

Continuity and Engagement in an Open Ecosystem: Challenges and Approaches

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Continuity and Engagement **in an Open Ecosystem:** *Challenges and Approaches*

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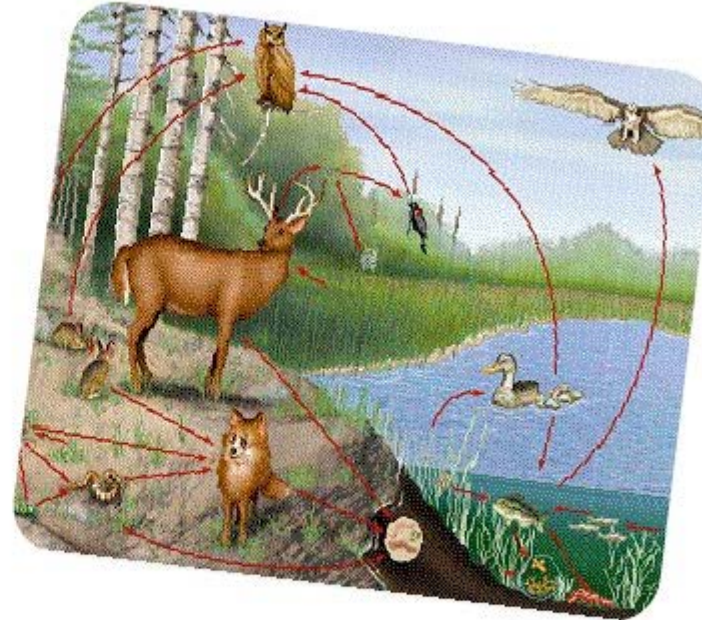
Open Ecosystems: What are they good for?

ECOSYSTEM – basic unit and probably the most important concept in ecology

Two Types of System:

1. **Open system** –
presence of inputs
and outputs (matter
and energy)

2. **Closed system** –
no exchange of
matter and energy
(usually artificially
made, e.g.
terrarium)



Except for the universe, all natural systems are OPEN!

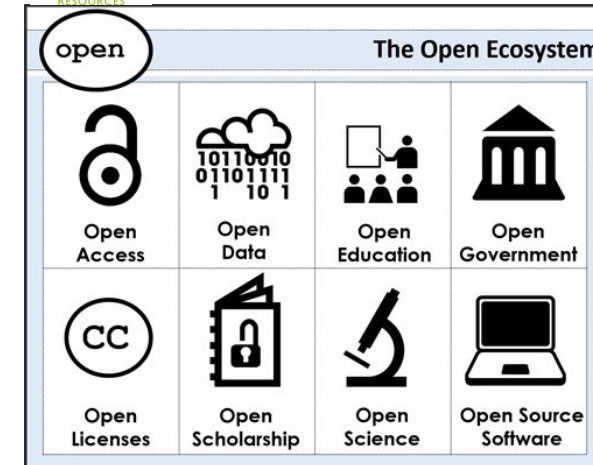
Source: Parungao, 2010: <https://www.slideshare.net/lhenparungao/lecture-1-ns-5-ecology-and-ecosystem-concepts-2010>

Open Ecosystems: What are they good for?

Benefits: Evolution

- Reproduction
 - New things (distribution)
 - Reuse
 - Reputation
- Mutation
 - Collaboration
 - Adaptation & Remixing
 - Assembly
- Competition
 - Evaluation/Ratings
 - Marketplaces

Examples



Source: clobridgeconsulting.com

Open Ecosystems: Problems

Challenges

- Continuity

- Technical I/O
- Grain size
- Semantics/data meaning
- Tone/glossaries
- Narrative flow



- Identity

- % Authorship/N-finite authors
- New vs. revised artifact



Teachers Pay Teachers

- Community Building

- Content producer incentives
- Cold start problem



WIKIPEDIA
The Free Encyclopedia

Open Ecosystems for Education/Training Content

Repositories/Marketplaces:

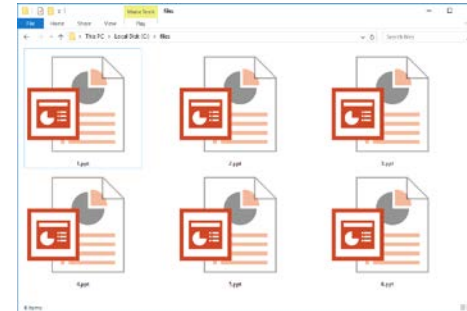
- Teachers Pay Teachers
- Open Educational Resources
- Amazon Inspire

Open Platforms

- Wiki (Wikiversity, Wikipedia, WikiEducator)
- WikiHow
- YouTube
- MOOC (EdX, Coursera, Udacity)

Registries of Links:

- Learning Registry variants
- Mason OER Metafinder
- Google search



Sequencing Resources

Not Adaptive

- **Linear:** Hand-crafted set of activities
- **Hypermedia:** Navigate through tree/links/search

Hand-Crafted Adaptive

- **Place-Out:** Skip parts by doing well (in linear/links)
- **Branching:** Hand-made if-then rules/states
- **Assignments:** Teacher assignment to class based on pace

AI/Machine Learning

- **Recommenders:** Select next problem or system
- **Problem Generators:** Injects/constructs practice exercises

Sequencing Open Resources

Benefits

- **Breadth:** Infeasible to re-invent the wheel on content
- **Running Start:** Leverage existing resources for new domain
- **Analytics:** Learn & apply empirically-effective resources
- **Varied Practice:** Deeper learning by using in multiple ways

Sequencing Open Resources

Challenges

- **Continuity:** Different terminology, activity types, goals
- **Engagement:** Maintaining “flow” when jumping around
- **Granularity:** Irregular resource size
- **External Links:** Many resources need custom “players”
- **Narrative:** Can resources be part of a broader goal/story?
- **Evaluation:** What *is* effective?

Background & Motivation



BACKSTORY

Motivating Use-Cases

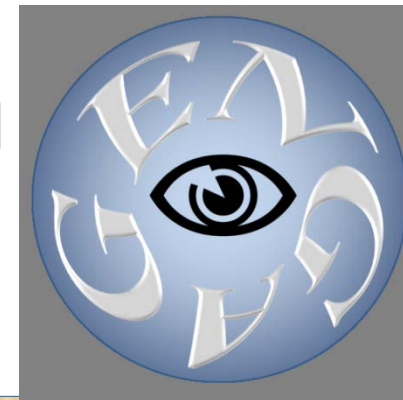
Personal Assistant for Life-Long Learning (PAL3)



GIFT Multi-Agent Architecture



Service for Measurement and Adaptation to Real-Time Engagement (SMART-E)



