



IITSEC 2024



Learning Engineering Competency Based Experiential Learning In Military Institutional Training

Kevin Owens*, Lisa Townsend**, Dr. Ben Goldberg**, Dr. Jared Abrams*, Dr. Gordon Cooke***

*Applied Research Laboratories: The University of Texas at Austin (UARC)

**DEVCOM Soldier Center – Simulation and Training Technology Center

***US Military Academy, Department of Military Instruction



NTSA



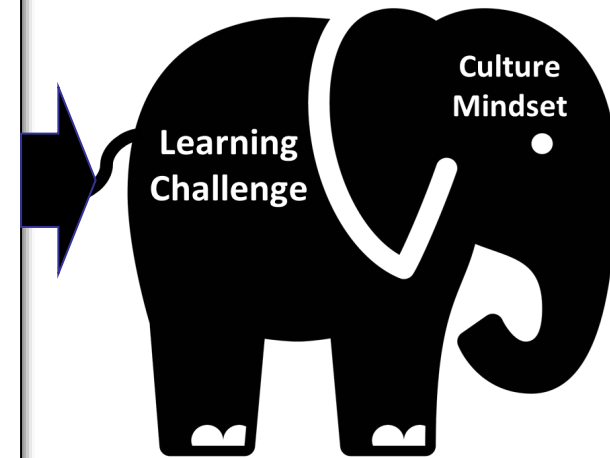
The Learning Challenge “Elephant”

Current Traditional / Legacy Industrial Instruction Model



Results:

- **50% of Army Institutional Training FAILS to transfer to a unit's daily activities/training**
 - 40% of Army institutional training is LOST immediately after training [ref 1]
 - 70% of Army institutional training is LOST ~1-year after training [ref 1]
 - Supports separate US Navy research
- **2.1 mil US HS dropouts** (2022)
 - 81% of HS dropouts* said there should be **more opportunities for real-world learning and more experiential learning** [ref 2]
 - They want to see connection between what they learn and getting a good job [ref 3]



WE NEED TO CHANGE THIS!
(Culture/Paradigm Problem)

*Sample: 467 ethnically / racially diverse high school dropouts, ages 16-25, from 25 different large cities, suburbs and small towns

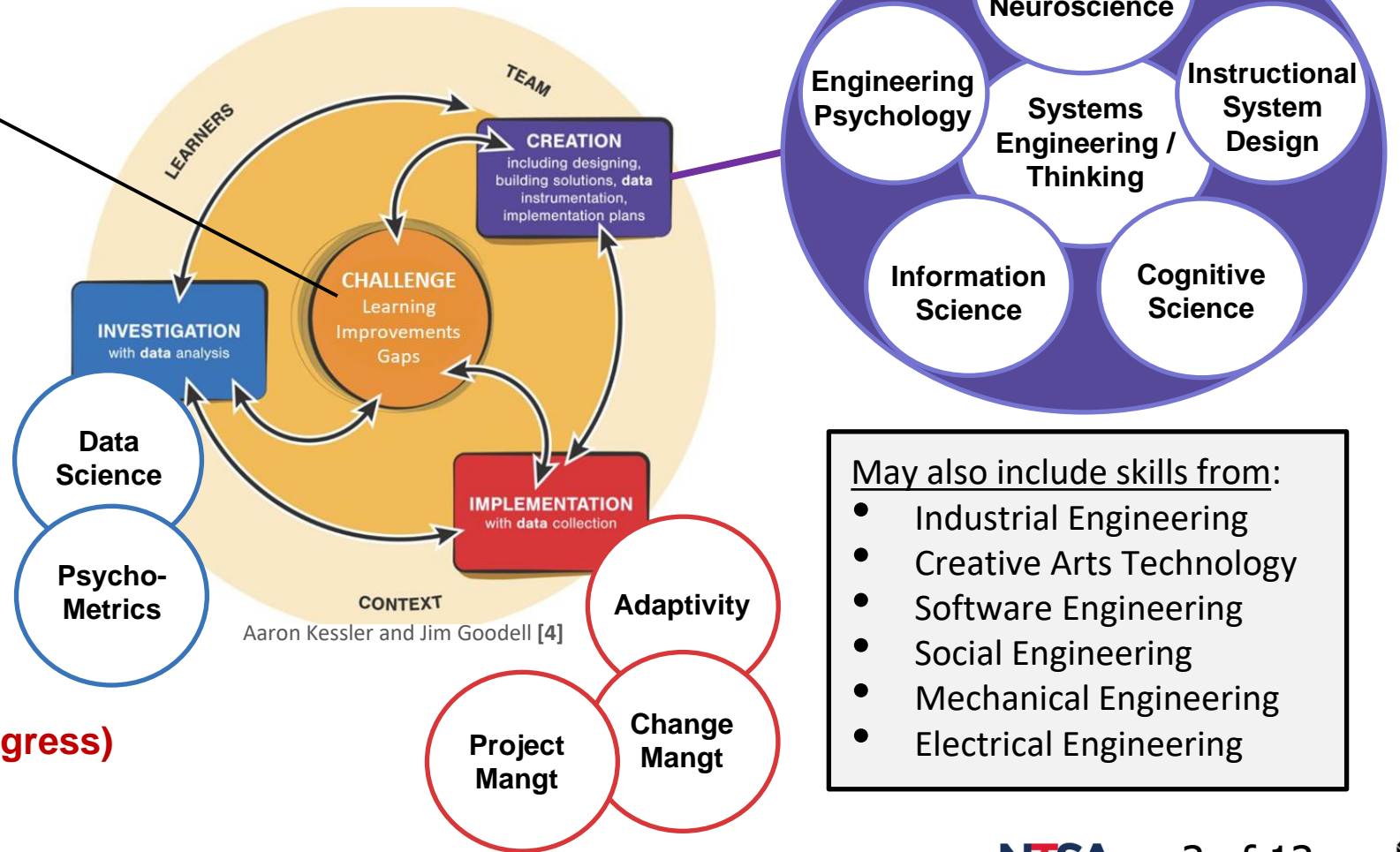
Learning Engineering Process (in Military/Govt)

