Intelligent Narrative-Centered Learning Environments

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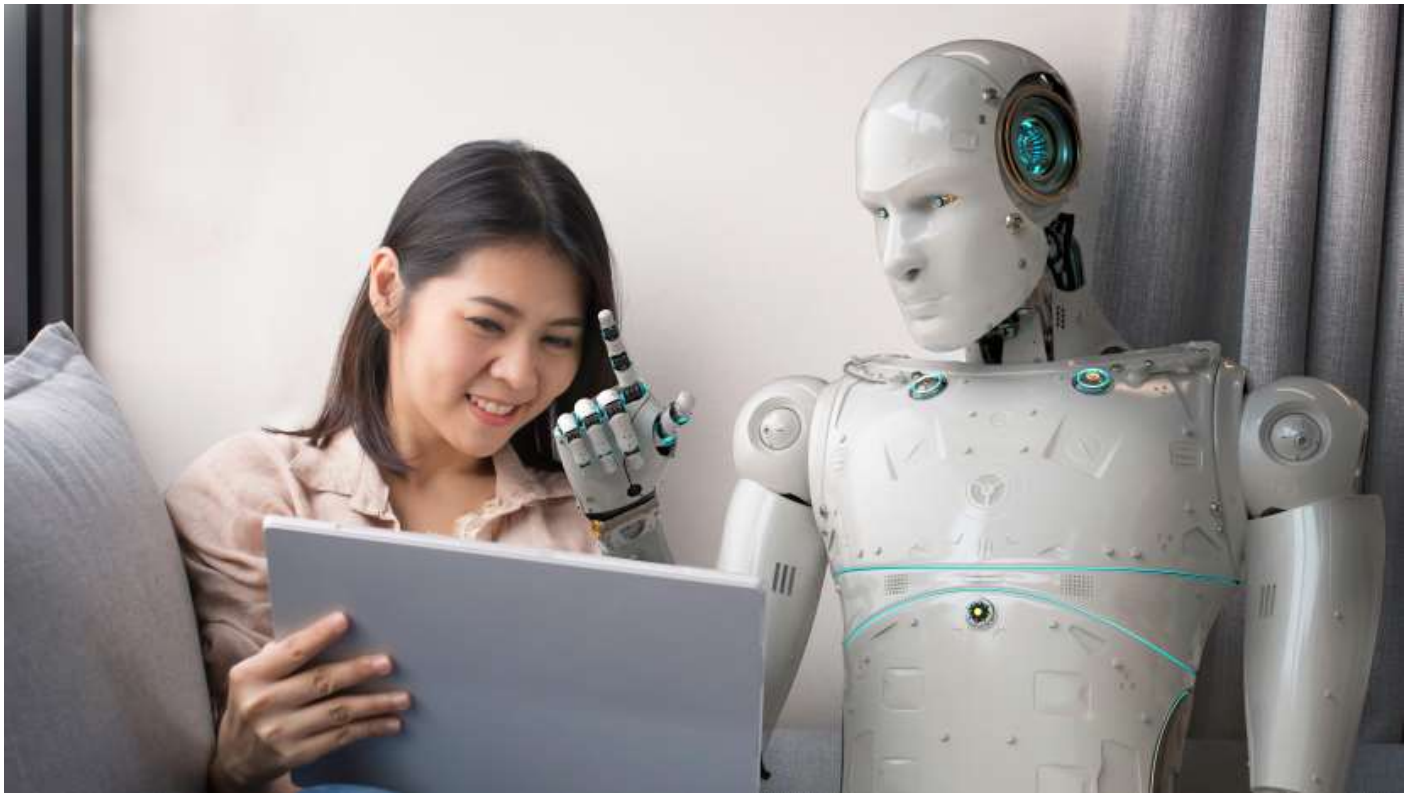
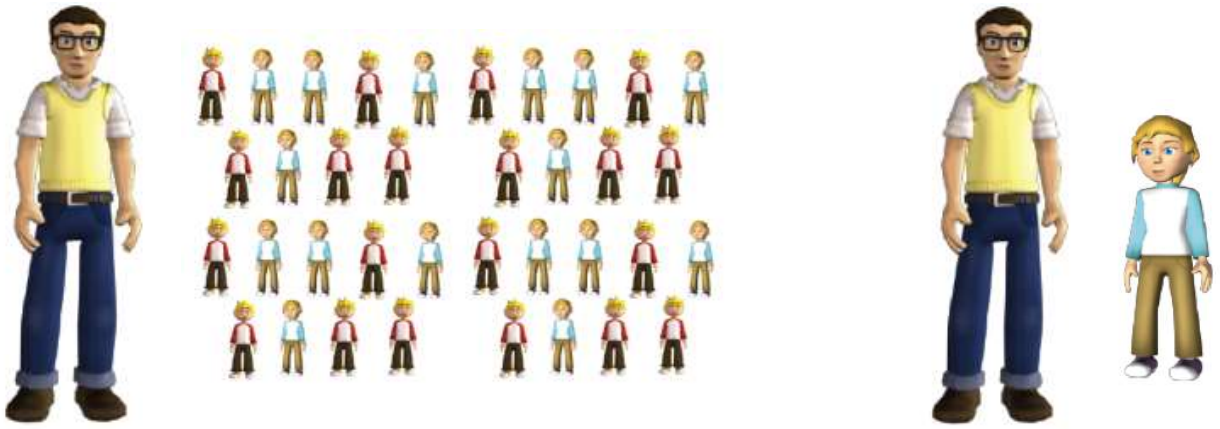
Transforming education with AI-driven learning environments