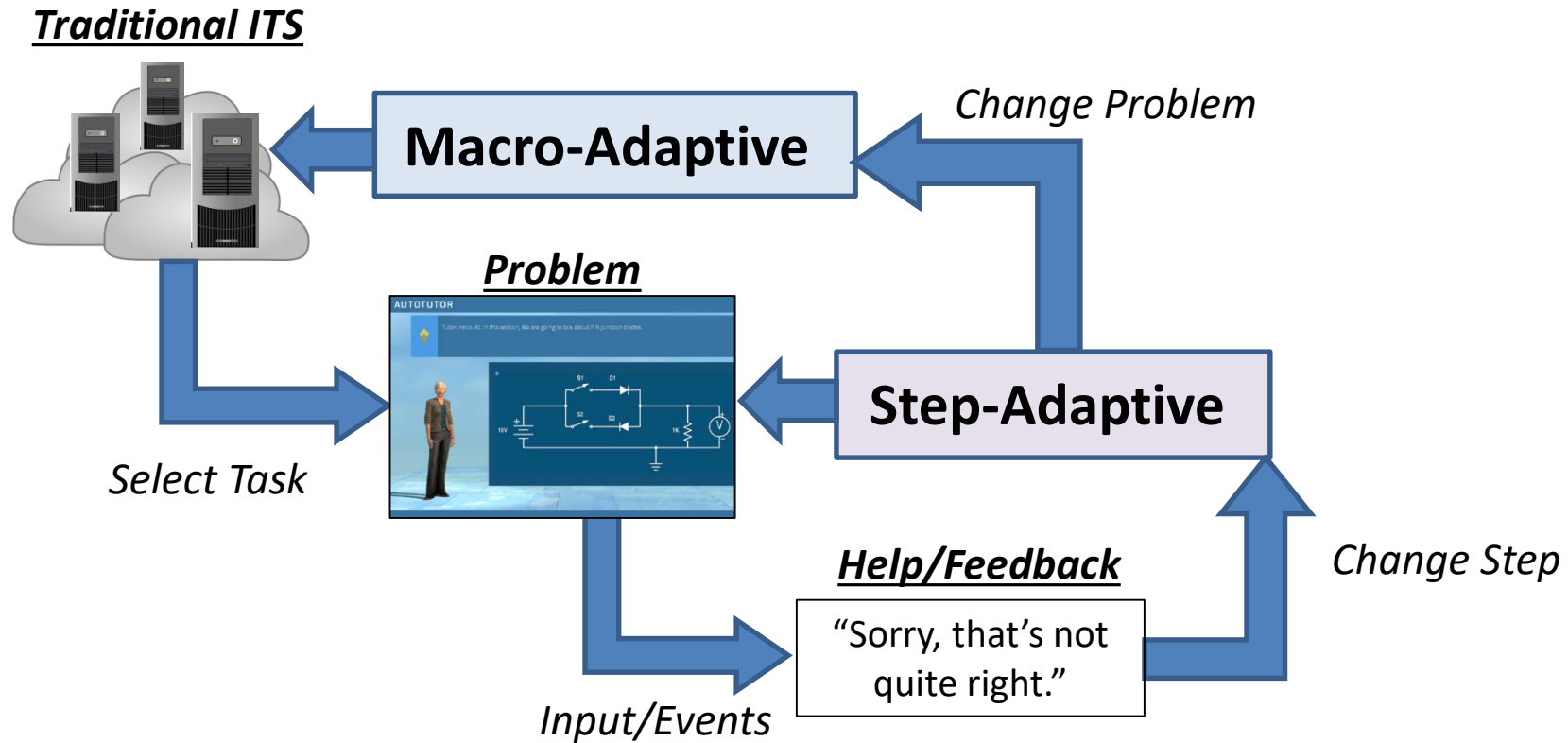
PAL3 Project Goals



A computerized personal assistant to help a learner:

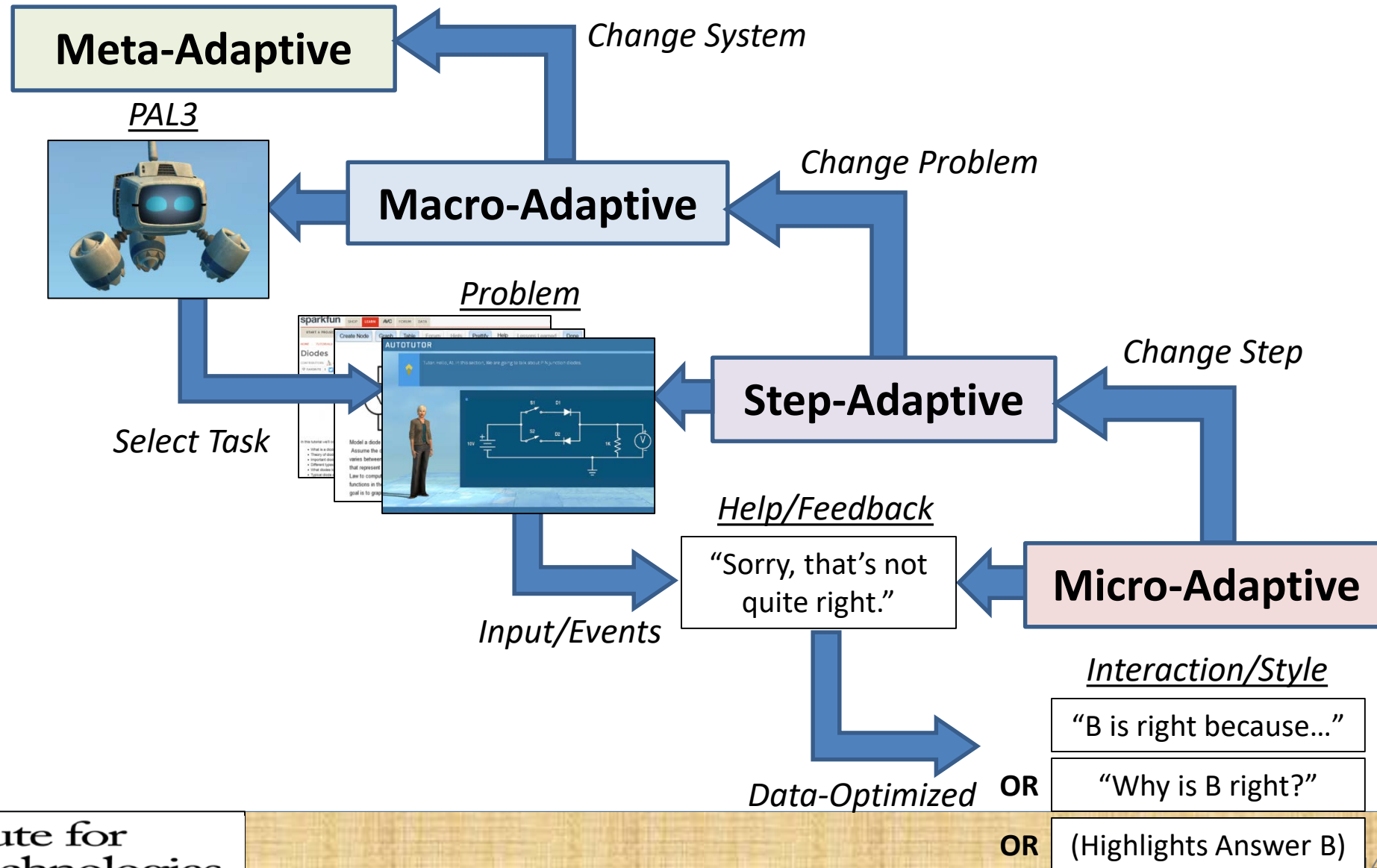
- Learn throughout their careers
- Successfully navigate career transitions
- Prevent skill decay
- Know their progress and mastery
- Adaptively find the right material at the right level
- Stay engaged: learn during free time

Traditional ITS Approach



- For 20 years, most ITS have had 2 loops...