“Learning engineering is concerned with solving [learning challenges] that teachers, curriculum designers, and textbook publishers are not asked to solve” [ref 4]

Military/Government Learning Engineering: Seems best aligned with training/education related science and technology research (S&T); that transitions into future or active training system acquisition or institutional curriculum programs after evaluation:

- [Technology Readiness Level scales...](#)
- [Human Readiness Level scales...](#)
- [Learning Readiness Level scales \(in progress\)](#)

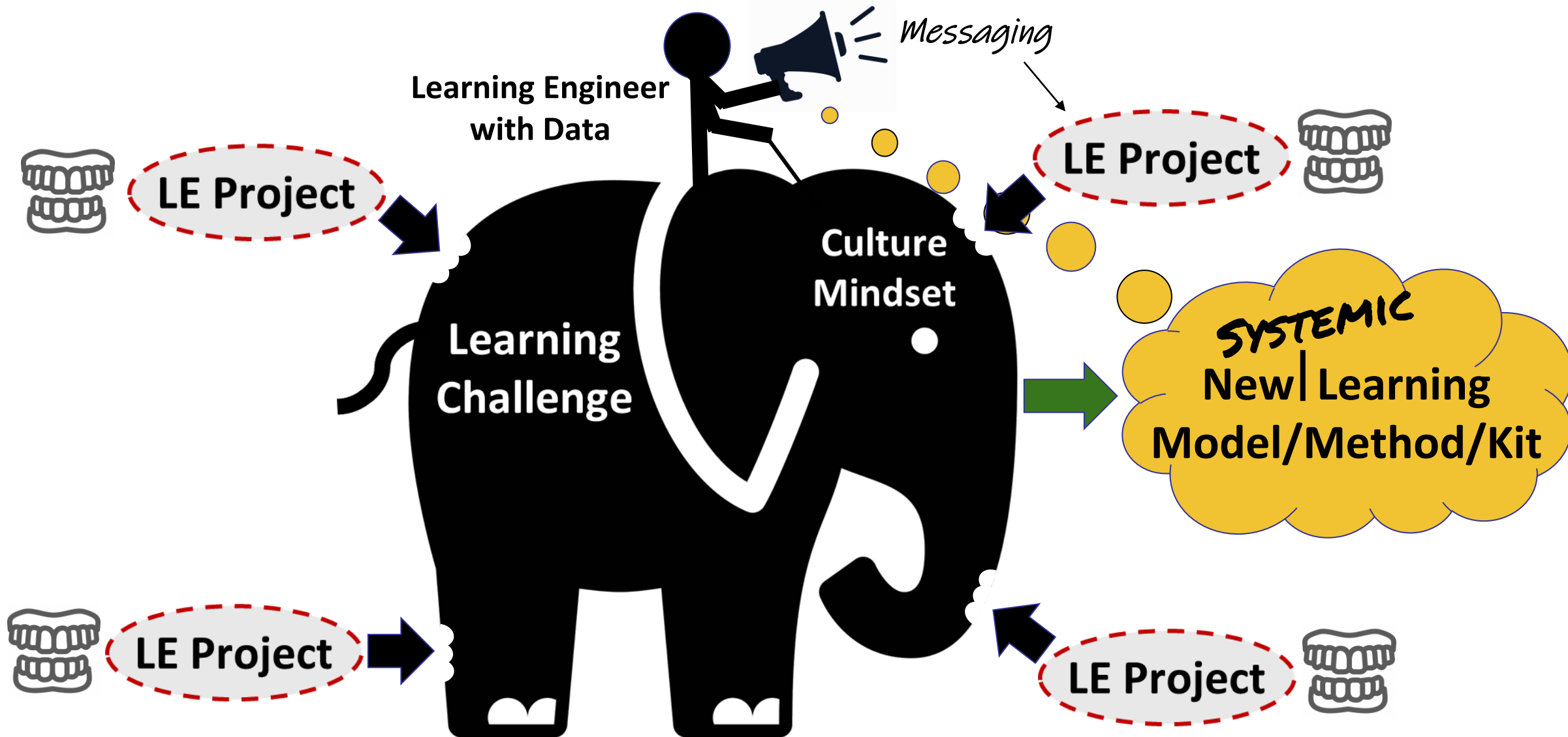
Learning Engineering Requires Multidisciplinary Domains/Skills



- May also include skills from:
- Industrial Engineering
 - Creative Arts Technology
 - Software Engineering
 - Social Engineering
 - Mechanical Engineering
 - Electrical Engineering



Solving Learning Challenges "One Bite at a Time"