AI-Enriched Learning

Personalized Learning Assistants for Lifelong Learning



One-on-One Tutoring



Design Challenge

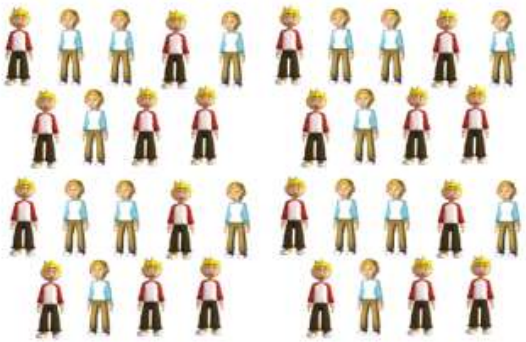
"Provide a teacher for every learner"

- Learn at their own pace
- Receive continuous, customized and meaningful feedback and assessment
- Acquire new skills in a way that is compelling and engaging

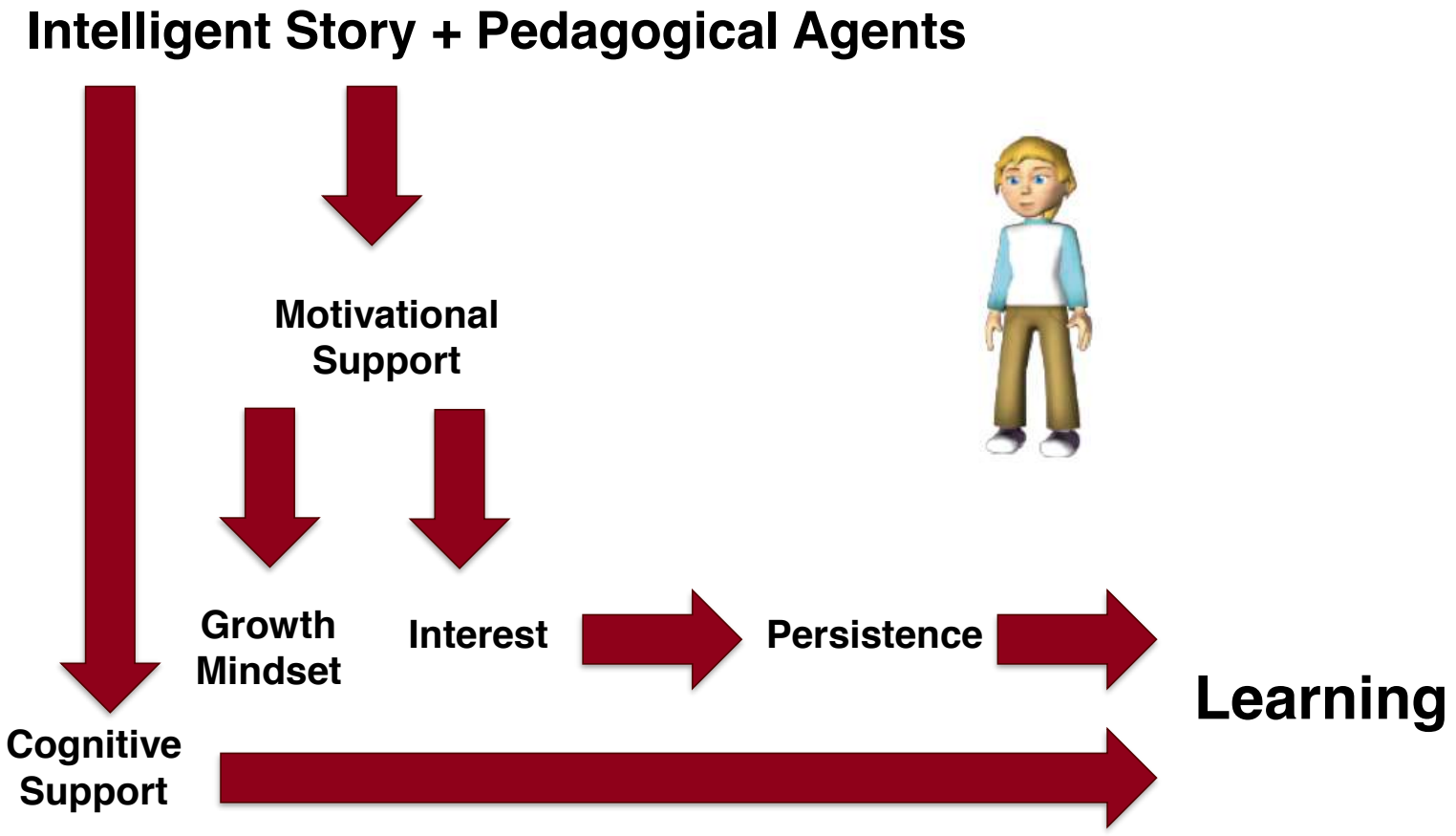
Design Challenge

"… provide learning environments that approach the effectiveness of one teacher for every learner. Such systems, properly used, can produce a significantly better-educated populace by combining advances in learning sciences with advances in information technology."

Narrative-Centered One-on-One Learning



Personalized Learning Hypotheses



Story-centric Games

- Game-based learning environments in which learners:
  - Participate in “story-centric” problem-solving activities
  - Immerse themselves in tailored narratives
- Revolve around:
  - Believable characters
  - Expansive virtual worlds
  - Rich stories

Affect-Rich Learning Environments

- Interplay of affect and cognition
  - Performance impacts affective states
  - Affective states impact performance
- Supporting affect
  - Natural component of tutoring
  - Keystone of effective learning
- Long term effects
  - Motivation
  - Self-efficacy

Intelligent Tutoring in Game-Based Learning Environments

- Affect-rich characters
- Problem-solving guidance
- Context-sensitive feedback
- Dynamic problem selection
- Tailored explanations

Crystal Island Narrative-Centered Learning Environment

- Curricular Focus
  - Eighth grade microbiology
  - NC Standard Course of Study
- Story
  - Investigate outbreak on remote island
  - Recover notes from earlier investigation
  - Identify illness and recommend treatment
- Evolution
  - ~10 years iterative refinement
  - Many laboratory and classroom studies

Crystal Island: Lost Investigation

1. Design a suite of intelligent game-based learning environment technologies for middle grade science + literacy education.
2. Create an implementation program to provide an account of middle grade students' acquisition of science and literacy skills as they interact with intelligent game-based learning environments.