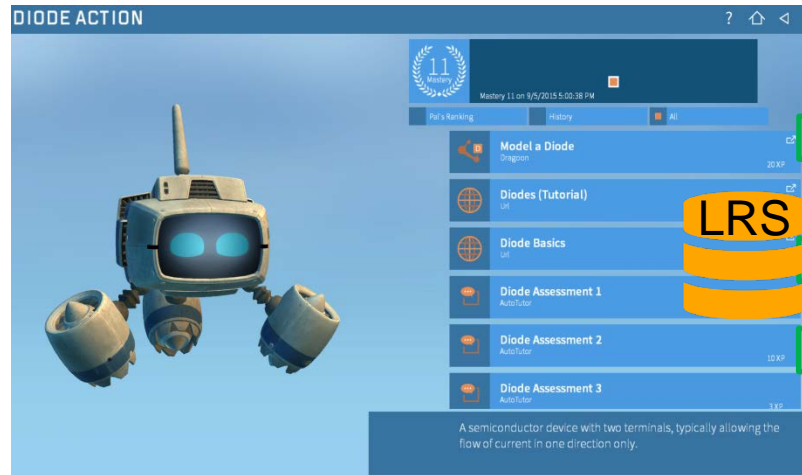
PAL3 – Four Loop Adaptivity



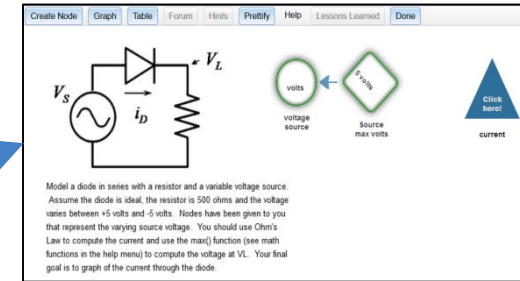
Personal Assistant for Life Long Learning (PAL3)

Personalized Recommendations

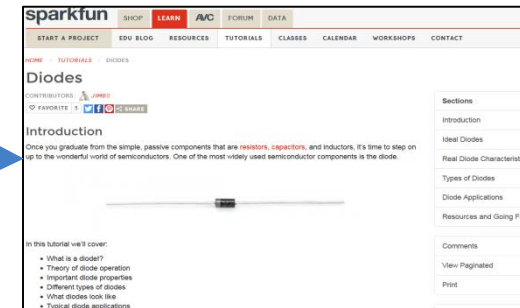
3 factors: Novelty, Exploration, Deficits



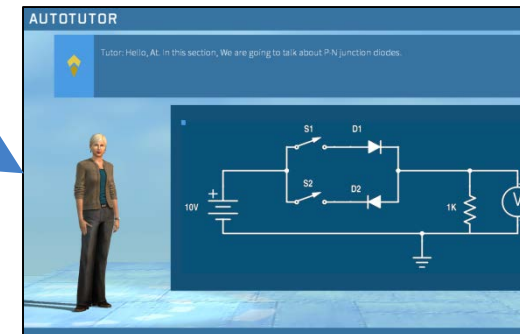
Guided Models & Simulations



Existing HTML Links & Videos



Interactive Computer Tutoring



Competitive Leaderboards

Ranking	Mastery	User
1	44	Z Z Tops
2	42	Bill Smith
3	37	Bahar Sh
4	32	At Test
5	23	Greta Stralou
6	15	Jon Wetzel
7		Amo Kharthout

Achievements to Encourage Effort



Recommender Basics

How is content modeled?

- Goals: Real-life goals a person would want to achieve
- Focus Areas: Domain areas within a goal
- Topics: Groups of skills and resources to organize learning
 - Set of Lessons
 - Set of Knowledge Components
- Knowledge Components: Skills to learn
 - Mostly in: Structure/Behavior/Function taxonomy
 - Ex. Diode Behavior in Forward Bias
- Lesson: Ways to practice/study
 - One or more resources
 - Ex. 5 multiple choice questions; 1 video; 1 AutoTutor

Recommender Basics

How are recommendations made?

- Novelty: How much this resource has been seen?
- Exploration: How open-end is the activity the user must do?
- Deficits: How much could this increase the user knowledge?

PAL3 Home Page

 HOME



John Young
Team Firebolt
Level 5
XP 322



Current Bonus:
+0 XP for resource completion
0-day streak: Earn 25 XP to increase
bonus to 1

 USER ROADMAP

 USER PROFILE

 LEADERBOARD

 SUBMIT RESOURCES



RECOMMENDED TOPICS



Diode Action
A topic you haven't worked on yet



RLC Circuits and Filters
A topic you haven't worked on yet



Tutorials for PAL3
A topic you haven't worked on yet

NOTIFICATIONS



makotrig completed 'Computer Security- Level 2'
8/16/2017 10:48:23 AM



ariajoie unlocked the Brilliance Skin by reaching level 22
8/16/2017 10:48:15 AM



cassander completed 'History and Leadership'
8/16/2017 10:47:43 AM



makotrig unlocked the Lazer Skin by reaching level 25
8/16/2017 10:47:43 AM



audy completed 'Robotic Systems 1'
8/16/2017 10:47:43 AM



lazerted completed 'Introduction to 3D Printing'
8/16/2017 10:47:43 AM

PAL3 Continuity Challenges

- **Within Resources**
 - Lexicon: Navy using different terms/conventions than college courses
 - Duration: Some resources much longer than others
 - Unfamiliar Activities: AutoTutor and Dragoon
 - Challenge Level: Harder and more open-ended resources
- **Transitions/Handoffs to Resources**
 - External Resources: Return from URL links and installed applications
 - External Adaptation: External resources, bundles, or modules
- **Metadata about Resources**
 - No KC's: Resource added w/o knowledge components being known
 - KC Override: Resource might test different KC's than registered

