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A Selective Model for Accelerated Realtime Training (SMART)

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About SoarTech

- **World leaders in Artificial Intelligence**

- Spun off from the University of Michigan Artificial Intelligence laboratory in 1997 to support DARPA's Synthetic Theater of War (STOW) program
- Small business: ~124 employees
  - 29+ with PhDs, 35+ with Masters
- 2 offices (Ann Arbor; Orlando)
- ~70 active research contracts
  - DARPA, Navy, Army, Air Force

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Challenges in Realtime Training

- **Cognitive skills** take numerous deliberately crafted repetitions to practice and master
- **Costly live or simulation-based training** events are the current gold standard for training
- **Game-based training** provides a readily available and successful alternative

Solution: SMART

The *Selective Model for Accelerated Realtime Training (SMART)* describes how to adapt a game grounded on the specific scenario context and performance for each game play.

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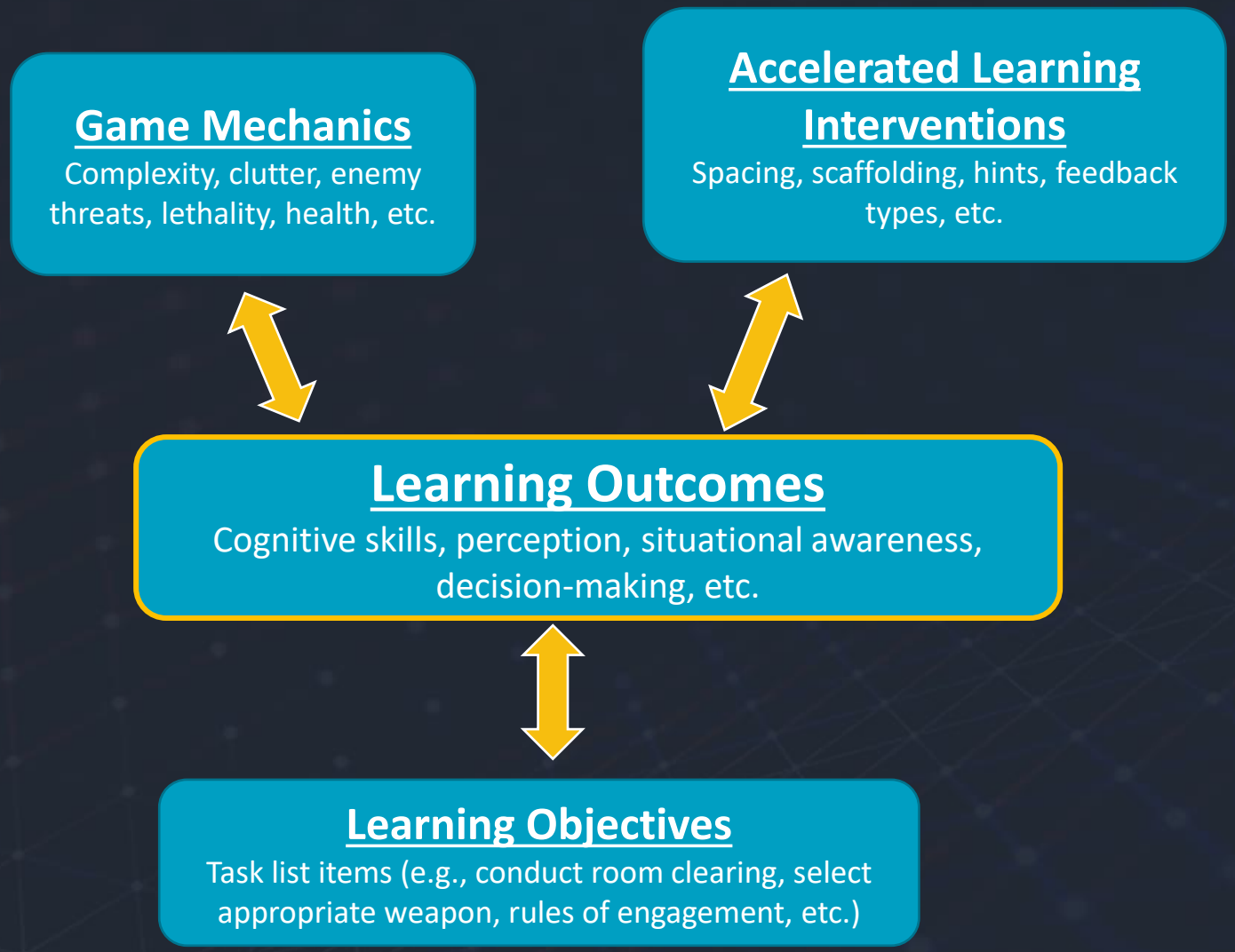
The SMART Model



