Adaptive Learning and the Power of Analytics

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Outline

- Adaptive Learning Framework in Realizeit
  - How we achieve adaptivity
- Learning Analytics
  - Integrated into learning
  - Student and instructor views
  - Academic analytics examples
- Predictive Analytics
  - Example of behavior based early warning system
- Questions

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Product Vision

- Emulate a good teacher in one-on-one learning situation
- Provide an individualized learning experience
  - Deliver learning at an appropriate time
  - Deliver appropriate learning material
  - Learn about the learner
  - Manage and adapt to change: abilities, metrics, behavior etc.
  - Identify weaknesses and try to remedy
- Remain subject and content independent

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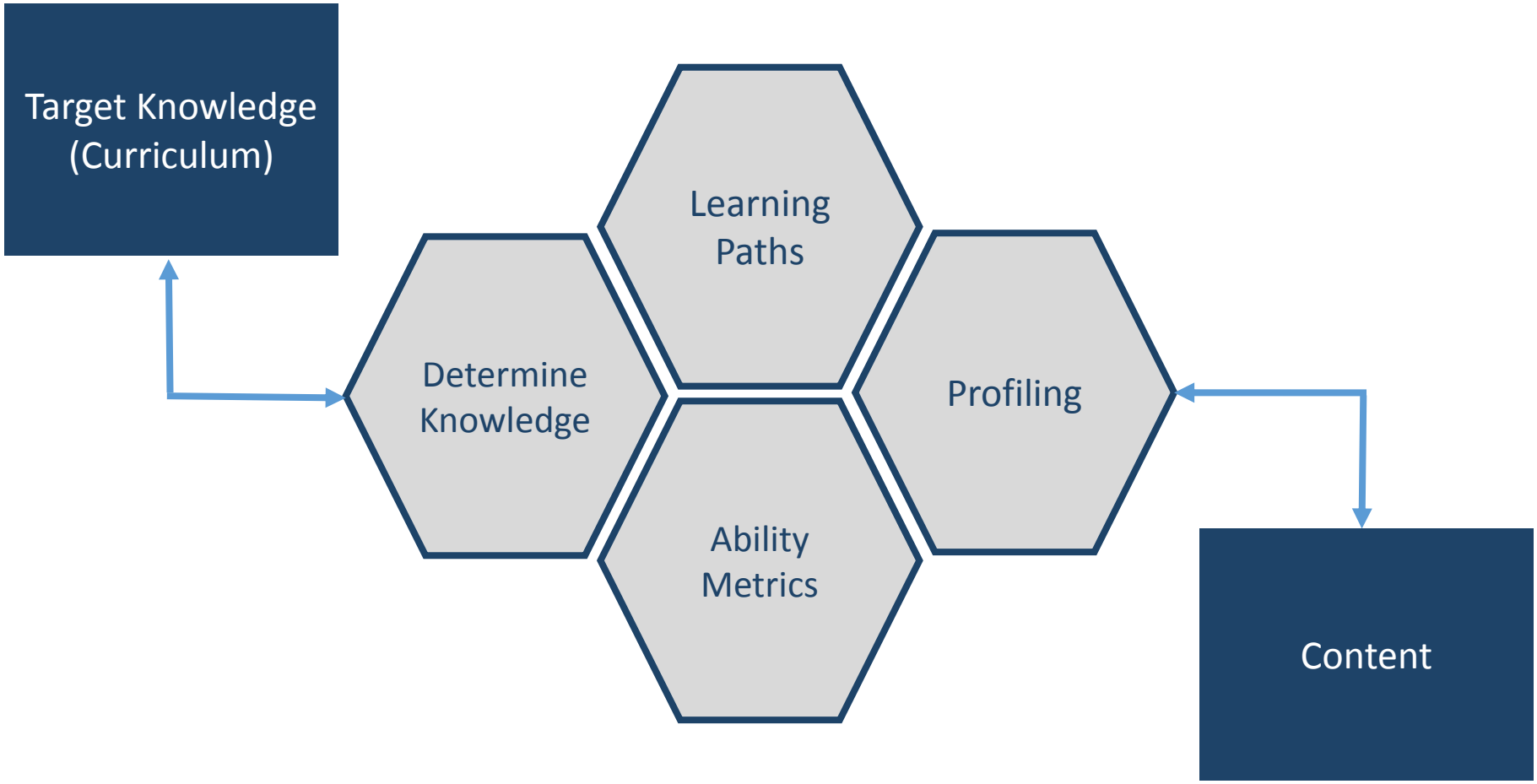
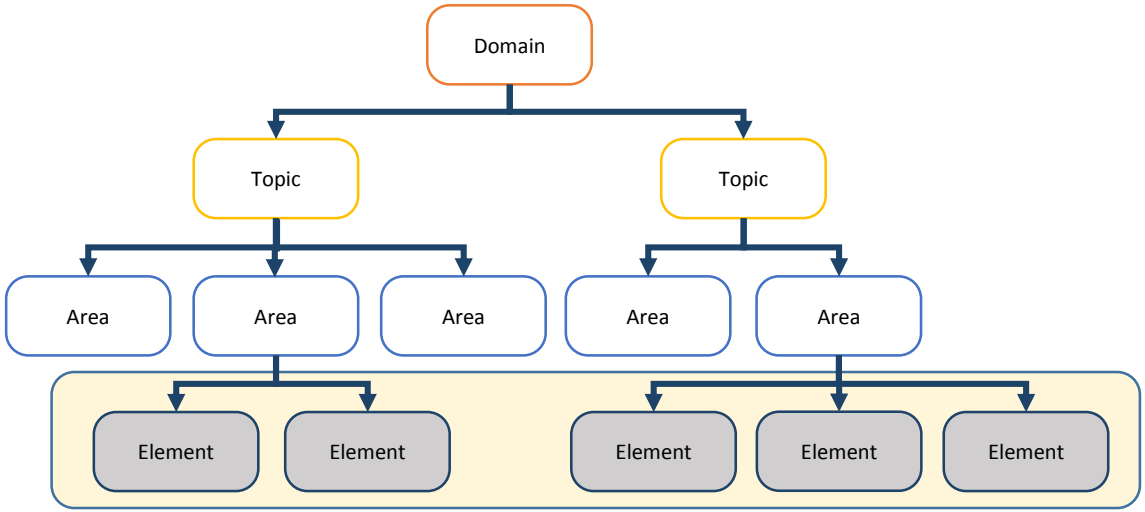
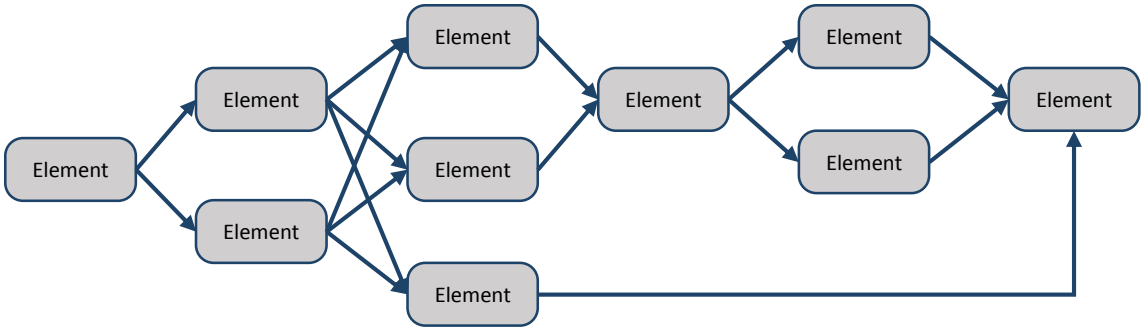
The Realizeit Learning Model