PAL3 Engagement Challenges

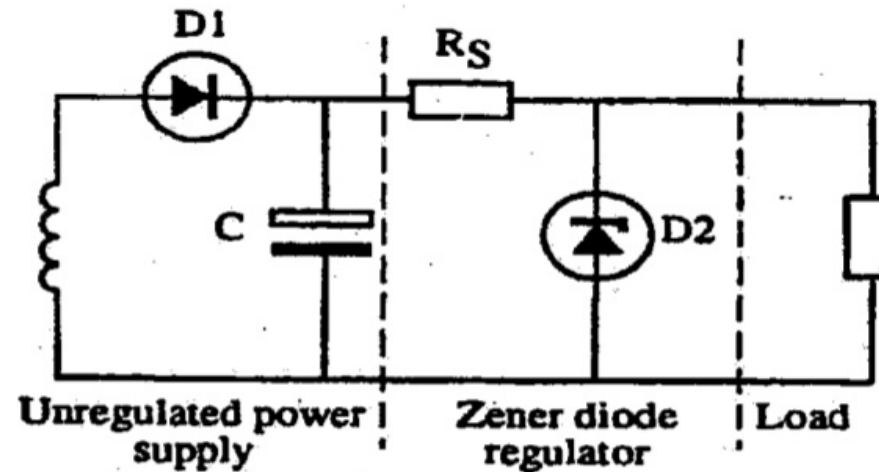
- **Trust in Recommendations**
 - Goals (Life) vs. Topics (Learning): What do I need these for?
 - Overconfidence: Didn't I already study these?
- **Social Influences**
 - Competition: Why compete if in the bottom half?
 - Activity Level: Why try if don't see others trying it?
- **Effort vs. Payoff**
 - Rewards: What do I get for working harder?
 - Effort Level: How much am I supposed to do per day?

CHALLENGES: Continuity



Challenges: Different Lexicon

- What happens to excess current?
 - Shunt
 - Dump
 - Sent to ground



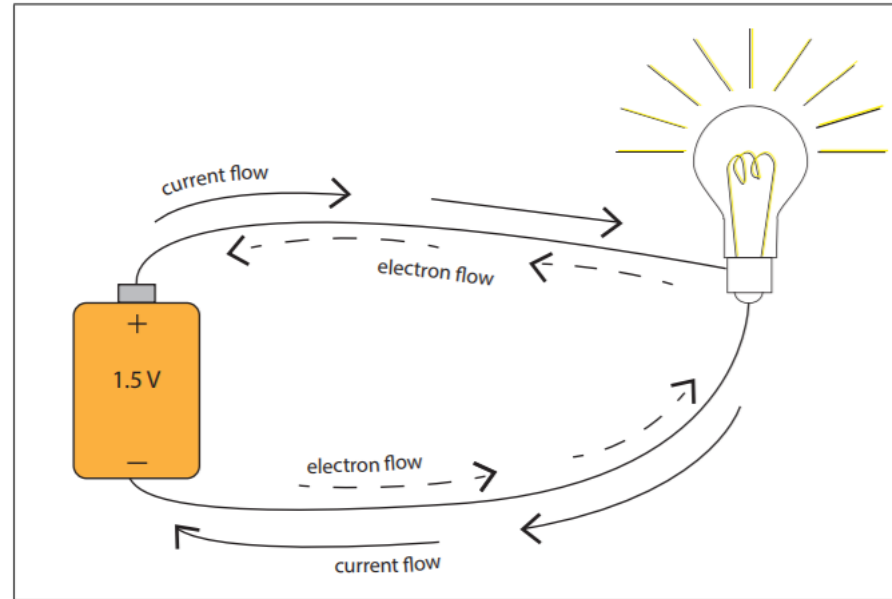
- What to do when your videos use “dump”, your text uses “sent to ground”, and your exercises use “shunt”?

Approaches: Different Lexicon

- **Canon Version:** Make derivative content w/ one set of terms
 - Pro: Simple, fairly quick
 - Con: Content becomes “dead” (no live link to others’ changes)
- **Glossary Key:** Identify key terms and hotlink to a glossary
 - Pro: Can help learners map between terms
 - Con: Need a glossary for each domain. Need to detect/highlight?
- **Cliff Notes:** Brief docs, which note alternate terms
 - Pro: Useful to have a custom doc on each core concept anyway
 - Con: More passive content. User needs to do it, or is useless.

Problem: Different Conceptualization

- Which way does *current* flow?
 - With the electrons
 - With the holes



- What to do when some resources may use a different (even opposite) concept of a key mechanism?

Approaches: Different Conceptualization

- **Canon Version:** Make derivative content w/ one set of terms
 - Pro: Simple, fairly quick
 - Con: Content becomes “dead” (no live link to others’ changes)
- **Parallel Content:** Curate content for each framework
 - Pro: Could present different content progressions, which may share some resources
 - Con: Managing twice the content

Problem: Different Granularity

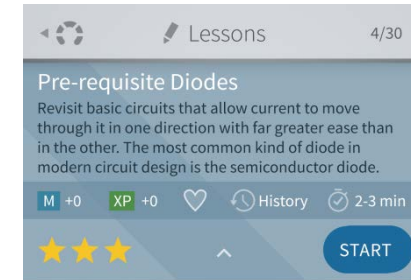
- How long will this lesson take?
 - 30 seconds
 - 3 minutes
 - 3 hours
 - 3 weeks



- What is a cutoff for expecting to return in the same session?
- How to deal with lessons with many resources in them?

Approaches: Different Granularity

- **Set Expectations:** Show expected time to finish
 - Pro: Simple to get a rough-order-estimate
 - Con: Might vary for different users
- **Max Time Cutoff:** Don't recommend too-long resources
 - Pro: User knows what to expect in a system.
 - Con: Expectations differ by platform (mobile vs. laptop vs. desktop) and context (in-class, home).
- **Differentiated UX:** Different systems, same resource bank
 - Pro: Optimize system for different users & places
 - Con: Potential for confusion between open learner models