- Numerous accelerated learning models are available; most systems employ one or two
- SMART expands on the Training Intervention Matrix (TIMx; VanBuskirk et al., 2009) to select the best accelerated learning model for the in-game context custom to each player's aptitude
- Central are the learning outcomes to both accelerated learning models and game features and mechanics
- Skill models with SMART define the most opportune accelerated learning intervention and game mechanics to elicit performance measurement

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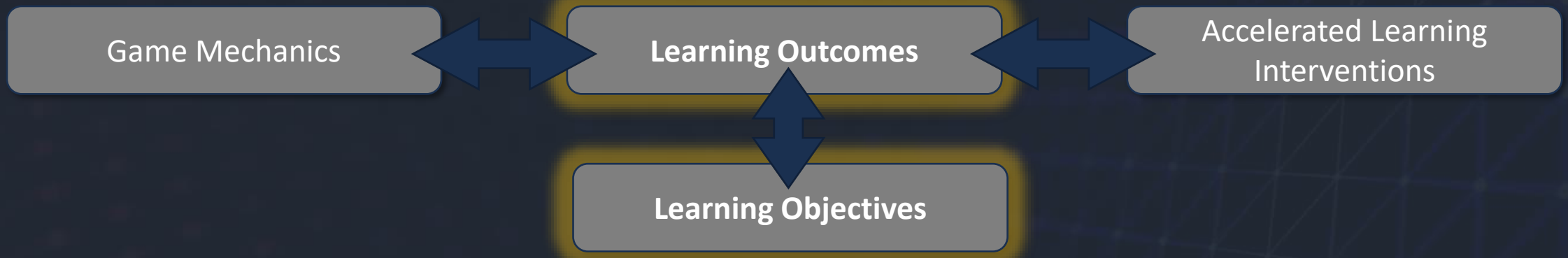
The SMART Model

Game Set Up (Domain Module)											Learning Outcomes	Accelerated Learning interventions (Local Module)									
			Statistics									Instructional Planning (pre-exercise)		Exercise Manipulation (during)		Feedback (during and post)					
Resources	Scenario Ambiguity	Civilians	Enemy Lethality	Number of Enemies	Enemy Ambiguity	Team / Unit	Friendly Lethality	Enemy Reaction Time	Health			Exploration Based Training	Role-Playing	Cueing/ Hinting	Highlighting	AAR	Normative (future)	Outcome	Progress/ Velocity	Scaffolding/Fading
											Information Interface									
											Perceptual Judgement									
											SA: Perception									
											Spatial Orientation									
					x						Visual Scanning			x	x					x
											Information Handling									
											Pattern Recognition									
											SA: Comprehension									
											Cognitive Task Execution									
x				x		x	x	x			Organizing/Planning									
											Problem Solving / Decision-Making	x				x		x	x	
											Resource Management									
											Interpersonal Interactions									
											Backup Behaviors									
											Error Correction									
											Memory and Knowledge Acquisition									
											Declarative Knowledge									
											Procedural Knowledge									
											Strategic Knowledge									