The Realizeit Learning Model





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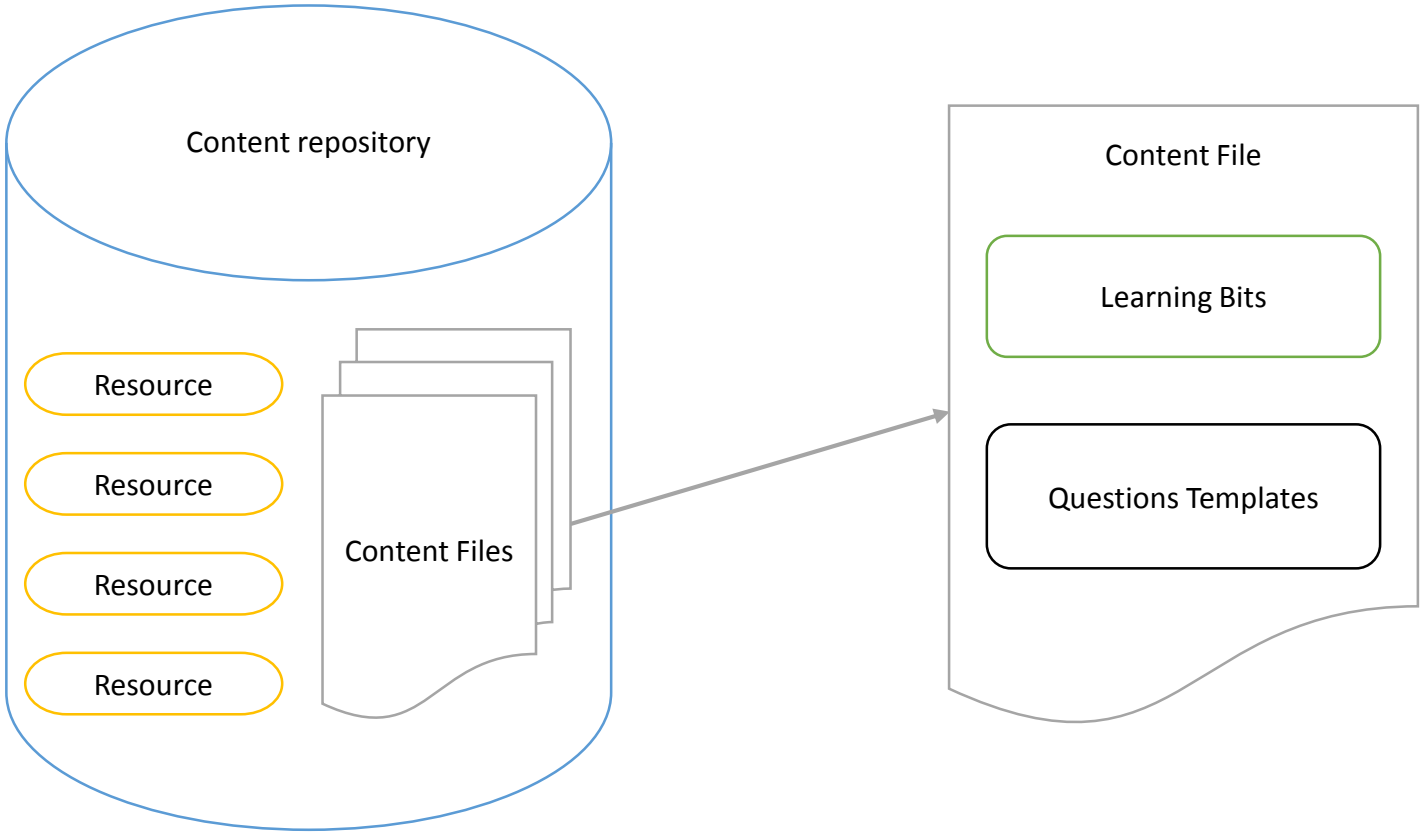
The Realizeit Learning Model



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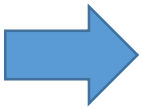
Content

- Learning Bits
  - Introduction
  - Learning Material
  - Example
  - Worked Example
  - Interactive Example
  - Questions
  - Summary
  - Review



ILEWNQSR
LRQ
LSQNILQR
LSIWQR

- Questions

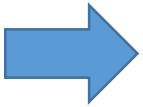
Template:

$ax + bx =?$

Conditions:

$1 \leq a \leq 10$

$1 \leq b \leq 7$



$2x + 7x =?$

$x + 3x =?$

$10x + 2x =?$

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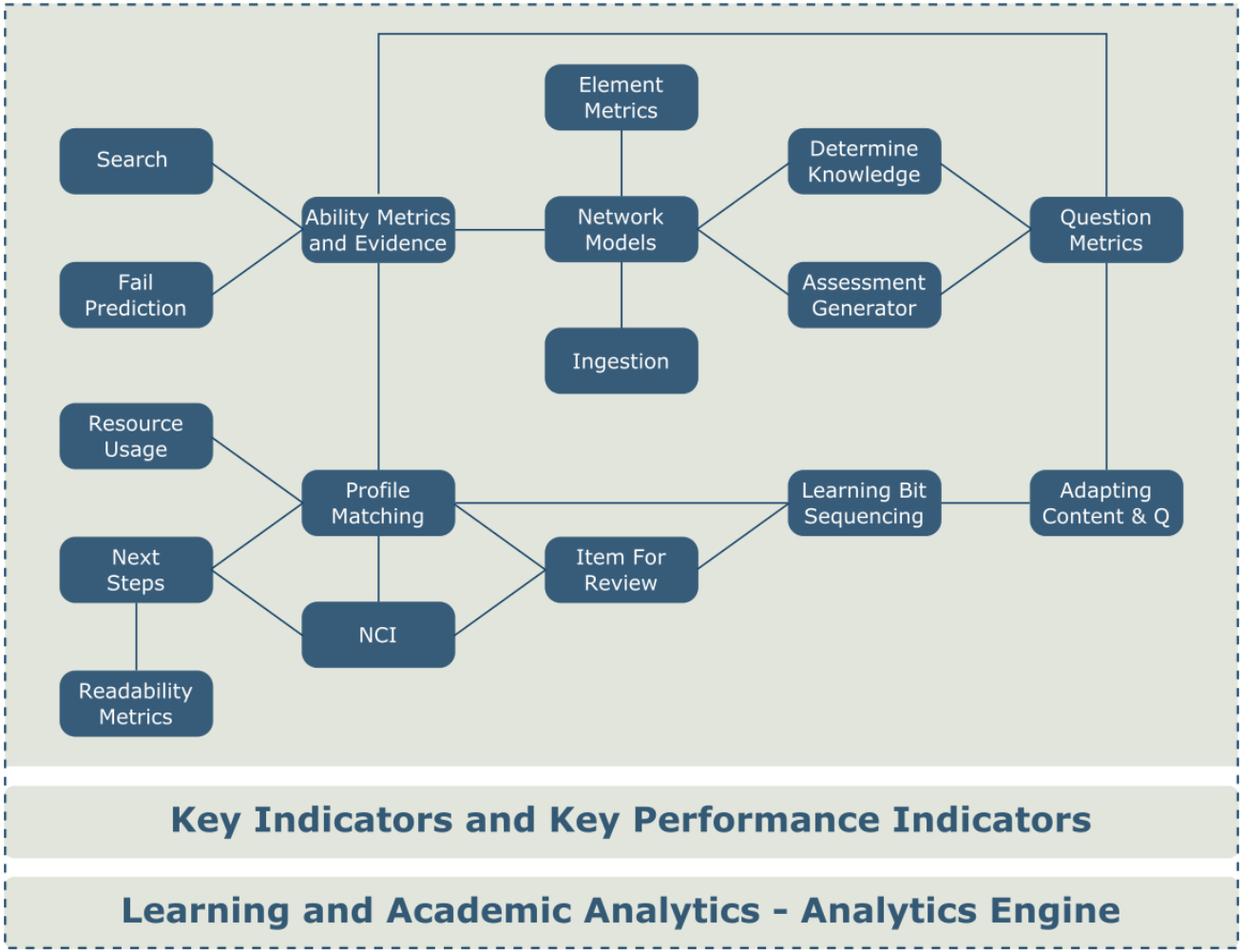
The Realizeit Learning Model



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Adaptivity in Realizeit

- Tailor a student's start position
- Alter a learner's pathway in real-time
- Select the most suitable content
- Select the most suitable pedagogical elements
- Adapt the content in real-time
- Main source of adaptivity comes from the adaptive intelligence engine
- Adaptivity and personalization also come from the instructor or the student themselves

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Learning and Academic Analytics

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

Penetrating the Fog
Phil Long and George Siemens
Educause Review, September/October 2011