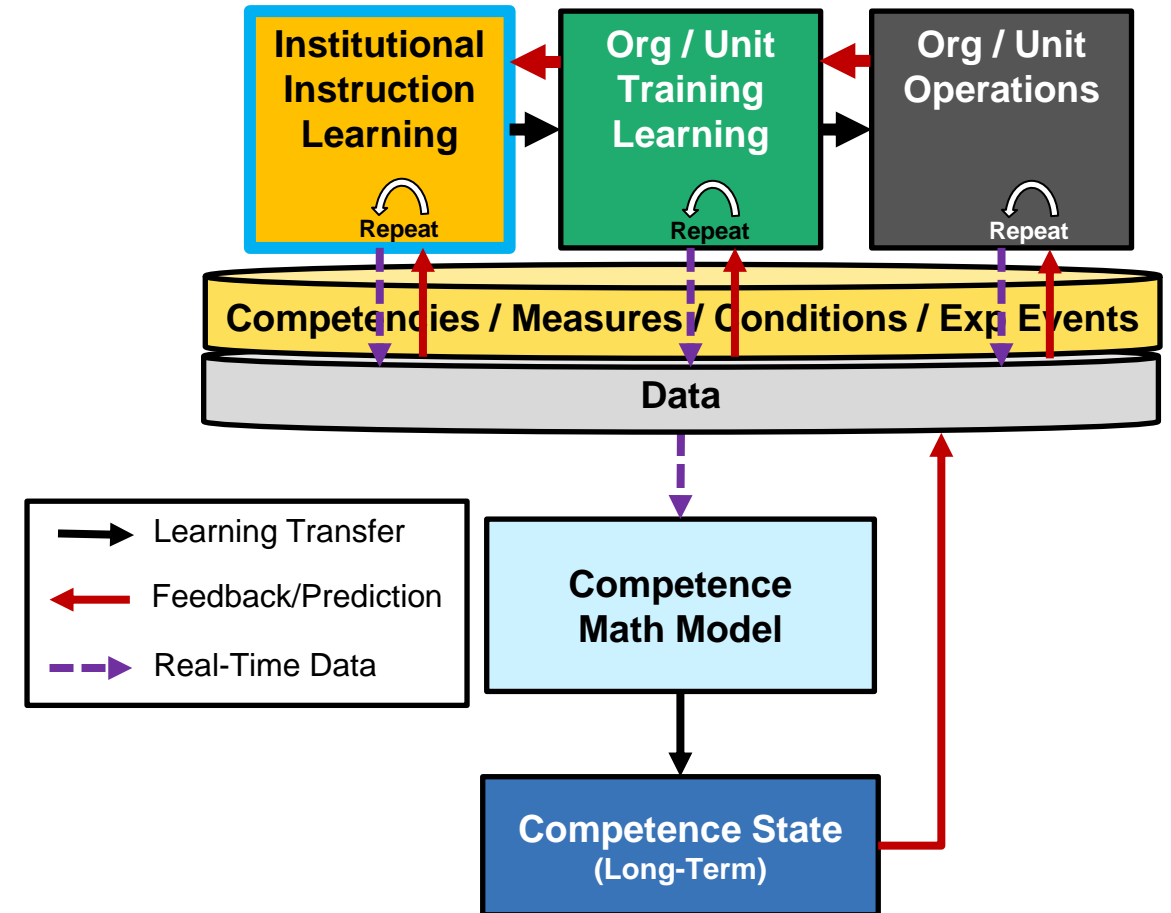
Learning Science: Improve Learning Transfer & Competence

Learning transfer is maximized when training includes... [refs 6, 7, 8, 9]

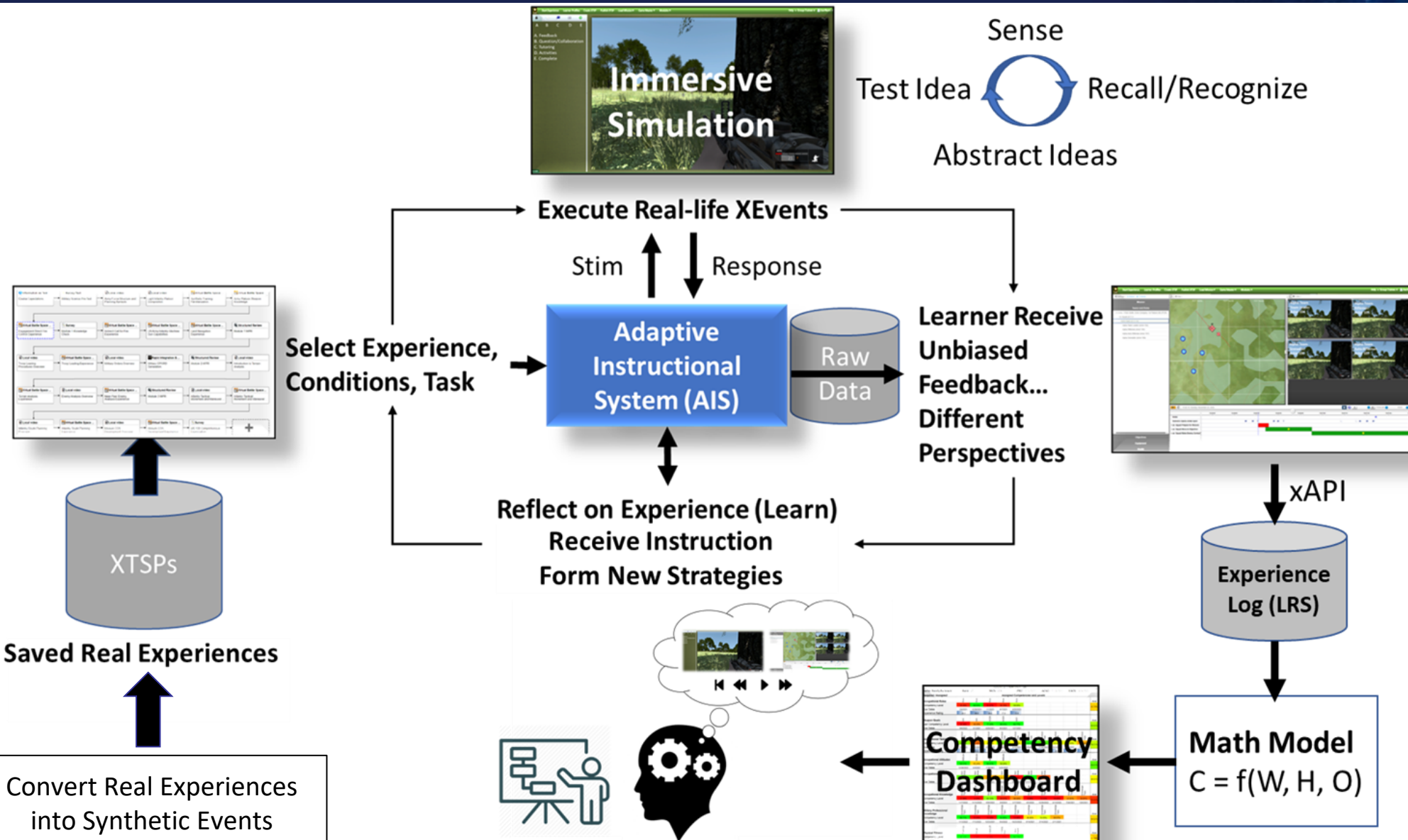
- Immersive modalities that match later work env.
- Latest best practices, capabilities, tools/systems.
- Non predictive variable conditions and situations.
- Difficulty just above learner competence state.
- Learning resources to “pull-up” while doing task.
- Data informed feedback / outside perspectives.
- Sufficient time/opportunity for reflection.
- Spaced retrieval/practice (days/weeks/months).
- Receiving organization that apply/test training