Problem: External Adaptive Systems

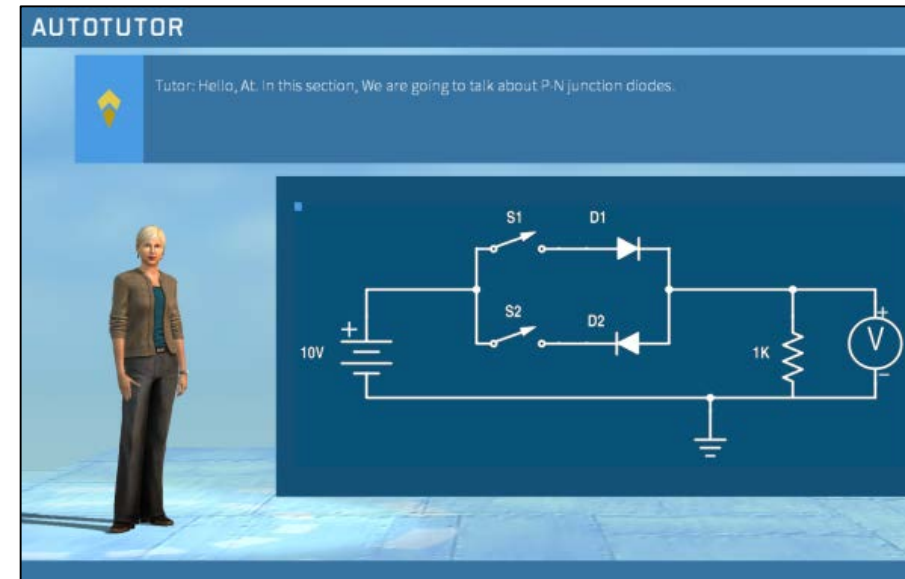
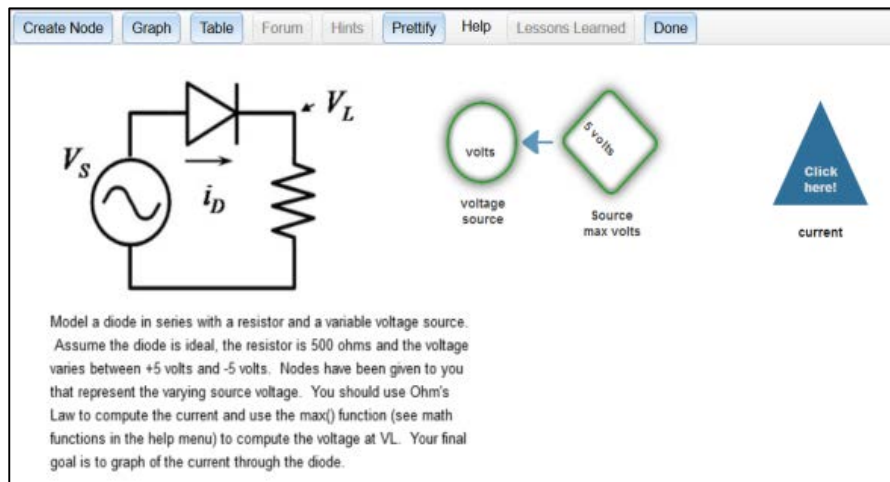
- What happens when we hand off to an external system?
 - 1 resource completed
 - N resources completed
 - ??? resources completed
 - 1 course completed
- How to deal with lessons with many resources in them?
- When should we wait for user to “finish” using an external system before recommending new things?

Approaches: External Adaptive Systems

- **Bundle Resource:** Wait for special resource to “Complete”
 - Pro: External system can send many records before/after special one
 - Con: User will need to “Abort” to return, if special incomplete.
- **No Return:** Pool LRS records, but don’t wait for return
 - Pro: Allows asynchronous use of both systems
 - Con: Systems will look (and be) uncoordinated
- **Explicit Handoff:** External resource sends user back to source
 - Pro: Bidirectional coordination and referral (e.g., to resources)
 - Con: Stronger coupling and coordination required

Problem: Unfamiliar/Hard Activities

- What if some learning activities are novel (or exotic, even)?



- What if learners get confused? What if some

Approaches: Unfamiliar Activities

- **Tutorials:** Send users to tutorials before they hit new things
 - Pro: Most new resources can be understood in 2-3 minutes.
 - Con: Users are averse to general tutorials, so might need topic-specific ones. Users might skip tutorials.
- **Emulate Familiar:** Make new tasks feel like familiar ones
 - Pro: If done well, can result in better overall user experience
 - Con: Requires custom development per resource type. Only works if resource backend is distinct from its front end.
- **Alert/Warning:** Alert user that resource may be new or hard
 - Pro: Fairly simple to do. Sets expectations.
 - Con: Doesn't actually make resource easier

Challenges: Partial KC Info

- What knowledge does this simulation test?
 - Takeoff
 - Landing
 - ... (it depends)

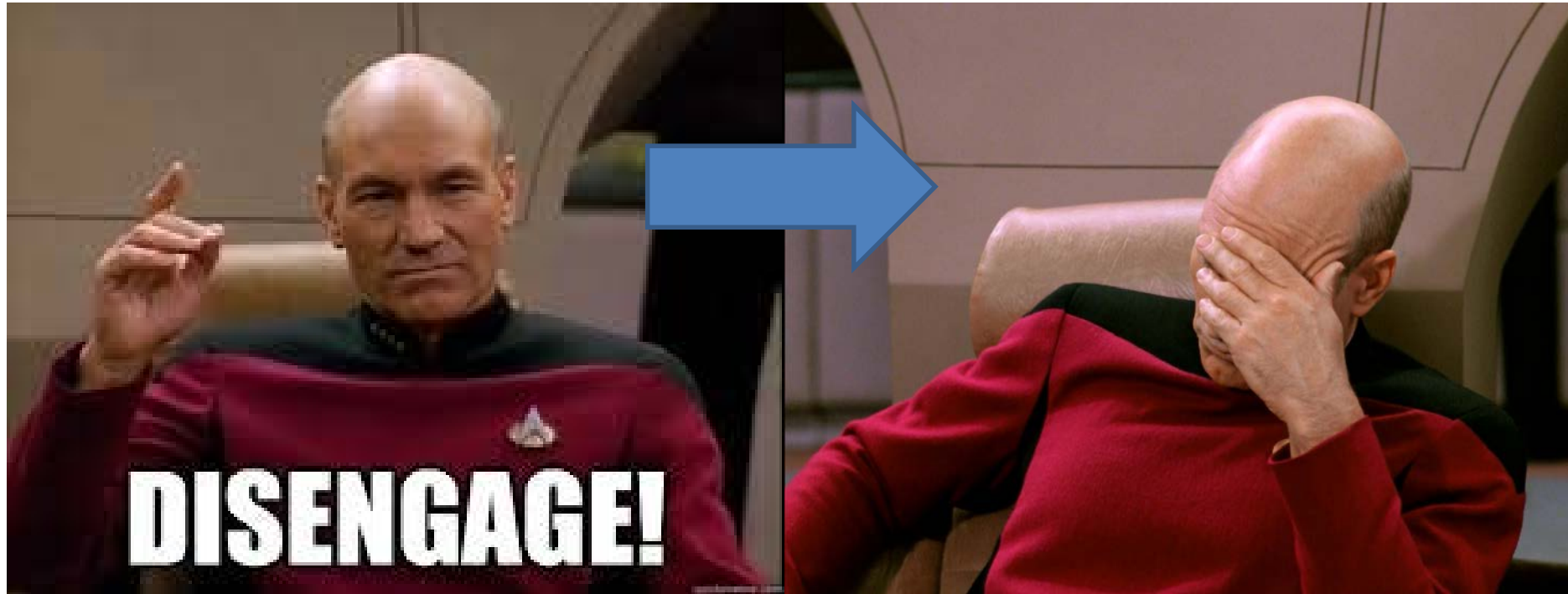


- What happens if someone adding a resource doesn't know its KC's?
- What happens if a resource tests different KC's depending on the user's decisions during it?