An expanded, yet condensed version of the SMART model

The SMART Model

Learning Outcomes v. Learning Objectives



Learning Objectives	Information Interface				Information Handling		Cogntive Task Execution			Interpersonal Interactions		Attention	Memory and Knowledge Acquistion		
	Perceptual Judgement	SA: Perception	Spatial Orientation	Visual Scanning	Pattern Recognition	SA: Comprehension	Organizing/ Planning	Problem Solving / Decision Making	Resource Management	Backup Behaviors	Error Correction	Attention Priorization	Declarative Knowledge	Procedural Knowledge	Strategic Knowledge
Neutralize Booby Trap	+														
Move as a fire team															
Control movement of a fire team															
Perform movement techniques during an urban environment															

The SMART Model

Learning Outcomes v. Learning Objectives

- Learning objectives are derived from MOUT training learning objectives
- These objectives were then mapped to learning outcomes based on the type of skills the learning objective included

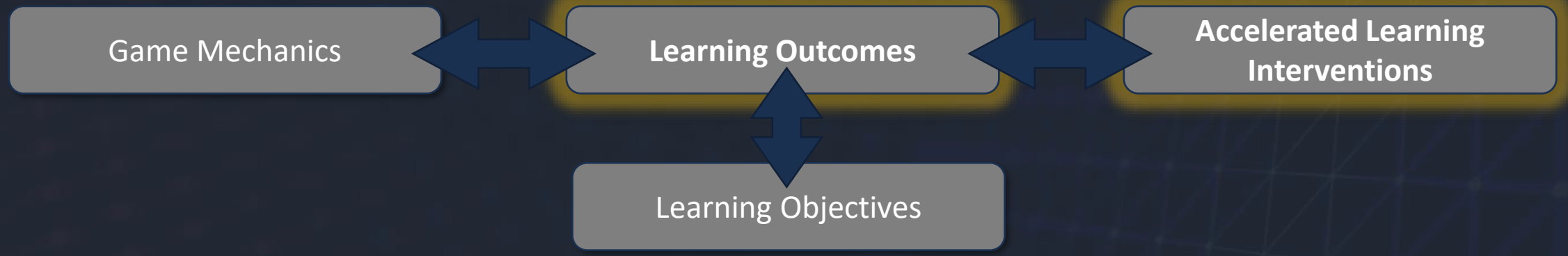
#	Learning Objective
071-326-0503	Move over, through, and around obstacles
052-193-013	Neutralize booby traps
071-326-0501	Move as member of a fire team
071-326-0541	Perform movement techniques during an urban operation
071-326-5605	Select hasty firing positions during urban operation
071-326-5611	Control movement of a fire team
071-325-4407	Employ hand grenades

Neutralize Booby Traps

Information Interface	• Perceptual Judgement • Situation Awareness: Perception
Information Handling	• Pattern Recognition • Situation Awareness: Comprehension
Cognitive Task Execution	• Problem Solving • Decision Making
Attention	• Attention Prioritization
Memory and Knowledge Acquisition	• Procedural Knowledge • Strategic Knowledge

The SMART Model

Learning Outcomes v. Accelerated Learning Interventions



Learning Outcomes	Accelerated Learning Interventions (Local Module)										
	Instructional Planning (pre-exercise)			Exercise Manipulation (during)		Feedback (during and post)					
	Exploration Based Training	Event Based Traning Approach	Role-Playing	Cueing/ Hinting	Highlighting	AAR	Environmental Feedback	Normative (future)	Outcome	Progress/ Velocity	Scaffolding/Fading
Information Interface											
Perceptual Judgement				X	X	X		X	X	X	X
SA: Perception				X	X	X		X	X	X	X
Spatial Orientation						X		X	X	X	X
Visual Scanning				X	X	X		X	X	X	X
Information Handling											
Pattern Recognition	X			X	X	X	X	X	X		X
SA: Comprehension		X					X				X
Cognitive Task Execution											
Organizing/Planning	X		X			X		X	X	X	X
Problem Solving / Decision-Making	X			X	X	X		X	X	X	X