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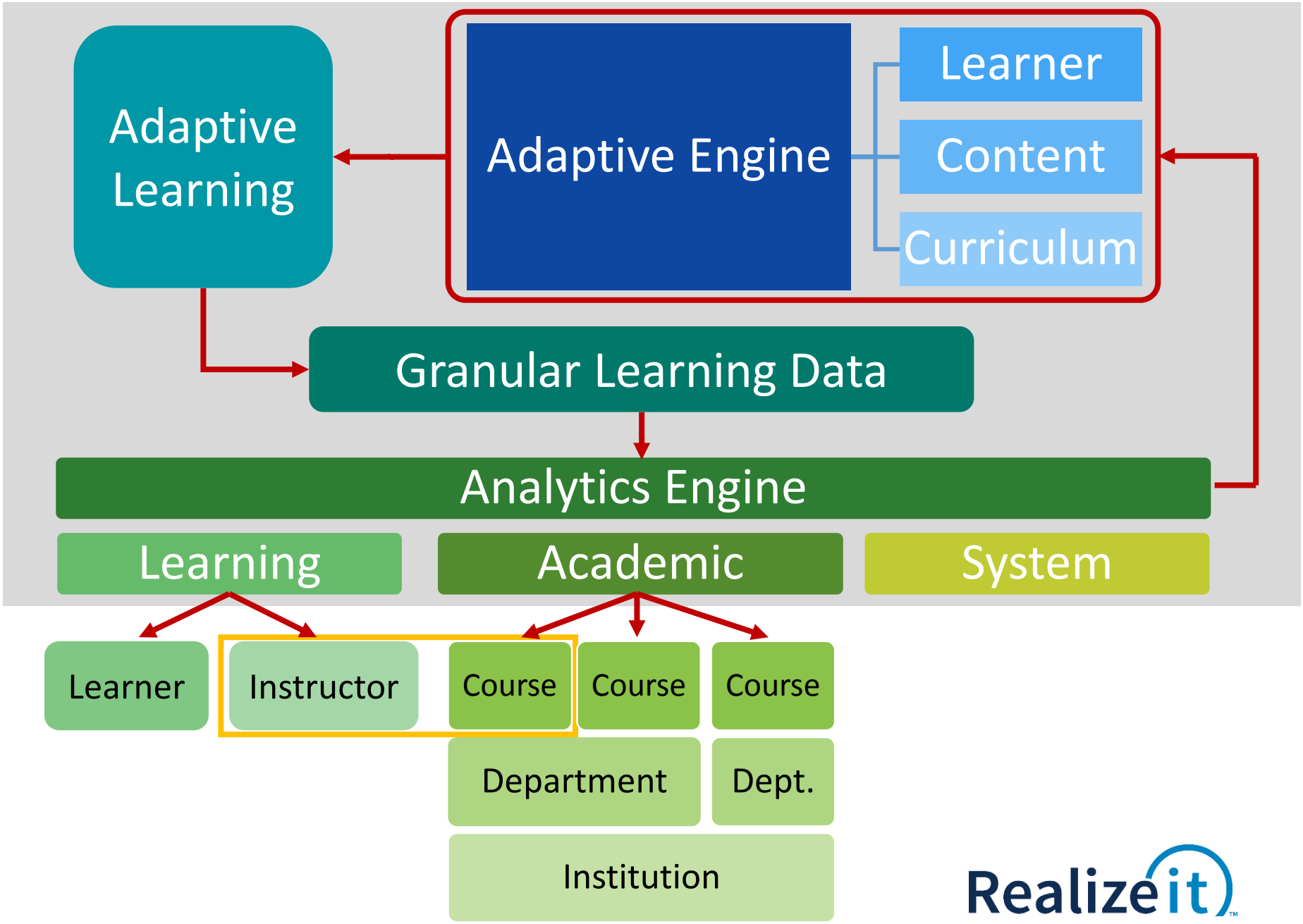
Adaptive Learning
Adaptive Engine
Learner
Content
Curriculum
Granular Learning Data
Analytics Engine
Learning
Academic
System
Learner
Instructor
Course
Course
Course
Department
Dept.
Institution
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Learner and Instructor Analytics

- Go beyond the traditional summative metrics – adaptive analytics
- Based on both attainment and behavioral metrics
- Easily understandable
- Actionable
- Integrate analytics into the functionality and use of the system
- Makes use of data as it is gathered and generates *real-time* analytics

