
Alerts & Warning  
Guiding/Nudging  
Systemic  
Improvements  
(Design, Teaching)

**Depends on Purpose**

- Marketing
- Advising
- Faculty Impact
- Learning
- Administration
- Institutional Research

**Data Sources**

- Datamarts
- LMS
- SIS
- Sensors
- Manual Entry



Action

Collection & Acquisition

Storage

**DATA LOOP**

Cleaning

Representation & Visualization

Analysis

Integration

Structured and Unstructured Data

**Tools & Techniques of Analysis**

- SNA
- NLP
- Concept Development
- Prediction
- Risk Determination
- Course Sequencing
- Help Seeking

**Data Team**

- Sponsor/Stakeholder
- Data Scientist
- Programmer
- Statistician
- Administration
- End User Experience (Visualization, Reporting)

Multiple Datasets/Formats

## Strategy

- Data Inventory
- Role of Data
- Problem or Opportunity
- Stakeholders (IR, Academic, Admin)
- Access
- Governance
- Compliance

## Planning & Resources Allocation

- Data/Analytics Team
- Data Sources
- Budget
- Priorities
- Stages of Deployment
- Policy Development

## Metrics & Tools

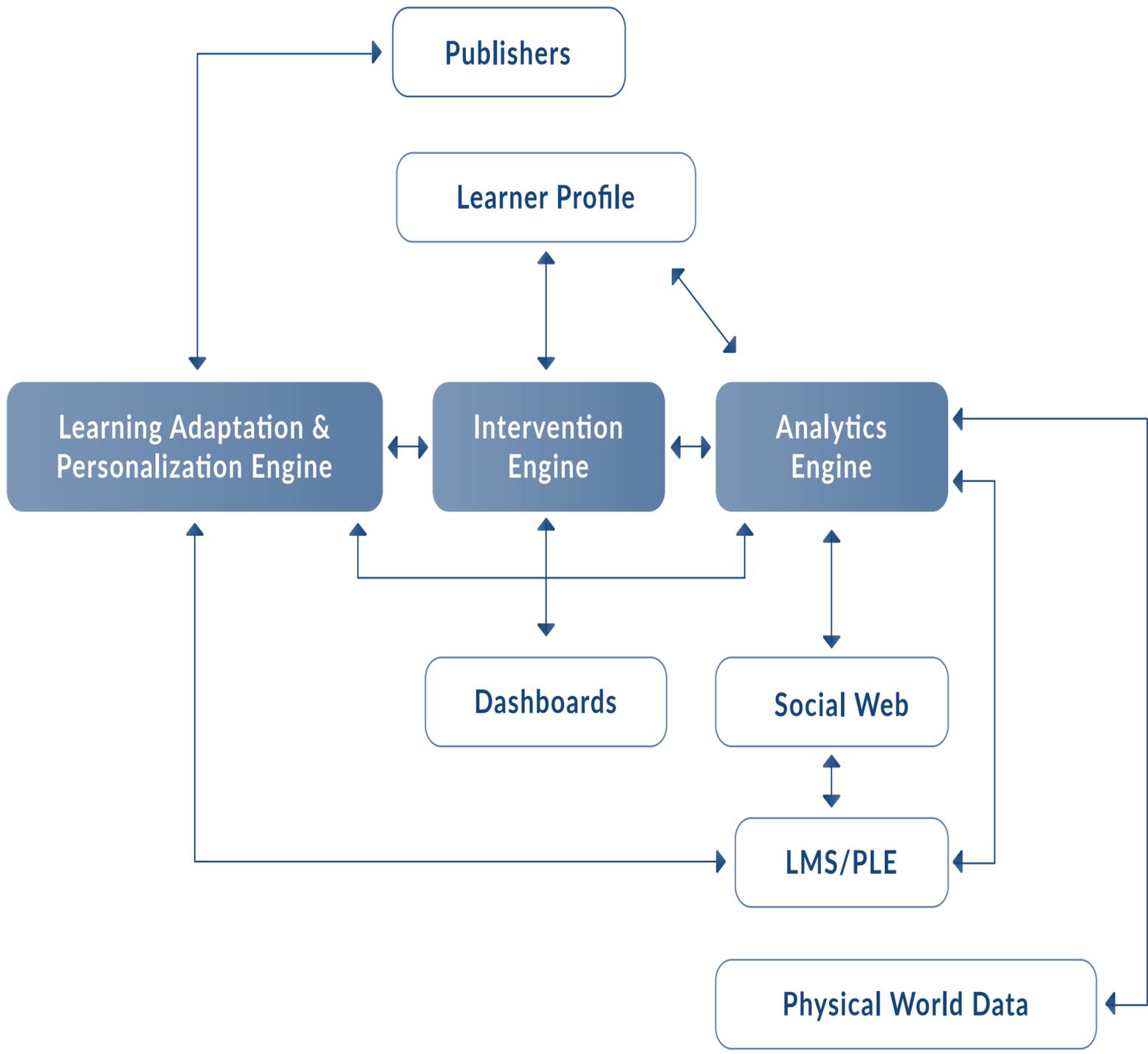
- Analytics Goals & Target Areas
- Educator-Controlled Tools
- Enterprise Tools
- Iterative Development of Algorithms
- Visualization

