

RAD API

Recommendations and Diagnostics (RAD) API



Monitor Evidence of Learning

RAD continuously tracks measurement events in real time



Diagnose Areas Needing Review

Mastery predictions are continuously updated



Personalized Recommendations

Anytime requests for personalized resources

What is the RAD API?

RAD API is used to continuously track evidence of learning, diagnose mastery & generate personalized recommendations

RAD is built on a scalable, industry-accepted Amazon AWS serverless lambda architecture backed by high performance DynamoDB data access. The solution is an ACT Software as a Service (SaaS) capability that has been integrated into ACT Academy as the initial learning & assessment client.

1

AVAILABLE

Robust, always on service that elastically scales up, on demand

2

EXTENSIBLE

Modular set of features that implement various algorithms/models

3

UNIVERSAL

RAD's approach can be applied to a range of subjects, systems

Application

RAD API offers insights and actions that augment an existing learning and assessment system (LAS)

RAD API was designed to work with the existing measurement resources of a learning platform. It only requires metadata associations that link item response data to one or more underlying skills. These skills can be associated with any hierarchical skill taxonomy, e.g. common core state standards, NGSS, state standards or the ACT Holistic Framework.

While RAD uses the OpenEd catalog to find relevant instructional content to recommend for a learner, it can work with any learning object repository (LOR) that is also tagged with the skill taxonomy used to perform item alignment.

“RAD ... can work with any learning object repository (LOR) ...”



RAD API consumers are issued keys that uniquely identify their application to RAD at runtime. This allows the solution to incorporate the configuration and customization of each learning and assessment environment.

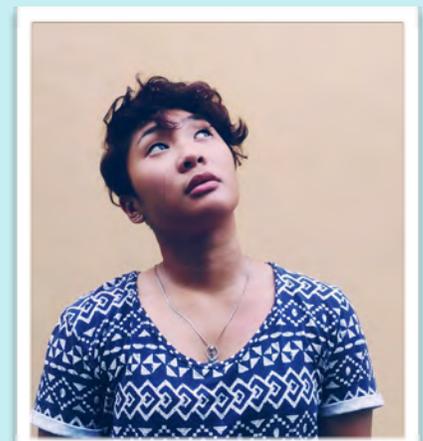
The RAD API parameters allow the users to specify both the **taxonomy** to use (i.e. skill taxonomy) and the **level** at which to provide insights and actions (e.g. subject, domain, strand, individual skill leaf).

RAD provides mechanisms that allow curators to specify/boost selected content instances at any level (i.e. prefer resource X for skill Y) .

WHAT DO I DO ABOUT IT?

Diagnosing an area that might need attention, is part one of a two part process. While RAD certainly does help predict and identify the area that a learner would benefit from review, it also takes the learner to the next logical step: **what specifically do you recommend I do for an area?**

RAD recommendations use the diagnostic profile RAD builds to then package a set of instructional resources, personalized to the specified learner, and for the given learning context of the platform. This learning context can be at any level (subject, domain, skill, etc.)



Technology

RAD API is a cloud-enabled set of methods that provide scalable compute, storage and web access

RAD API is deployed at Amazon Web Services (AWS) using industry leading services, API Gateway, Swagger API, Lambda, DynamoDB.

RAD is configured to monitor industry standard learning and assessment event data such as the IMS Global Caliper Assessment and Assessment Item Events.

RAD also uses emerging IMS standards for working with learning object repository providers via the LTI Resource Search API.

**“...industry standard ...
IMS Global Caliper
Assessment &
Assessment Item
events ...”**



RAD can consume document releases of hierarchical skill taxonomies expressed using the IMS Competencies & Academic Standards Exchange (CASE) standard.

AWS hosting provides RAD with a secure computing solution and deep monitoring and analytics capabilities using Amazon Cloudwatch, X-Ray, Athena, Data Pipeline and SageMaker and Machine Learning.

RAD implements aspects of an ACT Learning Architecture providing Recommendation Engines & Personal Learner Knowledge Graphs.

ARCHITECTURE PRINCIPLES

RAD is architected to adhere to a core set of architecture principles. They include:

- **Internet Scale:** public facing, elastic, high performance
- **Realtime Experience:** RAD minimizes delay between receiving learning and assessment events to providing up-to-date diagnostics and recommendations.
- **Micro-Service Architecture:** RAD is a non-monolithic set of targeted, modular services.