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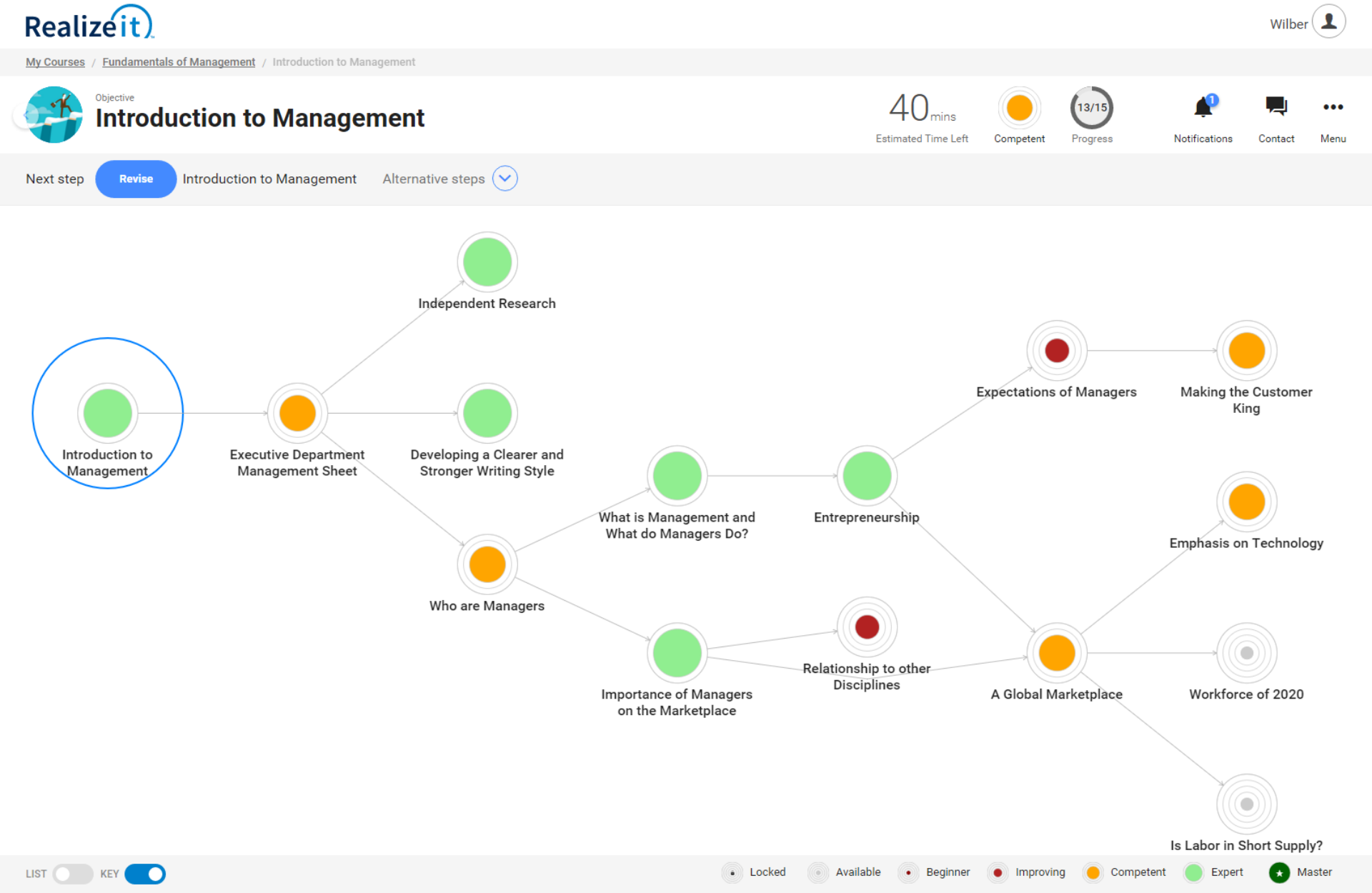
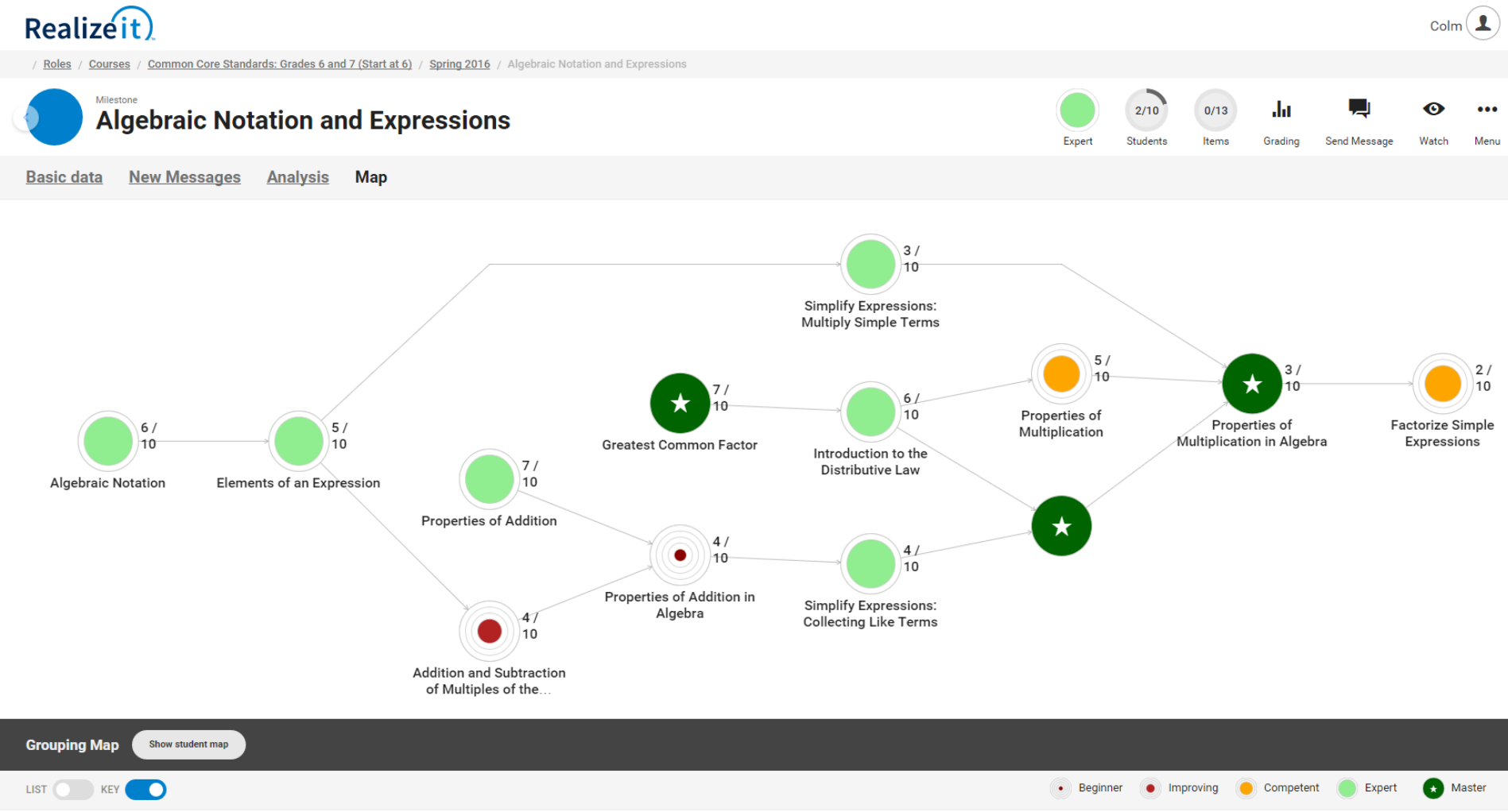
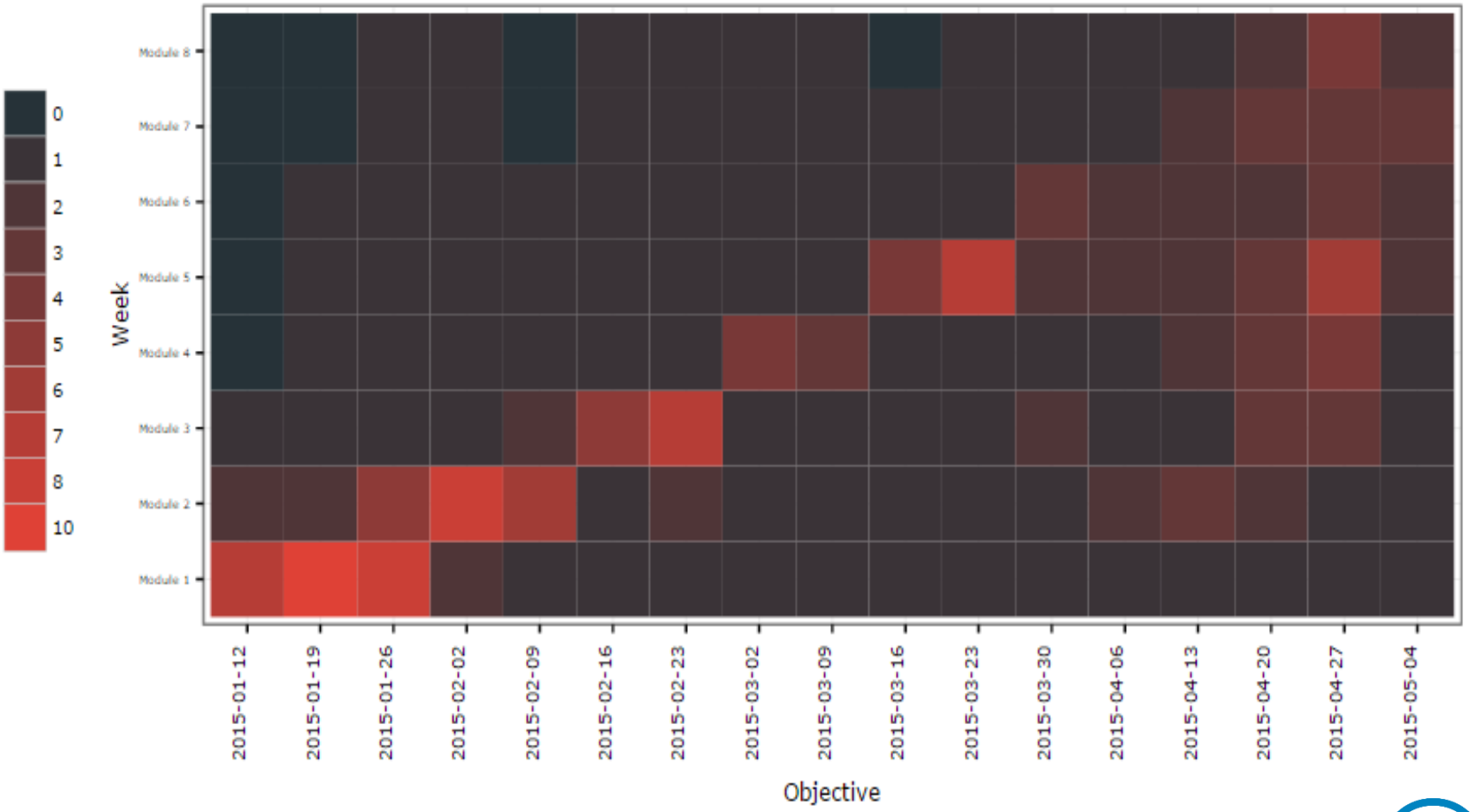
Learner


Realizeit
Wilber
My Courses / Fundamentals of Management / Introduction to Management
Objective
Introduction to Management
40 mins
Estimated Time Left
Competent
13/15
Progress
Notifications
Contact
Menu
Next step
Revise
Introduction to Management
Alternative steps
Independent Research
Introduction to Management
Executive Department Management Sheet
Developing a Clearer and Stronger Writing Style
Who are Managers
What is Management and What do Managers Do?
Importance of Managers on the Marketplace
Relationship to other Disciplines
Entrepreneurship
Expectations of Managers
Making the Customer King
Emphasis on Technology
A Global Marketplace
Workforce of 2020
Is Labor in Short Supply?
LIST
KEY
Locked
Available
Beginner
Improving
Competent
Expert
Master