The SMART Model

Learning Outcomes v. Accelerated Learning Interventions

- Accelerated Learning Interventions are organized into three categories that describe when an intervention could be employed based off the TIMx
- Based off the TIMx, specific interventions were selected if could be employed for MOUT training environment

Intervention Category	Utilization	Types
Instructional Planning	Pre-exercise	Exploration Based Training Event Based Training Role-Playing
Exercise Manipulation	During	Cueing/Hinting Highlighting
Feedback	During and Post	AAR Environmental Feedback Normative Feedback Outcome Scaffolding/Fading

- These interventions provide a framework to **dynamically tailor** learning objectives for a trainee depending on the actions they are taking during an iteration

The SMART Model

Learning Outcomes v. Game Mechanics

Game Mechanics ⟷ **Learning Outcomes** ⟷ Accelerated Learning Interventions

Learning Objectives

Game Set Up (Domain Module)																														Learning Outcomes
Scenario Set Up															Team															
Scenario Complexity													Scenario Size	Passive Threats	Resources						Scenario Ambiguity		Enemy		Team(s)					
Terrain (n)	Size	Non-combatants	Amount	Health	PCs	Amount	Lethality	Reaction Time	Hiding Spots (n)	Amount	Size	Amount of Tasks to Complete	Type (n)	Amount	Weapon Type	Amount	Ammo Type	Amount	Smoke	Amount	First Aid	Amount	Amount of Information Shared	Correctness of Information	Amount of Information Shared	Correctness of Information	Type (n)	Amount	Skill	Lethality	Reaction Time	Health	
																																Information Interface
	x	x	x	x			x	x		x																					Perceptual Judgement
	x	x	x	x			x	x		x																					SA: Perception
	x						x	x		x																					Spatial Orientation
	x	x	x	x			x	x	x	x																					Visual Scanning
																																Information Handling
	x	x	x	x			x	x	x	x												x	x	x	x						Pattern Recognition
	x	x	x	x			x	x	x	x												x	x	x	x				x	x	x	SA: Comprehension
																																Cognitive Task Execution
	x	x	x	x	x		x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Organizing/Planning
	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Problem Solving / Decision-Making
			x	x	x	x			x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Resource Management
																																Interpersonal Interactions
	x		x				x	x	x																	x	x			x	Backup Behaviors
									x	x																	x			x	Error Correction
																																Attention
		x	x	x	x	x			x	x																					Attention Priorization