will test learning quality and provide feedback

Macro Competency Building Concept [ref 10]

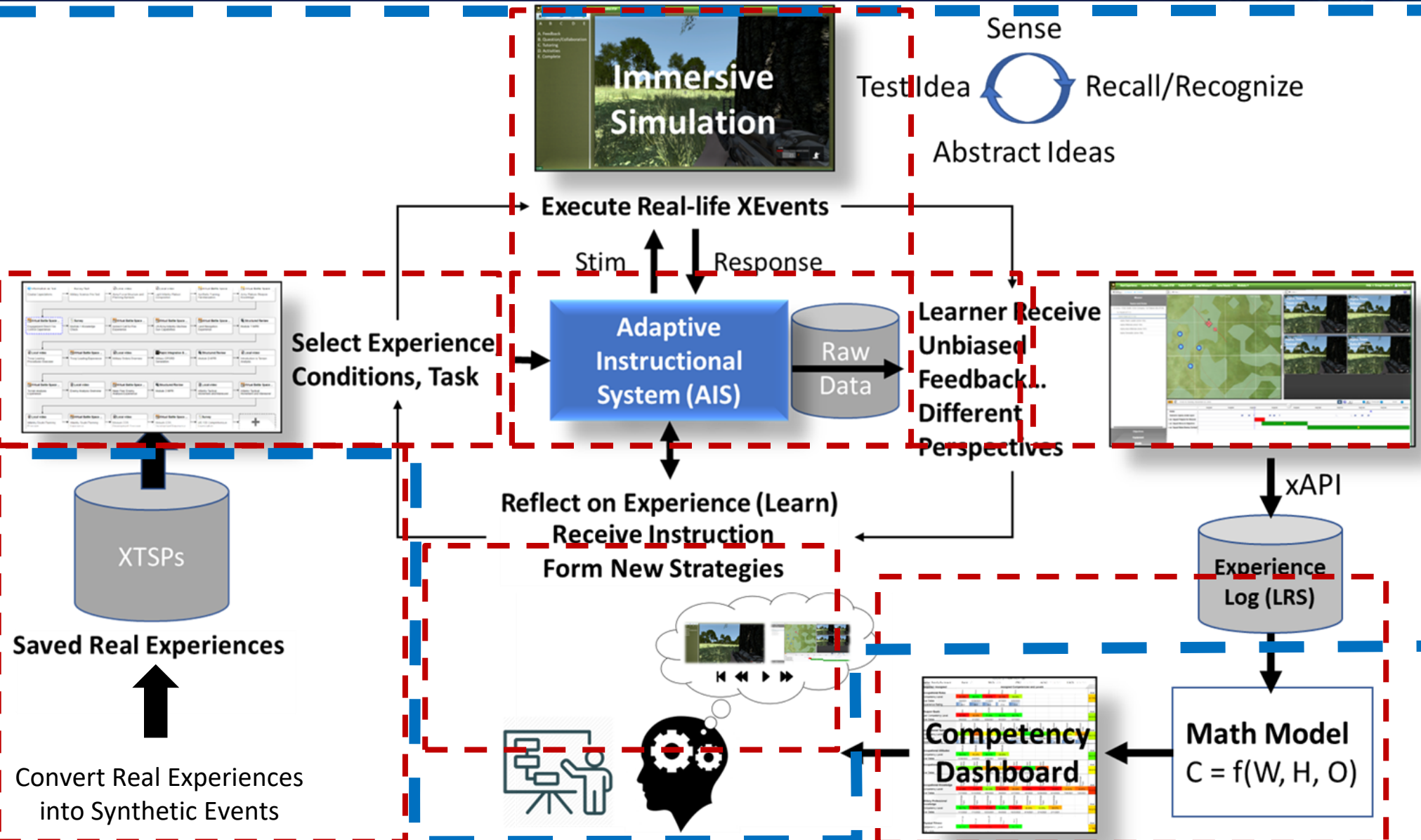


The Model: Competency-Based Experiential Learning



This model is based on the US Army DEVCOM SC, STTC “Synthetic Training Environment Experiential Learning for Readiness” (STEEL-R) Learning Engineering Project (2020-2023) [refs 10, 11,12,13]

The "Bites": Competency-Based Experiential Learning



Our Project
(In an Institutional Environment)

LE "Bites"



Our Learning Engineering Investigation

Learner Persona Analysis:

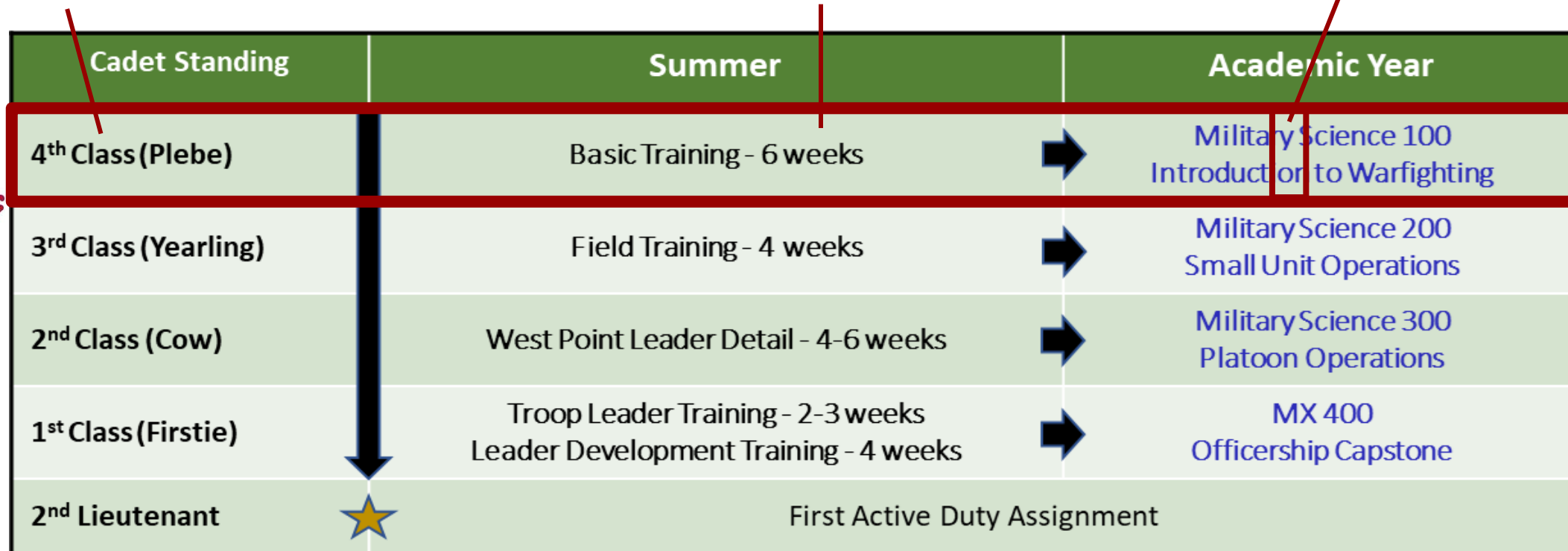
- Some right out of HS (some JROTC)
- Some prior enlisted
- Some mostly interested in Mil. Science
- Some less interested in Mil. Science

Existing Knowledge/Skill Analysis:

- Review prior “Basic Land Navigation” training outcomes (no data)
- Review prior year tests
- Plan for pre-test

Subject Domain Analysis:

- Land Navigation* (a core competency for many other simpler competencies).
- 75 minutes for experience/AAR



* Initially... to test/refine methods, tech' and new content design

Only two “sections” (classes) - a treatment & control .

Later multiple sections

US Military Academy - Department of Military Instruction (DMI):
29-38 sections per academic semester (varies by on course/year)
18-20 Cadets per “section” (class)

Designing a Simulated Experience / Events

Needs to Replicate Real Tools/Terrain/Activities Cadets Will Use in Future Live Events

Land Navigation Experience Event

WEST POINT, NEW YORK, UNITED STATES MILITARY ACADEMY

Plot MGRS coordinates on a map

Mission: Move to Rally Point Raven @ 18T WL78657845

Be there by 2315Z

Screen Video
Player Audio
Player/Game-Engine
Event Data

Adaptive Instructional System (AIS)

- Real-time Prompts
- Scenario-Changes
- Help
- xAPI outputs

Design same tools, conditions and limitations Cadets will have in-the-field

CBEL Data to Collect and Analyze

Timestamped Learner and Stimulus Game Engine Event Activity Data

	realEngTime	engActTime	realActTime	engAction	actor	target	result	shotProj	hitLat	hitLon	hitDir	hitElev	hitRelDir	hitZone	hitDmg	totalDmg	sho
0	2/19/2024 15:16	38.60400009	15:17:26	TgtShotAt	blufor1Team1	opfor_Team1Tgt2		tracer_red.p3d									
1	2/19/2024 15:16	38.63500214	15:17:26	ShotHit	blufor1Team1Gunner	opfor_Team1Tgt2	hit	tracer_red.p3d	31.18881	-97.657	356.0077915	-17.25987983	314.0727974				
2	2/19/2024 15:16	38.63500214	15:17:26	TgtShotAt	blufor1Team1	opfor_Team1Tgt2		tracer_red.p3d									
3	2/19/2024 15:16	38.67500305	15:17:26	TgtHit		opfor_Team1Tgt2								hull	0.059452221	0.059452221	
4	2/19/2024 15:16	38.67500305	15:17:26	ShotHit	blufor1Team1Gunner	opfor_Team1Tgt2	hit	tracer_red.p3d	31.18881	-97.657	37.85346297	86.78493043	314.0705269				
5	2/19/2024 15:16	38.67500305	15:17:26	TgtHit		opfor_Team1Tgt2								engine	0.113262825	0.113262825	
6	2/19/2024 15:16	38.67500305	15:17:26	TgtHit		opfor_Team1Tgt2								wheel_1_2_damper	0.021390291	0.021390291	
7	2/19/2024 15:16	38.67500305	15:17:26	TgtShotAt	blufor1Team1	opfor_Team1Tgt2		tracer_red.p3d									
8	2/19/2024 15:16	38.70500183	15:17:26	TgtHit		opfor_Team1Tgt2								glass_0_2	0.011260718	0.011260718	
9	2/19/2024 15:16	38.70500183	15:17:26	TgtShotAt	blufor1Team1	opfor_Team1Tgt2		tracer_red.p3d									
10	2/19/2024 15:16	38.70500183	15:17:26	TgtShotAt	blufor1Team1	opfor_Team1Tgt2		tracer_red.p3d									
11	2/19/2024 15:16	38.73600006	15:17:26	TgtShotAt	blufor1Team1	opfor_Team1Tgt2		tracer_red.p3d									
12	2/19/2024 15:16	38.73600006	15:17:26	ShotHit	blufor1Team1Gunner	opfor_Team1Tgt2	hit	tracer_red.p3d	31.18881	-97.65699	72.3545184	2.750089493	314.0570141				
13	2/19/2024 15:16	38.77500153	15:17:26	TgtHit		opfor_Team1Tgt2								glass_0_2	0.025748562	0.03700928	
14	2/19/2024 15:16	38.77500153	15:17:26	ShotHit	blufor1Team1Gunner	opfor_Team1Tgt2	hit	tracer_red.p3d	31.18881	-97.657	357.5445842	20.17403828	314.0503754				
15	2/19/2024 15:16	38.77500153	15:17:26	ShotHit	blufor1Team1Gunner	opfor_Team1Tgt2	hit	tracer_red.p3d	31.18881	-97.65701	38.17417588	86.72500423	314.0503754				
16	2/19/2024 15:16	38.77500153	15:17:26	TgtShotAt	blufor1Team1	opfor_Team1Tgt2		tracer_red.p3d									
17	2/19/2024 15:16	38.80700302	15:17:26	ShotHit	blufor1Team1Gunner	opfor_Team1Tgt2	hit	tracer_red.p3d	31.18881	-97.65699	86.75208861	-2.18275833	314.0437758				
18	2/19/2024 15:16	38.80700302	15:17:26	TgtHit		opfor_Team1Tgt2								glass_0_2	0.142149135	0.179158419	
19	2/19/2024 15:16	38.80700302	15:17:26	TgtShotAt	blufor1Team1	opfor_Team1Tgt2		tracer_red.p3d									
20	2/19/2024 15:16	38.80700302	15:17:26	ShotHit	blufor1Team1Gunner	opfor_Team1Tgt2	hit	tracer_red.p3d	31.18881	-97.657	42.71958125	86.96528115	314.0437758				