Instructor


Realizeit
Colm
Roles / Courses / Common Core Standards: Grades 6 and 7 (Start at 6) / Spring 2016 / Algebraic Notation and Expressions
Milestone
Algebraic Notation and Expressions
Expert
2/10
Students
0/13
Items
Grading
Send Message
Watch
Menu
Basic data
New Messages
Analysis
Map
6 / 10
Algebraic Notation
5 / 10
Elements of an Expression
3 / 10
Simplify Expressions: Multiply Simple Terms
7 / 10
Properties of Addition
4 / 10
Addition and Subtraction of Multiples of the...
7 / 10
Greatest Common Factor
4 / 10
Properties of Addition in Algebra
6 / 10
Introduction to the Distributive Law
4 / 10
Simplify Expressions: Collecting Like Terms
5 / 10
Properties of Multiplication
3 / 10
Properties of Multiplication in Algebra
2 / 10
Factorize Simple Expressions
Grouping Map
Show student map
LIST
KEY
Beginner
Improving
Competent
Expert
Master

Instructor – Analytics Examples



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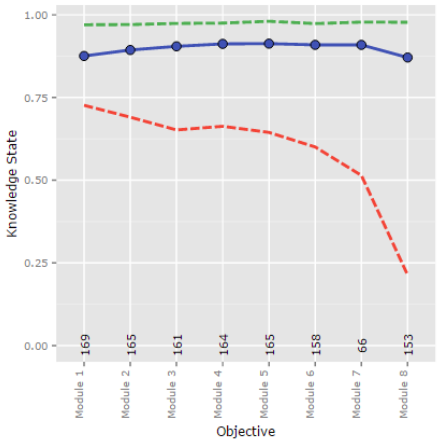
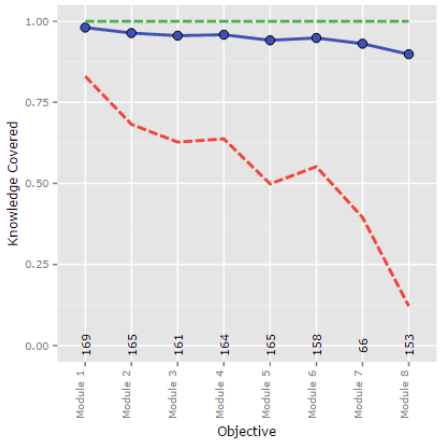
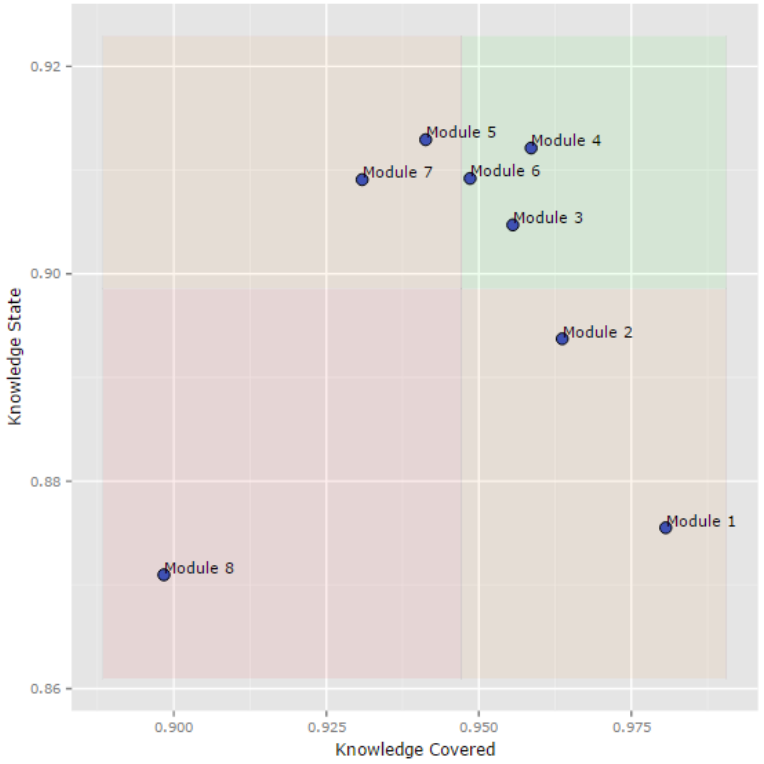
Instructor – Analytics Examples







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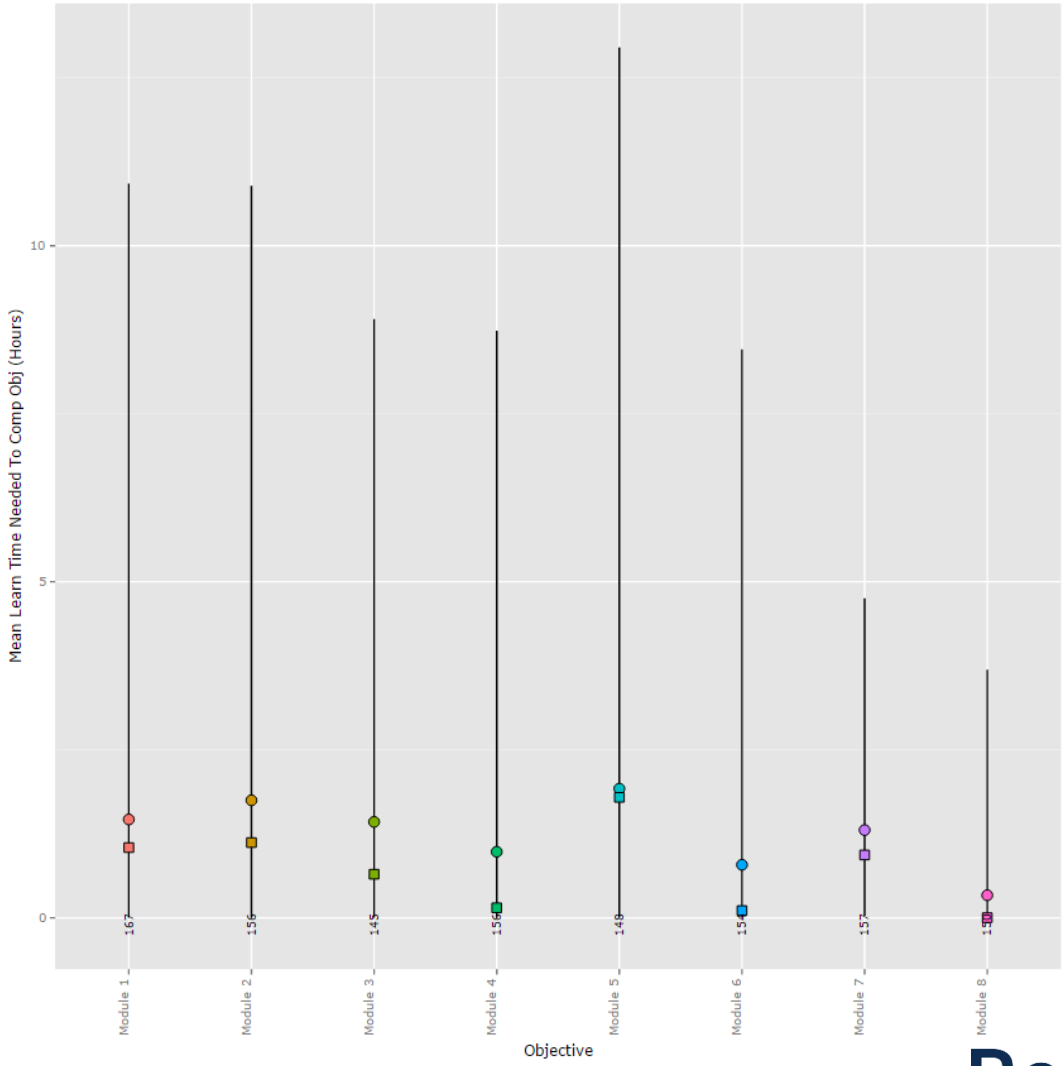
Instructor – Analytics Examples