BILL & MELINDA GATES foundation

WILLIAM + FLORA Hewlett Foundation

EDUCAUSE

Tailoring Events in Narrative-Centered Learning Environments

- Game elements have dual roles
  - Pedagogical
  - Narrative
- Multiple forms of narrative-centered tutorial events
  - Side quests for knowledge remediation
  - Narrative events for embedded assessment
- Dynamically tailored sequences of embedded assessments

Explore Virtual Environment

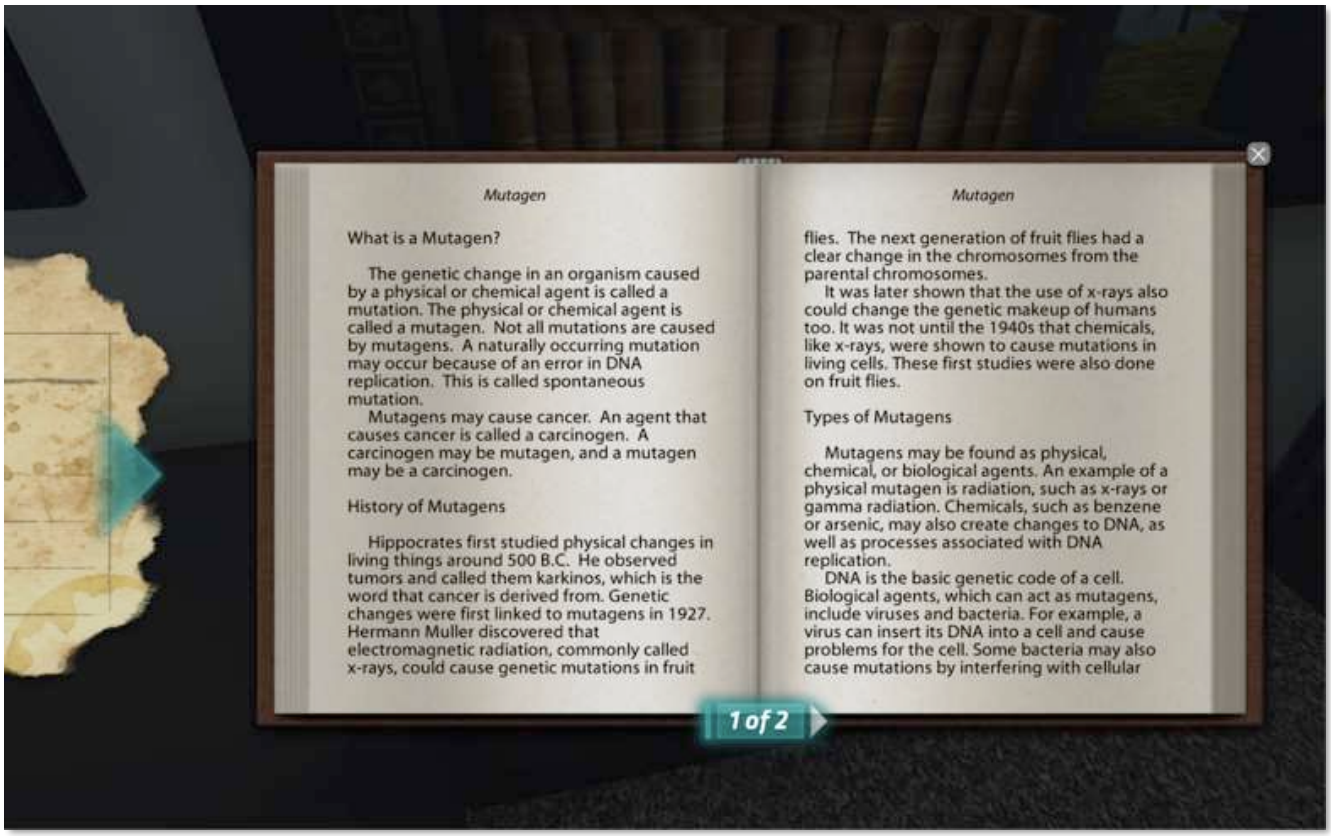
Posters


SIZE COMPARISON
VIRUS REPRODUCTION
Once inside a cell, a virus uses the host cell's functions to make its own proteins and genetic material.
The proteins and genetic material

Laboratory Equipment

Diagnosis Worksheet

Informational Texts



Mutagen

What is a Mutagen?

The genetic change in an organism caused by a physical or chemical agent is called a mutation. The physical or chemical agent is called a mutagen. Not all mutations are caused by mutagens. A naturally occurring mutation may occur because of an error in DNA replication. This is called spontaneous mutation.

Mutagens may cause cancer. An agent that causes cancer is called a carcinogen. A carcinogen may be mutagen, and a mutagen may be a carcinogen.