Approaches: Partial KC Info

- **Register w/o KC's:** Allow adding and use, even w/o KC's
 - Pro: Allows layman instructors to add content.
 - Con: System has no idea when to recommend it or what it tests/helps
- **KC Override:** Allow external systems to override KC's tested
 - Pro: Resource creator should know what it tests best
 - Con: What if system sends an unknown KC? (Or all unknown KC's?)
Also, no standard way to send this. Using xAPI extension, currently.

CHALLENGES: Engagement



Challenges: Trust in Recommendations

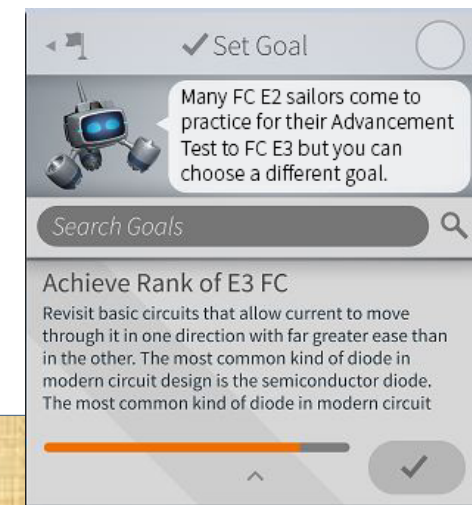
- Why was this topic selected for me?



- What if I feel like I know this already?

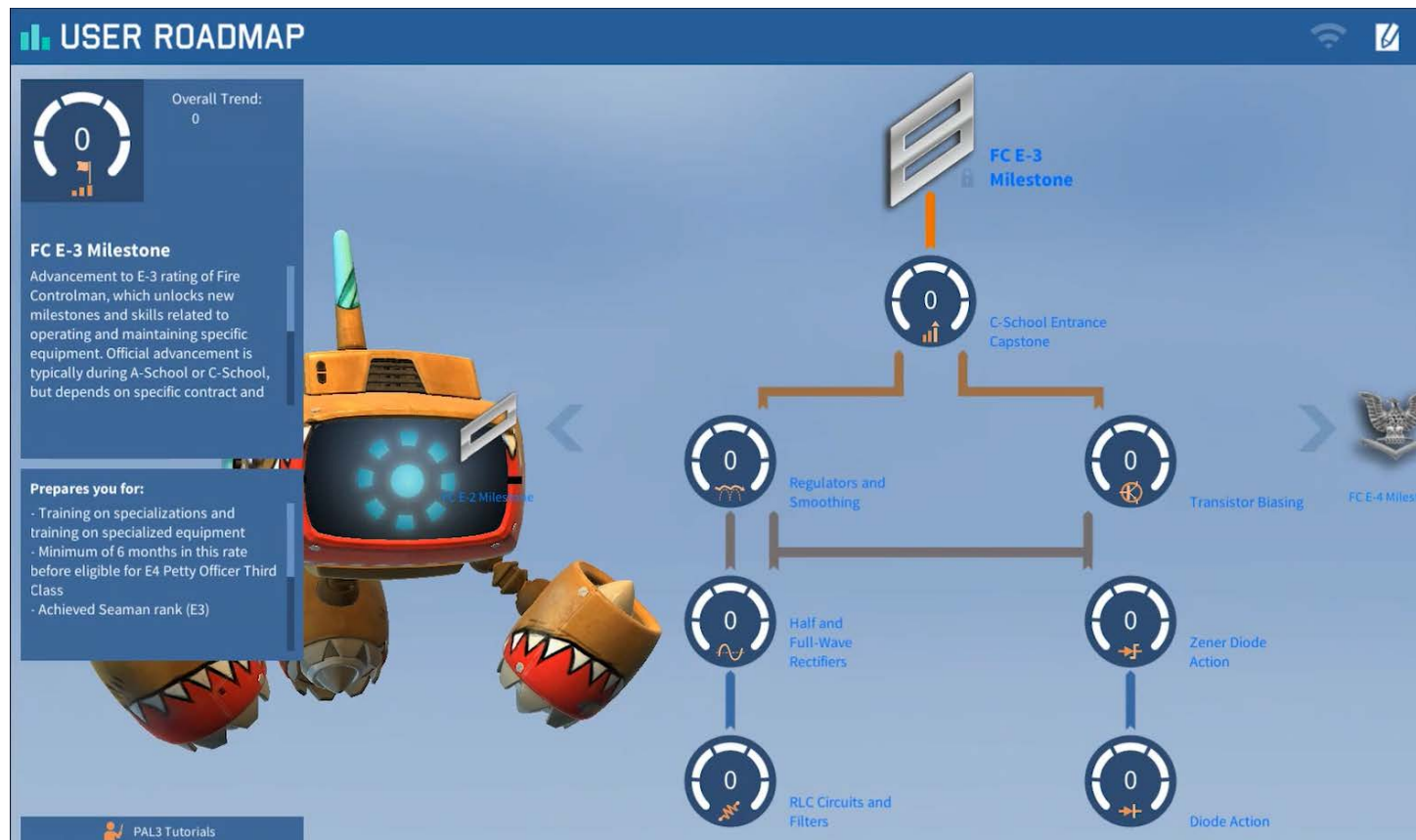
Approaches: Trust in Recommendations

- **Pretest/Placement Test:** Comprehensive test upfront
 - Pro: Creates uncertainty and impasses->more ready to learn
 - Con: Barrier to getting started on learning immediately
- **Explainable AI:** Annotate recommendations w/ descriptions
 - Pro: Gives context about the resource
 - Con: Only usable with some types of recommender models. Reason for recommending may be not be useful to communicate (i.e., “You don’t know what the word ‘transitive’ means.”).



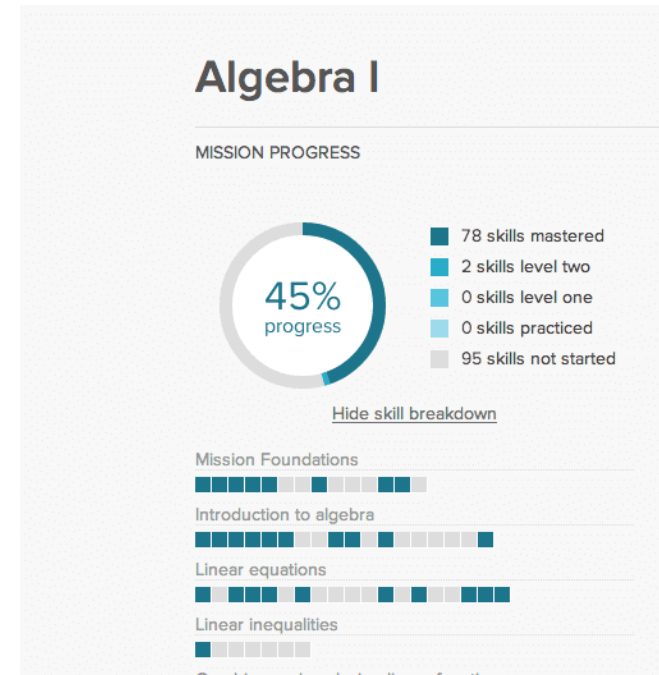
Approaches: Trust in Recommendations

- **Roadmap:** Show “skill tree” of how learning builds to goal
 - Pro: Open learner model. Connect to authentic goal
 - Con: Non-trivial to lay out automatically