Course Review – Analytics Examples

realizeit | My courses | My groups | I want to learn... | SysAdmin

Course review | Close

Course review | Overall review | Instructor review | Course development review

BS-01-03: BS-01-03 Introduction to Business

Course review

Course structure

Summary metrics
- Students
- Instructors
- Engagement
- Outcomes
- Grades
- Milestones
- Competencies

Session analysis
- General performance
- Student performance
- Milestone performance
- Competency performance
- Element performance
- Course relationships
- Instructor performance

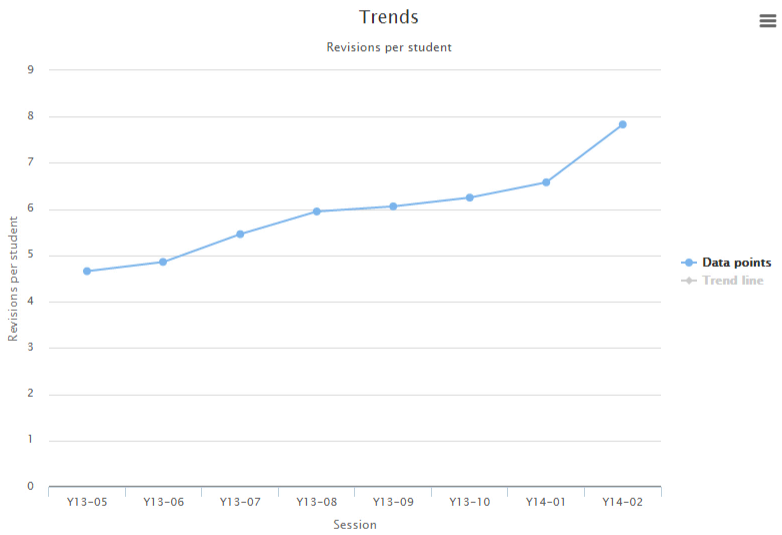
Trend analysis
- Trends
- Correlations

Trend analysis

Trends

Values that have been generally increasing:
- Number of students
- Number of groups
- Number of instructors
- Percentage repeating
- Students per group
- Interactions per student
- Messages from students (per student)
- Messages to students (per student)
- Interventions per student
- Learning hours per student
- Questions per student
- Practices per student
- **Revisions per student**
- Calculated score
- Percentage retained
- Knowledge state
- % of students with grade D
- % of students with grade B
- % of students with grade A

Values that have been generally decreasing:
- Number of new instructors
- Number of learning nodes
- Groups per instructor
- Percentage of questions queried
- Percentage of queried questions without response
- Percentage with Determine knowledge
- % of students with grade F
- % of students with grade E



Value	Slope	Correlation	1	2	3	4	5	6	7	8
Revisions per student	0.420	0.962	4.660	4.860	5.460	5.950	6.060	6.250	6.580	7.830

Prediction of Student Success

- To build an early warning system to detect at-risk students
- Traditionally built on demographic - cannot change
- Focus on learner behaviour - one week of learning
- From the predictions and associated probabilities determine a list of at-risk students.
- Take action - Inform the appropriate stakeholders and provide appropriate remediation
- Monitor the impact of any intervention

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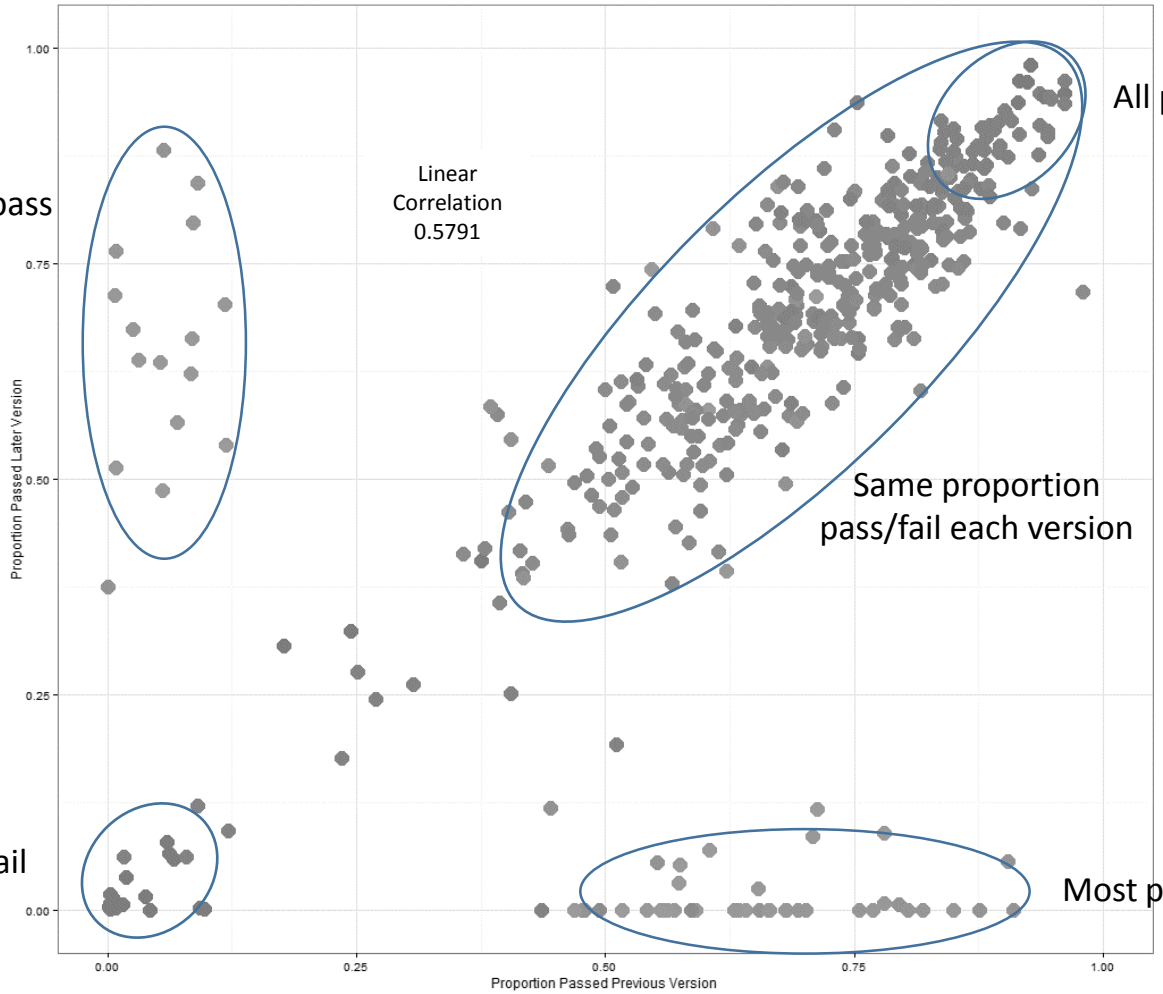
Relationship between versions



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Dependant Variable

- **FinalGrade** - The average student grade across the course objectives at the final due date.

- **PassFail** - A binary version of FinalGrade

$$PassFail = \begin{cases} 1 & \text{if} \quad FinalGrade \geq 60\% \\ 0 & \text{otherwise} \end{cases}$$

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Independent – Course Level

Behavior

- **Activity1** – First activity on course
- **Activity2** – Second activity on course
- **ActivitiesEachDay** – Total number of learning activities
- **AvgActivitiesEachDay** – Average number of activities each day
- **DayStarted** – Number of days before finish date that student started learning
- **Days** – number of days on which learning activities where delivered
- **NumPrevCourses** – The number of previous courses in which the student was enrolled.

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Independent – Course Level

Attainment

- **Grade** – Final grade if calculated at this point in time
- **GradePF –** Binary version of Grade.
- **QuestionsAsked** – Num of questions
- **QuestionsCorrect** - Num correct
- **QuestionsIncorrect** – Num incorrect
- **PerQuestionsCorrect** – Percent correct
- **PerQuestionsIncorrect** – Percent incorrectly

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Independent – Objective Level

Attainment

- **Obj_i_Grade** – The grade the student.
- **Obj_i_KC** – The knowledge covered.
- **Obj_i_KS** – The knowledge state.
- **Obj_i_Pass/Fail** – A binary version of the objective grade.