The SMART Model

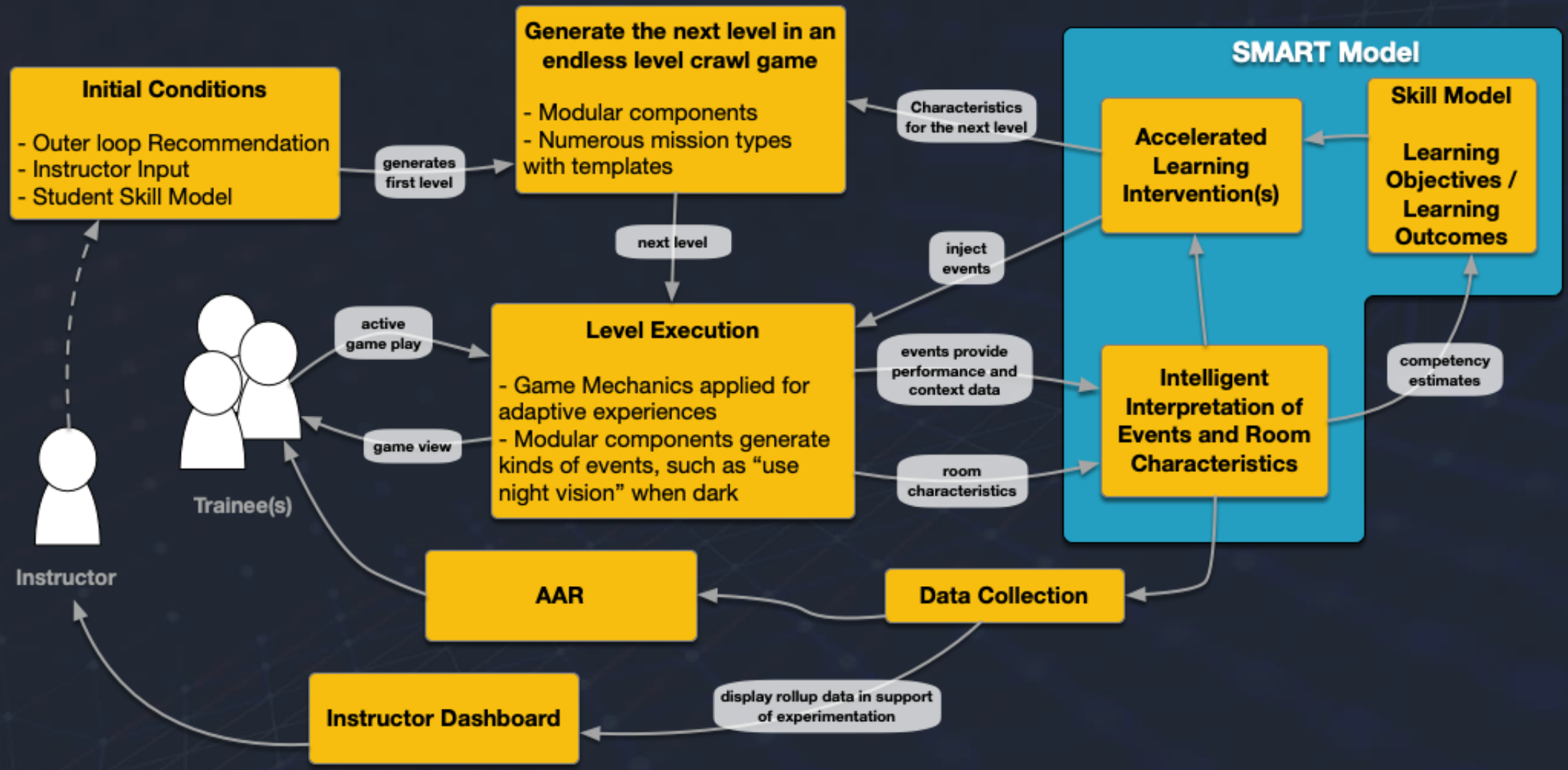
Benefits of the SMART Model

- Capitalizes on foundational research
  - TIMx (Van Buskirk et al., 2009), Durlach & Spain's FIT (2014)
- Supports both instructorless and instructor-led training
- Generalizable model to other tasks (kinetic, non-kinetic, sustainment, mass casualty) for real-time strategy, tactical agility, and cognitive decision-making
- The SMART architecture method is modular and componentized
  - SMART can drive each subsequent level – **automatically and intelligently generating levels** based on skill model and learning outcome

So, **SMART is not adaptive branching but a true intelligent tutoring system – and supports building an engaging replayable game**

SMART Model Testbed: MOUT ‘86

Game Architecture



SMART Model Testbed: MOUT ‘86

- “Dungeon crawl” style real-time strategy game that tailors within and between an iteration based off the SMART Model
- Adaptive to facilitate learning across expertise from novice to expert, not just experts
- Players receive an Operational Order with mission, timeline info, METT-TC
  - Tailored based on player aptitude, learning objectives targeted
- Players plan their strategy using doctrinal maneuvers
- Game starts, and players must reassess and adapt their plan demonstrating cognitive flexibility and tactical agility as the game progresses

MOUT ‘86

MOUT 86

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Future Research

- Reinforcement Learning for micro-adaptations
- Investigate additional tasks for deployment of the SMART model and innovative architecture
- Training efficacy analysis

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Questions & Discussion

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