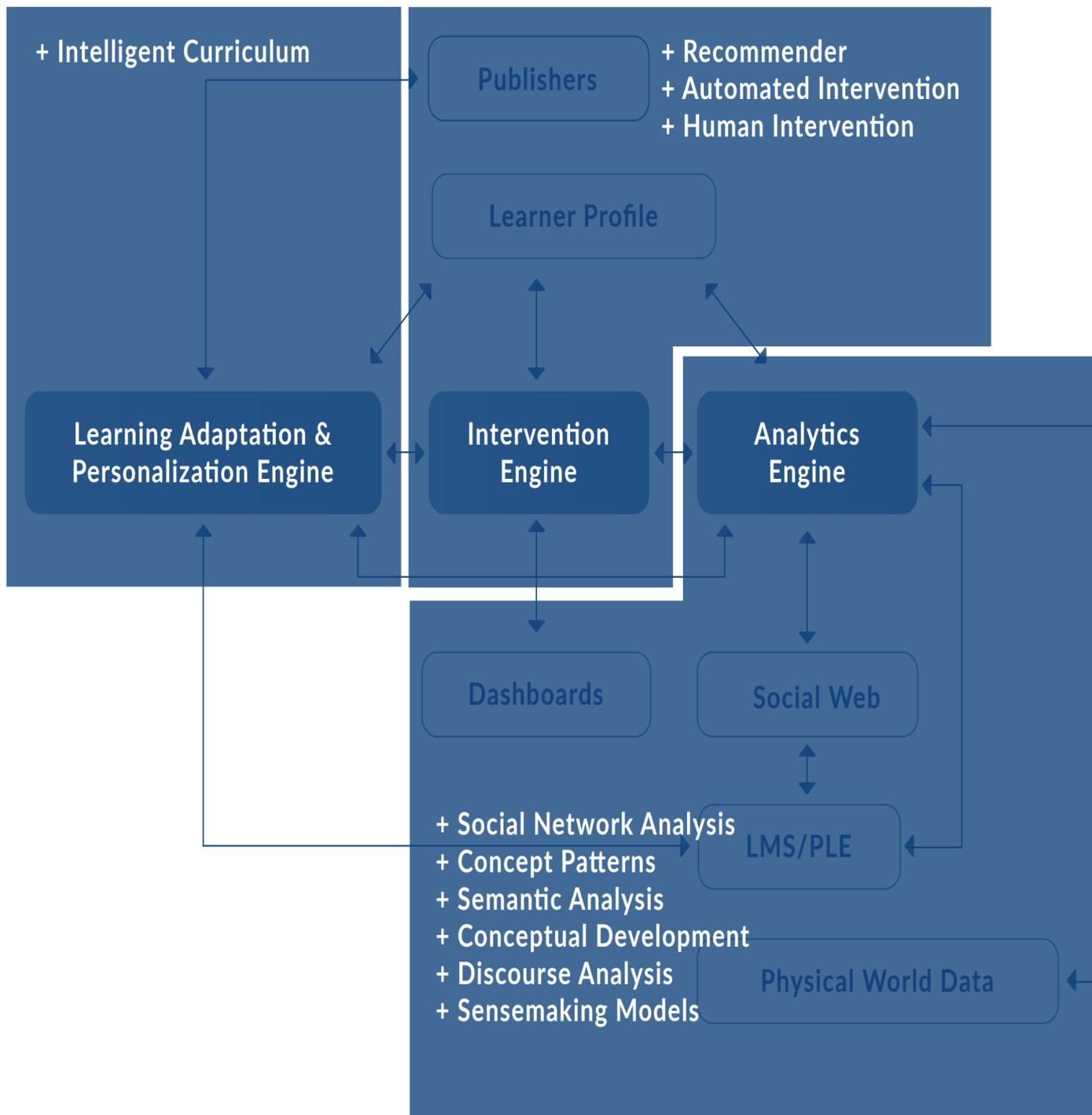
## Capacity Development

- Faculty/Staff PD
- Student Access
- Learning Design
- Process Mapping & Evaluation

## Systemic Change

- Course Models
- Self-directed Learning
- Automated Discovery
- Student Models
- Intelligent Curriculum





# UTA UA

iMotions

Ambient computing/Wearables

Mindfulness

Integrated university-wide analytics (all data under one department's control)