Behaviour

- **Obj_i_Learning Prop** – The proportion of activities that are learning activities (before mastery).
- **Obj_i_Revision Prop** – The proportion of activities that are revision activities (after mastery).
- **Obj_i_TimePerNode** – The average amount of time per node.

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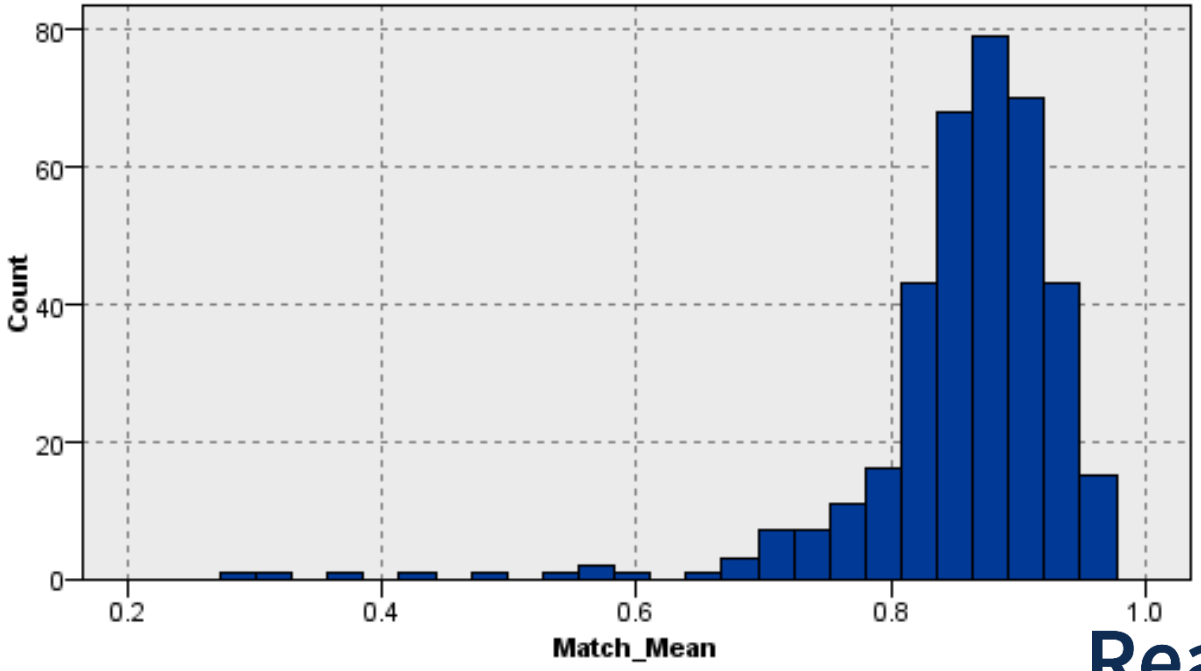
Model Accuracy – Unseen Data

		Predicted	
		Fail	Pass
Observed	Fail	22.35%	7.11%
	Pass	7.98%	62.57%

Fit - 94.23%

Accuracy - 84.92%



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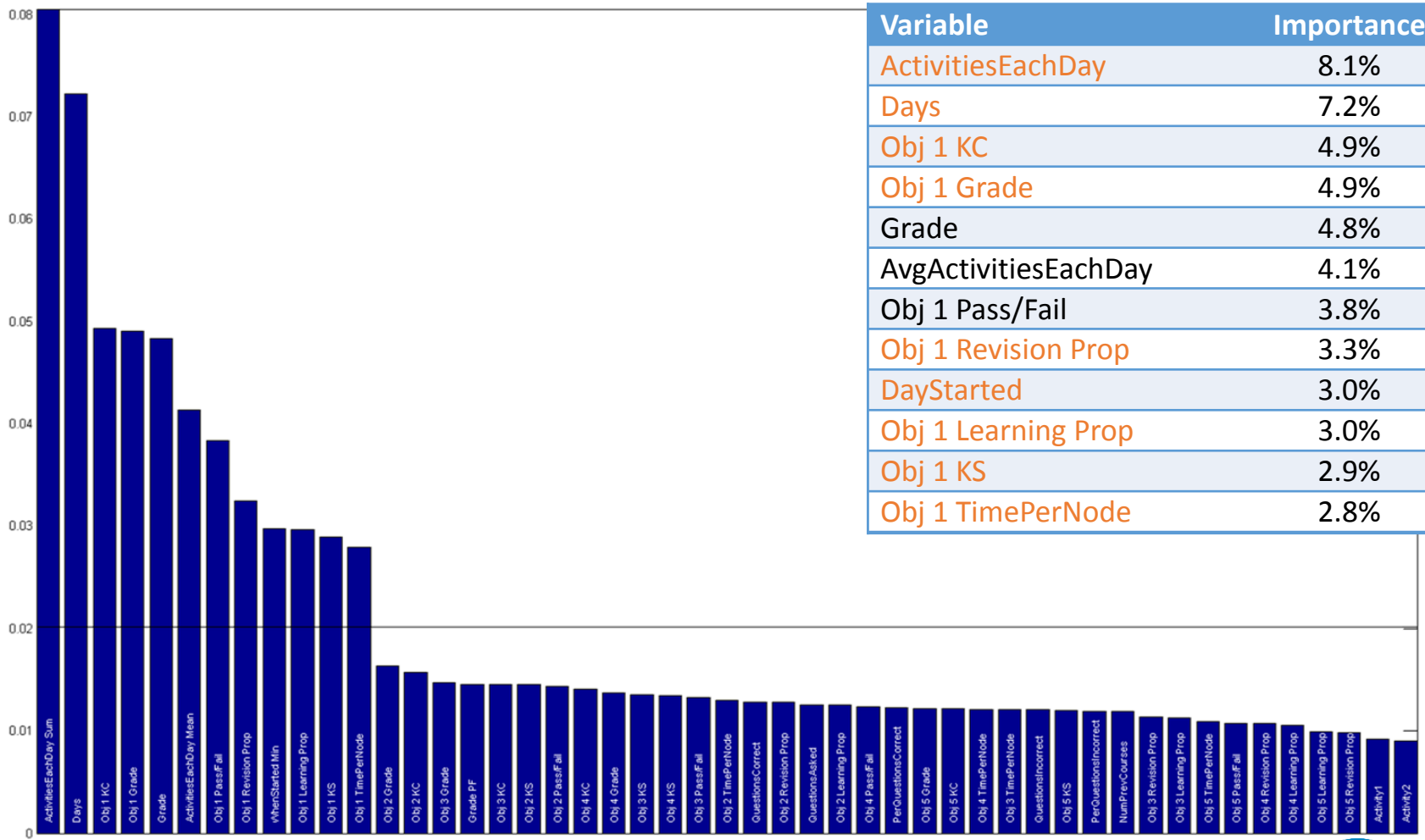
Predictor Importance



Variable	Importance
ActivitiesEachDay	8.1%
Days	7.2%
Obj 1 KC	4.9%
Obj 1 Grade	4.9%
Grade	4.8%
AvgActivitiesEachDay	4.1%
Obj 1 Pass/Fail	3.8%
Obj 1 Revision Prop	3.3%
DayStarted	3.0%
Obj 1 Learning Prop	3.0%
Obj 1 KS	2.9%
Obj 1 TimePerNode	2.8%

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Simplified Model

Behavioural Metrics

- –Activities Each Day
- –Days
- –Day Started
- –Obj 1 Revision Prop
- –Obj 1 Learning Prop
- –Obj 1 Time Per Node