Taxonomy

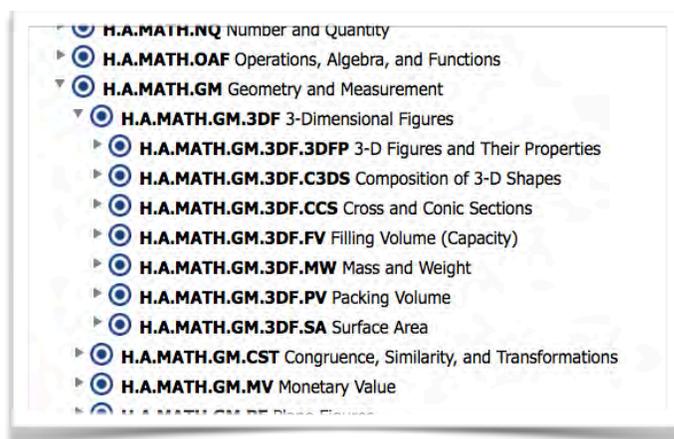
RAD connects learning & assessment evidence to instructional content via a common hierarchical skills taxonomy

RAD relies on taxonomic metadata tagging of assessment item data. These tags typically identify one or more skills that content experts determine are needed to successfully answer the item.

RAD uses the direct tag associations drawn from the taxonomy to update prior estimates of skill mastery for a learner from new evidence via a submitted set of events.

The hierarchical relationships from the taxonomy are also updated by chaining up the entries inferring mastery at multiple levels.

“... hierarchical [mastery] relationships ... are also updated by chaining up the taxonomy ...”



Over time RAD learns the difficulty of skill areas in the taxonomic set and uses that knowledge to increase accuracy in mastery ratings.

The taxonomy implemented for the RAD client (e.g. ACT Holistic Framework, Common Core State Standards, NGSS, State Standards, etc.) is typically also specified as a parameter to RAD method calls along with the required taxonomic level e.g. H.A.MATH (use all of math to report a learners diagnostics) or H.A.MATH.GM (retrieve personalized resources for a learner within Geometry).

SKILLS-BASED ASSESSMENTS

Skill based assessments are designed to measure the knowledge, skills, abilities and other characteristics (KSAOs) required for competency in a given domain. RAD tracks competency with a skills taxonomy over time for individual learners using prior estimates and updating in realtime as learning and assessment event data arrives. By also mapping the instructional content to the taxonomy, RAD can then link learners to efficacious resources that will aid in skill review.



Statistical Approach

RAD currently deploys a variation of the Elo rating system to dynamically estimate the skill of learners and difficulty of skills

The Elo rating system was originally developed for rating chess players but it can be used in learning and assessment systems when we interpret a learner's answer to an item as a match between the learner and the item.

In a nutshell, the RAD Elo implementation uses its knowledge of the difficulty of skills (as derived from a large population sample over time) and the prior estimate of learner ability for a skill area to perform an update based on whether the learner answered the item correctly or incorrectly (i.e. won or lost a 'match').

RAD's implementation also factors in overall latent variable (theta) continuous estimates in linear combination with computed Elo update calculations.



RAD maintains overall item counts as well as correct/incorrect counts at every hierarchical taxonomy level in a personal learner's knowledge graph (PLKG). These counts are used to intelligently control the rate of Elo updates over time.

“...we interpret a learner's answer..as a match between the learner and the item ...”

DIAGNOSTIC SNAPSHOTS

While RAD is optimized to maintain and provide a realtime data structure that represents the learner's up-to-date personal learner knowledge graph (PLKG), it also takes regular snapshots of the entire structure and dynamically stores them as snapshots associated with a timestamp. This historical trace enables reporting of diagnostic trends for learners over time.

```
programmingSkills(){
  .skills
  +skill('programming', '98%', '(html5 - java, ...
  +skill('planning', '88%', '(I can plan very well
  +skill('organisation', '77%', '(I am good with
  +skill('visual design', '75%', '(I am really good
  (style="margin: 0" )
  my[personal="skills"]
  .skills
  +skill('creativity', '98%', '(creative thinking
  +skill('learning', '93%', '(I would describe m
  +skill('communication', '89%', '(I understand
```

Features	ACT Academy with RAD	Original ACT Academy
Diagnostic	Network-Skills Based	Simple Ratio-Based
Provides 3-star subjective/area ratings	<input checked="" type="radio"/>	<input type="radio"/>
Tracks low-level skill mastery predictions	<input checked="" type="radio"/>	<input type="radio"/>
Provides intermedial level predictions	<input checked="" type="radio"/>	<input type="radio"/>
Tracks skill difficulty based on item data	<input checked="" type="radio"/>	<input type="radio"/>
Integrates overall ability with skill level estimates	<input checked="" type="radio"/>	<input type="radio"/>
Maintains continuous progress snapshots	<input checked="" type="radio"/>	<input type="radio"/>
Recommendations	Dynamic, Full Catalog	Fixed, Limited Set
Provides instructional resources per category	<input checked="" type="radio"/>	<input type="radio"/>
Selects resources based on skill area needs	<input checked="" type="radio"/>	<input type="radio"/>
Pulls resources from entire catalog	<input checked="" type="radio"/>	<input type="radio"/>
Allows for both automatic and curated selection	<input checked="" type="radio"/>	<input type="radio"/>
Uses deep knowledge of taxonomy relationships	<input checked="" type="radio"/>	<input type="radio"/>