Research Questions:

- How to best "farm" this data?
- How to organize it and label it (method/cost common ontology)?
- How to reduce, analyze and process it and make it usable to users?
- How to map to competencies (metadata and with xAPI)?

NEEDS TRAINING DATA...

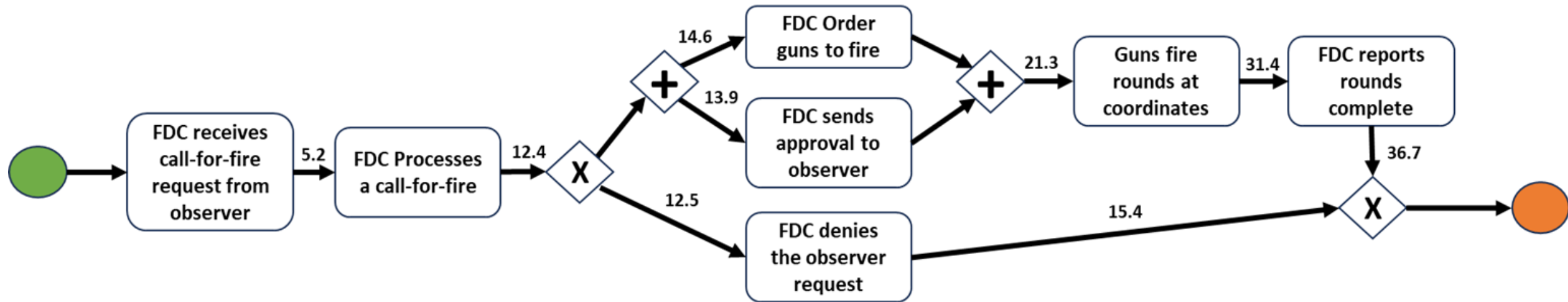
- **POLICY,**
- **PRACTICES,**
- **ARCHITECTURE**



Process Mining - How to Use Data for Learning Decisions

Events/activities of a targeted objective task performance (case).

Outcomes for each form decisions and complex performance criteria [ref 14]