Attainment Metrics

- –Obj 1 KS
- –Obj 1 KC
- –Obj 1 Grade

Accuracy

Observed		Predicted: Fail	Predicted: Pass
	Fail	20.92%	8.53%
	Pass	6.73%	63.82%

Unseen Data

- Full Model: 84.92%
- Simplified Model: 84.74%

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Sample model

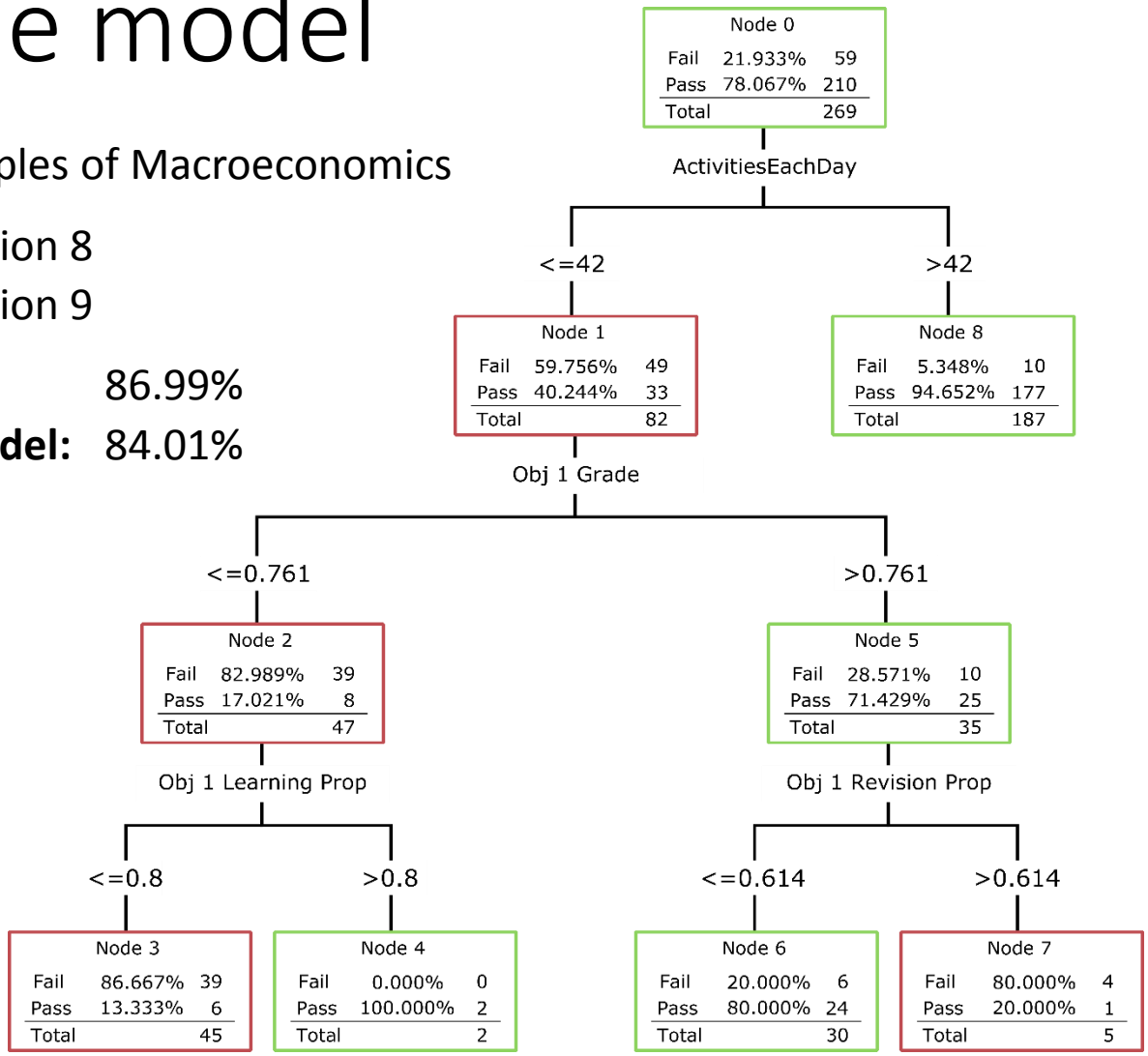
Course: Principles of Macroeconomics

Training: Version 8

Test: Version 9

Full model: 86.99%

Simplified model: 84.01%



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Insights

- Model based on behavioural and attainment metrics.
- Models allows insights into what behaviours make a student successful and what puts them at risk.

- Behavioural Metrics
  - Activities Each Day
  - Days
  - Day Started
  - Obj 1 Revision Prop
  - Obj 1 Learning Prop
  - Obj 1 Time Per Node
- Attainment Metrics
  - Obj 1 KS
  - Obj 1 KC
  - Obj 1 Grade

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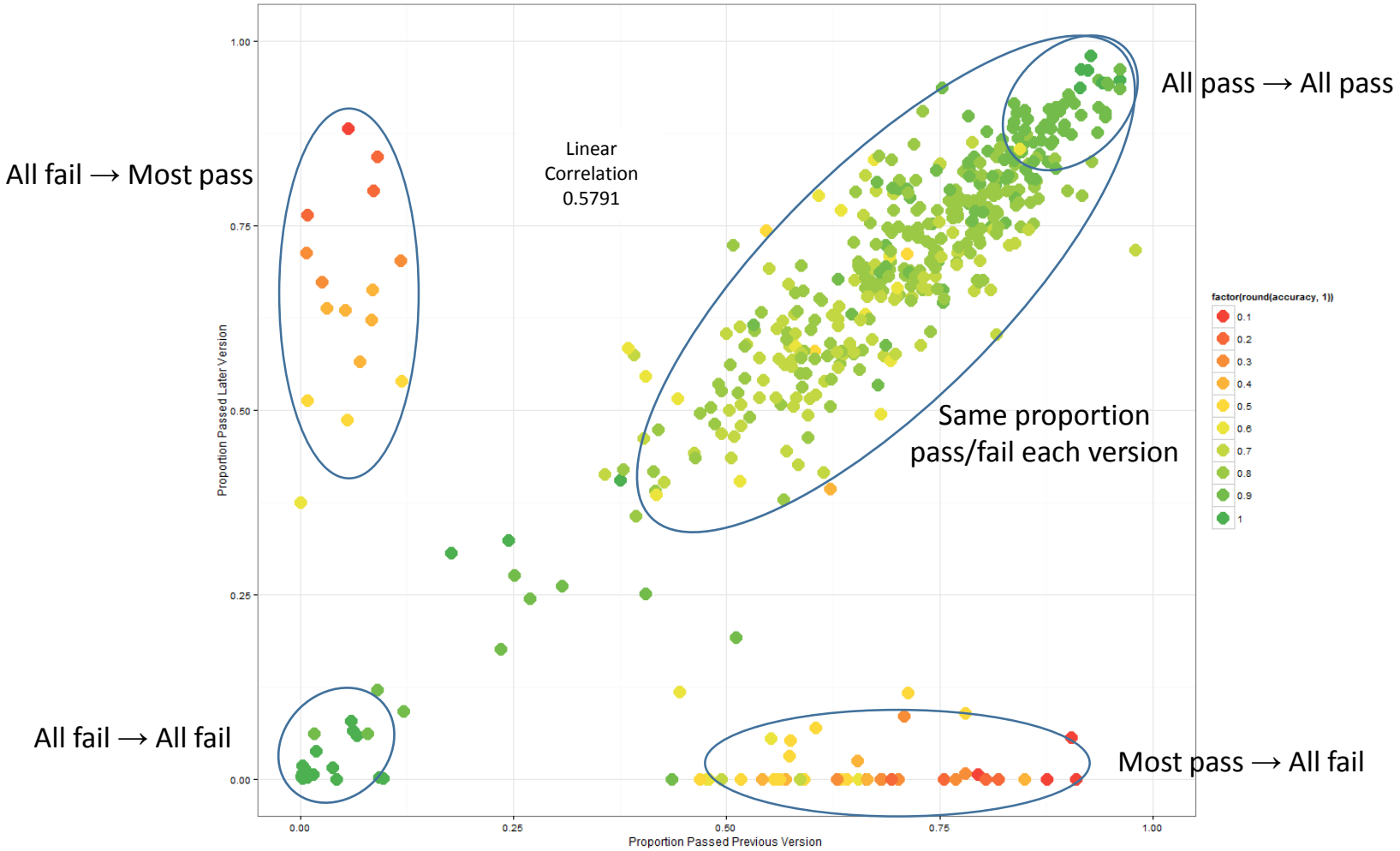
Overall Prediction Accuracy



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Summary – three main takeaways

- Adaptive Learning can provide unique fine grained data which can power new insights and analytics
- Analytics in real-time, actionable and integrated into the use of the system
- Adaptive learning can power predictive analytics based on learner behavior

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Evaluation: bit.ly/nercomp_analytic16

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