Approaches: Trust in Recommendations

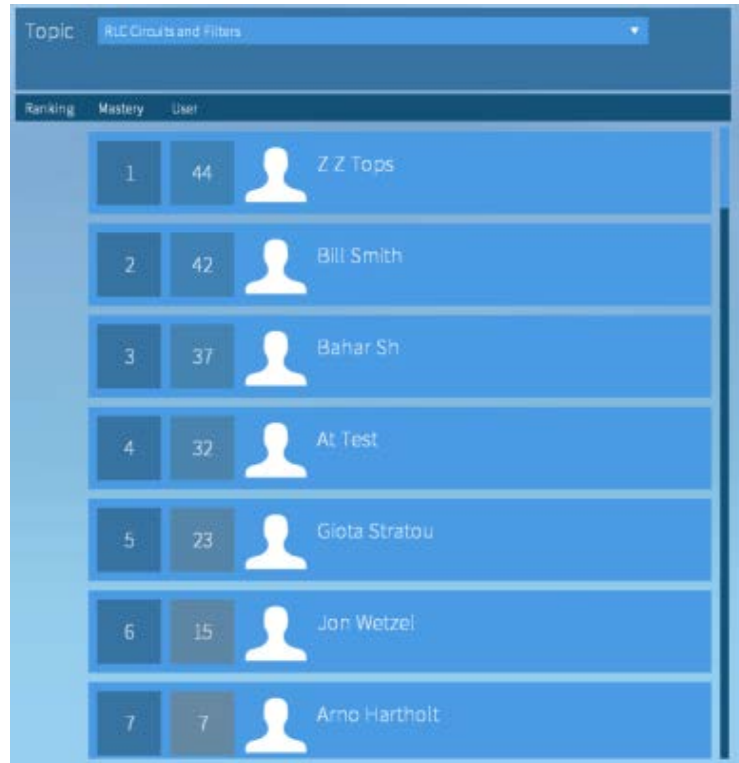
- **Goal Readiness:** Estimate of preparation for a real-life goal
 - Pro: Not a reward, but an indicator of authentic progress
 - Con: Hard to calibrate without real data on the goal. Just because you are ready for a goal doesn't mean you will accomplish it.



Khan Academy

Challenges: Competition as Motivation

- What if I am not near the top of a leaderboard?



A screenshot of a digital leaderboard interface. At the top, there is a dropdown menu labeled 'Topic' with the selected value 'RLC Circuits and Filters'. Below this, the leaderboard is presented as a table with three columns: 'Ranking', 'Mastery', and 'User'. The table lists seven users, each with a corresponding ranking number, mastery score, and a generic user icon. The users are ordered from highest to lowest mastery score.

Ranking	Mastery	User
1	44	Z Z Tops
2	42	Bill Smith
3	37	Bahar Sh
4	32	At Test
5	23	Giota Stratou
6	15	Jon Wetzel
7	7	Arno Hartholt

- Who cares about the difference between 50th and 45th?
- What if I am embarrassed about my position?

Approaches: Competitive Motivation

- **Show Top-N:** Don't show the whole group, only the top
 - Pro: Reduces risk of feeling highlighted if doing poorly
 - Con: Somewhat complex to implement with varied class sizes
- **Teams:** Group learners and compete/cooperate as teams
 - Pro: Lowest learners can add to team scores more quickly. Team standings make for good notifications/activity.
 - Con: Need a way to re-form teams if people drop out/disengage

LEADERBOARD			
Topic: Diode Action			
Group: Individual Team			
Rank	Mastery		Change
1	78	John Barry Team Shark	—
2	71	Mako Trigg Team Gladiator	—
3	54	Grace Hopper Team Second	—
4	52	John Young Team Firebolt	—
5	43	Isaac Hull Team Firebolt	—

NOTIFICATIONS	
	Rick Sanchez completed Diode Action, Diode Resistor Circuit Cliff Notes increasing mastery to 10 and gained 5 experience points 3/5/2017 7:34:22 PM
	Rick Sanchez completed Diode Action, Diodes (Tutorial) increasing mastery to 10 and gained 5 experience points 3/5/2017 7:46:16 PM
	Mark earned the achievement Crawl, Walk, Run 3/3/2017 5:14:29 PM

Challenges: Gamification/Rewards

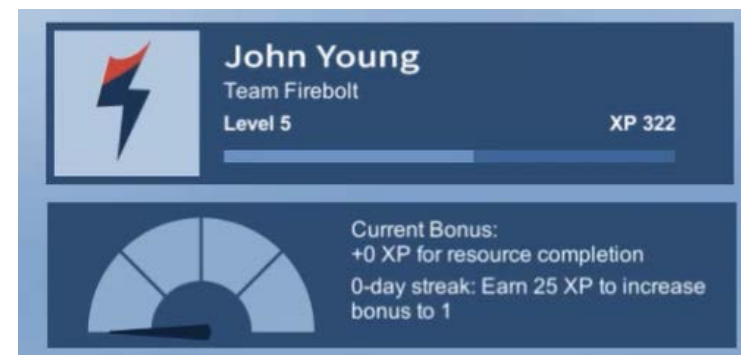
- Risks of Gamification: What is measured = what is done.



- How to ensure that rewards are aligned to learning goals?

Approaches: Gamification/Rewards

- **Mastery Points:** Open learner model is a core metric
 - Pro: Total alignment to learning process.
 - Con: Yolked to open learner model. Can decrease.
- **Effort Points:** Reward time on challenging tasks
 - Pro: Increases with effort, even if struggling. Can use for level-ups.
 - Con: Can lead to gaming the system for points



APPROACH: Personal Assistant



Hi! I'm Flal!

PAL3 Design Criteria

System Guidelines

1. Engage user.
2. Be an efficient use of user's time.
3. Guide user to what they need to focus on.
4. User must believe system is helping.
5. Reward user for using the system.
6. Provide user with an overview of their own learning.
7. Provide a variety of motivations to the user.

Pal Character Design Criteria

Design Guidelines – 5 Laws of Pal

1. Pal shall not get in the way of the user.
2. Pal shall be like the perfect butler.
3. Pal shall do things that are difficult for the on-screen GUI to achieve.
4. Pal shall reflect the user.
5. Pal shall create a desire to return to the system.