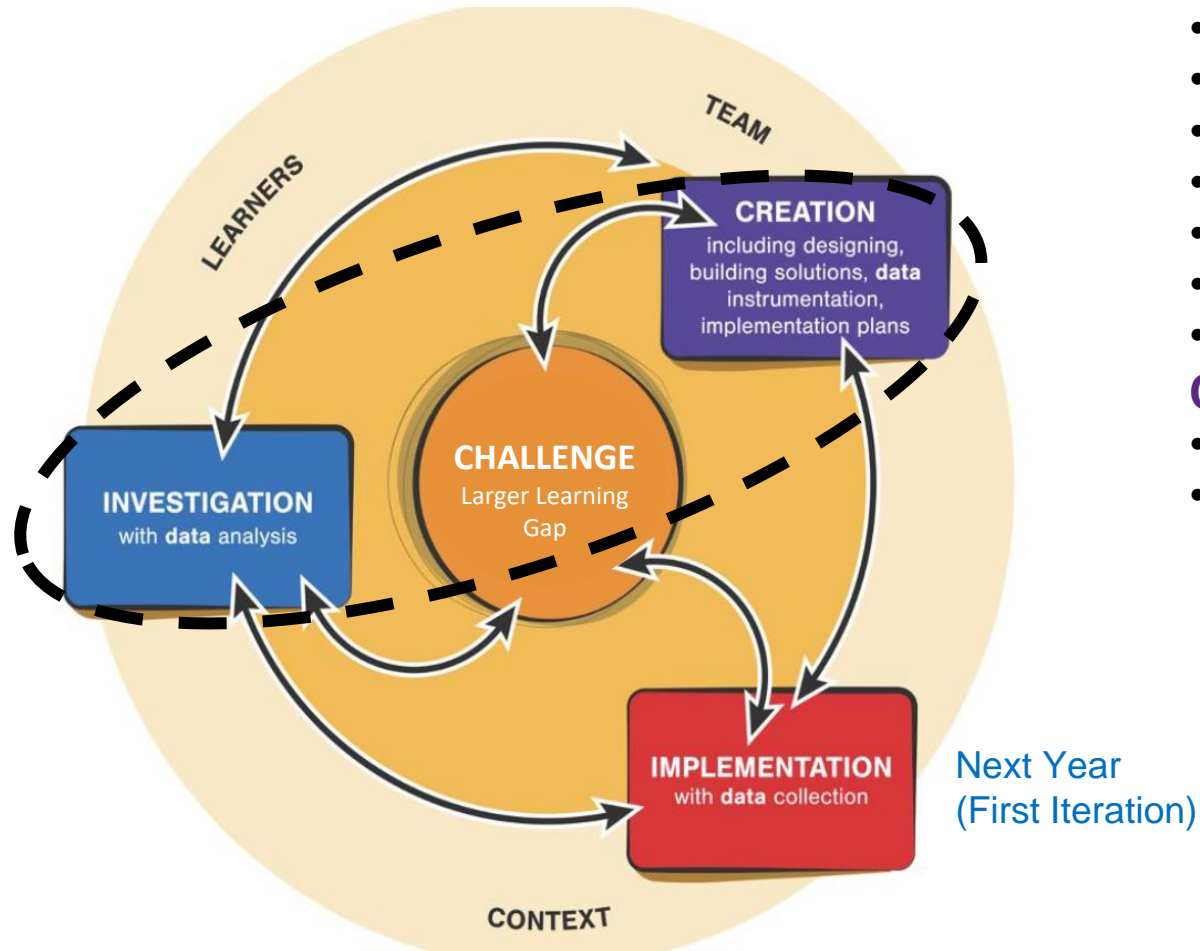


PRODUCES ANSWERS TO:

- *What are the trends?*
- *What are the key activity events / conditions / performance outcomes?*
- *What activity trends correlate to complex task results?*
- *How does this improve my competency framework*
- *What are new criteria for competencies?*

Our Learning Engineering Project Status

WE ARE HERE (Fall 2023>Fall 2024)



INVESTIGATION events

- Institutional agreements (to do experiment)*
- Institutional approvals (to collect data)*
- Analyzed existing data and practices*
- Gathered perspectives on legacy method
- Observed control learning session
- Selected sample learning topics*
- Determined needed LE team roles/skills **
- Determined trainer/learner profiles (general)

CREATION events

- Creating experiment design (variables) - iterate
- Selecting/creating/reviewing learning concept***

*** DON'T UNDERESTIMATE TIME TO DO THIS**

**** Our needed LE team roles/skills:**

- Instruction Systems Designer / Human-System Engineer
- Data Scientist
- Experimental Psychologist
- Cognitive Scientist
- Software Engineer(s)
- Target Instructors/Trainers/Learners

*** Design “Learner Flow”. Needs to fit within institutional culture/capability while “pushing” to adopt learning technology and data informed assessment

Learning Engineering Maturity Model Employment



Generalizable Learning Engineering Adoption Model Checklist

GENERALIZABLE LEARNING ENGINEERING ADOPTION MATURITY MODEL as a Checklist	
Indicators of Adoption of Learning Engineering as a Multidisciplinary Practice	
<input checked="" type="checkbox"/>	The organization employs multidisciplinary teams (or accesses multidisciplinary expertise) to address learning engineering challenges.
<input checked="" type="checkbox"/>	When employing a team, the team members may contribute different levels of effort at different stages but continue to meet regularly and make shared design and development decisions based on data and insights gained from end-users of the experience or solution.
<input checked="" type="checkbox"/>	The organization employs cross-training and team performance optimization.
<input checked="" type="checkbox"/>	Team members are continuously learning from each other and developing skills in other domains of learning engineering.
<input checked="" type="checkbox"/>	Data are used to continuously improve the learning engineering process and team performance. <i>(Teams may include one or more humans working with AI agents learning from each other to optimize performance of the learning engineering process.)</i>
Indicators of Adoption of the Learning Engineering Process	
<input checked="" type="checkbox"/>	The organization uses the learning engineering process enterprise-wide and with full fidelity.
<input checked="" type="checkbox"/>	It is fully supported by the enterprise policy, e.g., budgets and procurement policies support iteration for continuous improvement.
<input checked="" type="checkbox"/>	The full iterative, data-informed, multi-cycle process is used that includes (a) defining the challenge in context, (b) considering resources and constraints, (c) iterative design-development cycles, (d) implementation with instrumentation, (e) investigation to inform the next cycle or next challenge.
<input checked="" type="checkbox"/>	The organization uses the learning engineering process enterprise-wide and with full fidelity.
<input checked="" type="checkbox"/>	It is fully supported by the enterprise policy, e.g., budgets and procurement policies support iteration for continuous improvement.
<input checked="" type="checkbox"/>	The full iterative, data-informed, multi-cycle process is used that includes (a) defining the challenge in context, (b) considering resources and constraints, (c) iterative design-development cycles, (d) implementation with instrumentation, (e) investigation to inform the next cycle or next challenge.
Indicators of Adoption of Applying the Learning Sciences	
<input checked="" type="checkbox"/>	The organization is able to explain design decisions with sound learning sciences concepts.
<input checked="" type="checkbox"/>	The organization maintains logs of key design decisions with justification of those decisions supported by sound learning sciences principles.
<input checked="" type="checkbox"/>	Management direction is informed by learning sciences expertise.
<input checked="" type="checkbox"/>	Learning engineering practitioners or teams employ applied research methods when the prevailing science is not sufficient to inform design decisions.
Indicators of Adoption of Human-Centered Design Practices	
<input checked="" type="checkbox"/>	The organization develops learning solutions with input from learners using human-centered design processes and best practices—including using processes to identify target learners, human factors principles, learner contexts, and variability based on empathy from iterative engagements with learners.
<input checked="" type="checkbox"/>	The organization builds learning resources, events, and solutions that adapt, scaffold, and make accessible learning experiences for a full range of learners and context variability factors.
<input checked="" type="checkbox"/>	The organization adopts an engineering mindset and systems thinking.
<input checked="" type="checkbox"/>	The organization applies system engineering design principles to address complex problems, including modularization, i.e. addressing component solutions as part of a larger overall solution, using standard common interface protocols to integrate components.
<input checked="" type="checkbox"/>	The organization addresses learning and learning solutions as data-informed closed loop control systems.
Indicators of Adoption of Data-Informed Decision-Making	
<i>Instrumentation</i>	
<input checked="" type="checkbox"/>	The organization considers data instrumentation while creating the solution.
<input checked="" type="checkbox"/>	The organization specifies the instrumentation to capture data needed to fully meet the feedback requirements of the solution (e.g. feedback to learners) and data to inform decisions about the current solution (e.g. for A/B testing solution alternatives).
<input checked="" type="checkbox"/>	The organization configures or adapts data capture and logging (such as with sensors and data pipelines), or develops new instrumentation when needed using open data standards (e.g., xAPI).
<input checked="" type="checkbox"/>	The organization uses instrumentation that includes linked learning resources and competency definition metadata (e.g. IEEE 2881, IEEE 1484.20.3).
<i>Data Use</i>	
<input checked="" type="checkbox"/>	The organization develops each iteration of learning solutions or content based on testing (which may include A/B testing of alternatives) of the solution or intervention with targeted users, environments and context.
<input checked="" type="checkbox"/>	The organization uses well formulated data questions; high-quality data; and appropriate learning analytics methods, and data science technologies.