History of Mutagens

Hippocrates first studied physical changes in living things around 500 B.C. He observed tumors and called them karkinos, which is the word that cancer is derived from. Genetic changes were first linked to mutagens in 1927. Hermann Muller discovered that electromagnetic radiation, commonly called x-rays, could cause genetic mutations in fruit

Mutagen

flies. The next generation of fruit flies had a clear change in the chromosomes from the parental chromosomes.

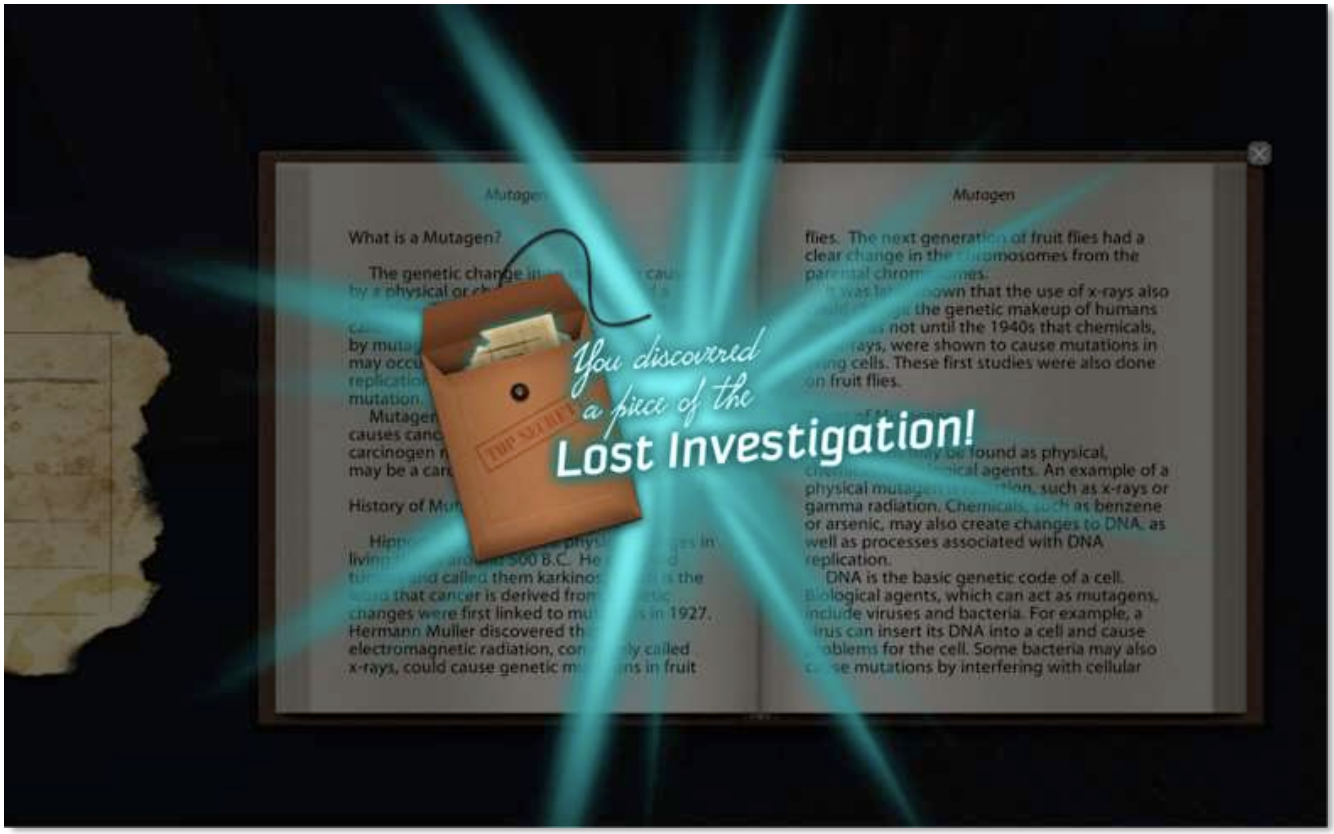
It was later shown that the use of x-rays also could change the genetic makeup of humans too. It was not until the 1940s that chemicals, like x-rays, were shown to cause mutations in living cells. These first studies were also done on fruit flies.