Pal Character Roles

- **Goal-Monitoring:** Setting and tracking progress toward goal
 - Pro: Use dialog to connect completing lessons -> mastering topics -> achieving goals. Help to set new goals when done.
 - Con: Since goal is in real-life, can't see status of other factors
- **Support:** Positive messages for struggling users, growth mindset messages, etc.
 - Pro: Improve relationship & engagement for struggling learners
 - Con: Potential to be too “saccharine” for some users

Pal Character Roles

- **Contextual Info:** Data on “users like you” or on-screen elements that would be hard to show on UI always
 - Pro: Useful for explainable AI and connecting effort to goals
 - Con: Data hungry, prioritization requires solid dialog management
- **Quotables:** Snark, inspiration, or other flavor text to enjoy
 - Pro: Breaks up a session, sometimes memorable
 - Con: Users respond very differently to different quotables

Goal Setting Stages

- People set goals for at different time scales:
 - Long-Term (years):
 - Decisions: Who you are / Why you do it / Identity
 - Pathway Choice: Career Choice, Selecting a Rate
 - Medium-Term (weeks):
 - Decisions: How to reach a long-term goal
 - Milestone Choice: Role, Certification, Degree, Position/Rank
 - Short-Term (days):
 - Decision Made: What to do to reach a milestone
 - Topic Choice: What skills to build, What to study

Goal-Setting Criteria

Interests: How much do they want it?

- Infer from: Self-report, Rating tasks, etc.
- Importance: Self-initiative; Retainment

Skills: How prepared are they?

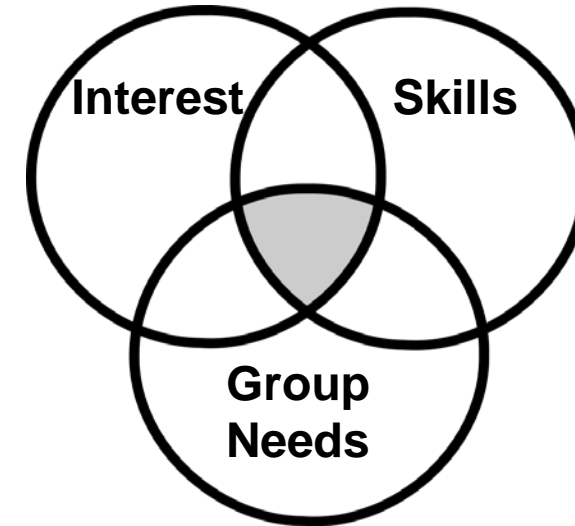
- Infer from: Learning records, Assessments (e.g. ASVAB)
- Importance: Time to train; Likelihood to reach criteria

Needs: How much do others need it?

- Infer from: Unmet demand (e.g., projected unfilled posts)
- Importance: Force readiness; Ready relevant learning

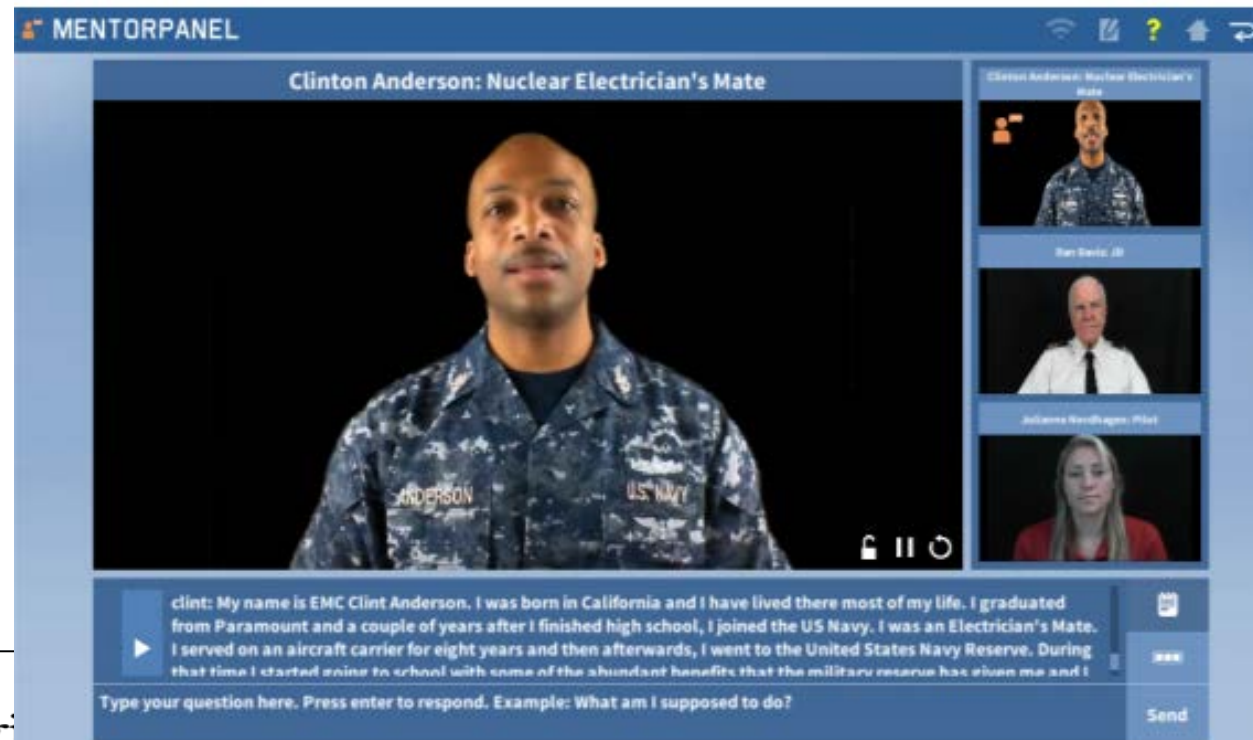
* Multiplicative: Only as good as the weakest link

Note: Not all of these are suitable for a character like Pal



MentorPal: Considering Career Paths

- Virtual Mentors in PAL3
 - Interactive Q&A w/ virtual mentors (one-on-one or panel)
 - Individual experiences, not a generic “career guide”
 - Realistic open-ended 5m-20m dialog
 - Compare answers from multiple mentors (MentorPal)



WRAP UP: General Strategies



General Strategies: Continuity for Resources

- **Moderated Resources:** Open resources but with moderation/curation that ensures areas with canonical language and shared user experiences (e.g., similar activities)
- **Annotated Resources:** Show information to help decide to use recommended resource (time, activity, content)
- **Lesson vs. Module:** Wait and acknowledge user return for lessons, but assume asynchronous use for large modules

General Strategies: Engagement

- **Effort->Mastery->Goals:** Establish clear paths between effort on resources to mastery, and from mastery to their goals
- **Social/Competition:** Collaboration can be more powerful than competition. Teams of learners help bridge the two.
- **Rewards:** Weaker than motivation for goal-achievement and social ties. Useful for setting expectations for time-on-task.
- **Guides/Assistants:** Provide continuity for learning over time (e.g., “Welcome back”). Can use to message/reinforce productive mindsets. Challenging due to different user prefs.

Questions & Discussion