Our Learning Engineering Adoption: 100% / 26 of 26 points

- ✓ **Indicators of Multidisciplinary Practice = 5 points**
 - *Employing a multi-disciplinary team and skills tailored to the challenge*
 - *Learning expertise forms leadership of the team*
- ✓ **Indicators of the Learning Engineering Process = 6 points**
 - *Integrated and funded into multiple Army S&T efforts for learning challenges*
 - *Process includes investigation, creation, and implementation based on time and resource availability and institutional challenges and process limitations.*
- ✓ **Indicators of Applying the Learning Sciences = 4 points**
 - *Learning model based on published learning sciences from multiple related fields and empirical learning research (classified)*
- ✓ **Indicators of Human-Centered Design = 5 points**
 - *Integration of Human Readiness Levels and systems thinking for larger processes*
 - *Integration of target trainers and learners in the investigation process.*
 - *Integration of target trainers and learners in the creation process*
 - *Learning experiences and resources integrated into the learning experience*
- ✓ **Data Informed Decision-Making and Data Use = 6 points**
 - *Integration of existing and new data sources mapped to target competencies from existing systems*
 - *Integration of data science technology*

References

1. Bickley, et.al. (2010). Army Institutional Training: Current Status and Future Research. US Army Research Institute
2. Bridgeland, J., Dilulio, J., Morison, K. (2006). The Silent Epidemic: Perspectives of High School Dropouts
3. National Center for Education Statistics - <https://nces.ed.gov/>
4. Goodell, J. & Kolodner, J. (Eds.). (2022). Learning Engineering Toolkit: Evidence-Based Practices from the Learning Sciences, Instructional Design, and Beyond (1st ed.). Routledge NY
5. Kirkpatrick Partners, LLC. (2024, July 24). What is The Kirkpatrick Model? / Kirkpatrick. <https://www.kirkpatrickpartners.com/the-kirkpatrick-model/>
6. Merrill, M. D. (2002). First principles of instruction. Educational Technology Research and Development, 50(3), 43-59
7. National Research Council (on education) (2000). How People Learn: Brain, Mind, Experience, and School. National Academy Press
8. Zull, J. (2023). The Art of Changing The Brain – Enriching Teaching by Exploring the Biology of Learning. Routledge, NY
9. Kolb A & Kolb D (2017). The Experiential Educator – Principles and Practices of Experiential Learning. EBLS Press, Kaunakakai, HI
10. Owens, K. (2023). Learning Engineering for Competency-Based Experiential Learning Design. Proceedings of Human Factors and Ergonomics Society Conference, Washington DC.
11. Goldberg, B., Owens, K., Gupton, K., Hellman, K., Robson, R., Blake-Plock, S., & Hoffman, M. (2021). Forging Competency and Proficiency through the Synthetic Training Environment with an Experiential Learning for Readiness Strategy. I/ITSEC 2021, Orlando, FL.
12. Owens, K., Goldberg, B., Blake-Plock, S., Robson, R., Mishra, S. (2022). Introduction to Competency-Based Experiential Learning. I/ITSEC Orlando FL 2022.
13. Owens, K., Townsend, L., Goldberg, B. (2024). Integrating Experiential Simulation into Classroom Instruction with Synthetic Experience Events. AHFE International 15th Proceedings – The Human Side of Service Engineering: Vol. 143
14. Totino, L. & Kessler, A. (2023). “Why did we do that?” A Systematic Approach to Tracking Decisions in the Design and Iteration of Learning Experiences. Journal of Applied Instructional Design.



IITSEC 2024



NTSA

Any Questions?

Authors:

Kevin Owens - kowens@arlut.utexas.edu

Lisa Townsend - lisa.n.townsend2.civ@army.mil

Dr. Ben Goldberg - benjamin.s.goldberg.civ@army.mil

Dr. Jared Abrams - jared.abrams@arlut.utexas.edu

Dr. Gordon Cooke - gordon.cooke@westpoint.edu

NTSA