Types of Mutagens

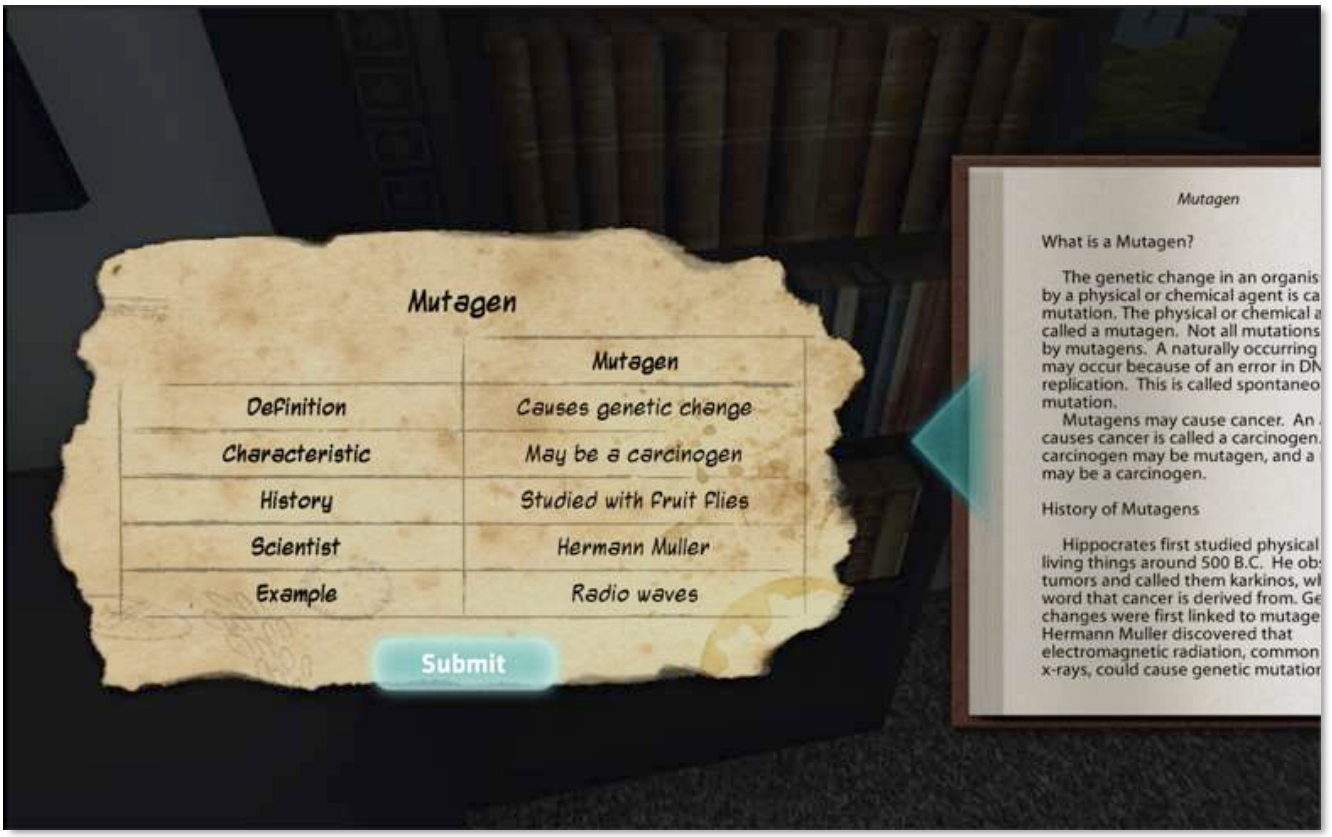
Mutagens may be found as physical, chemical, or biological agents. An example of a physical mutagen is radiation, such as x-rays or gamma radiation. Chemicals, such as benzene or arsenic, may also create changes to DNA, as well as processes associated with DNA replication.

DNA is the basic genetic code of a cell. Biological agents, which can act as mutagens, include viruses and bacteria. For example, a virus can insert its DNA into a cell and cause problems for the cell. Some bacteria may also cause mutations by interfering with cellular

Informational Texts

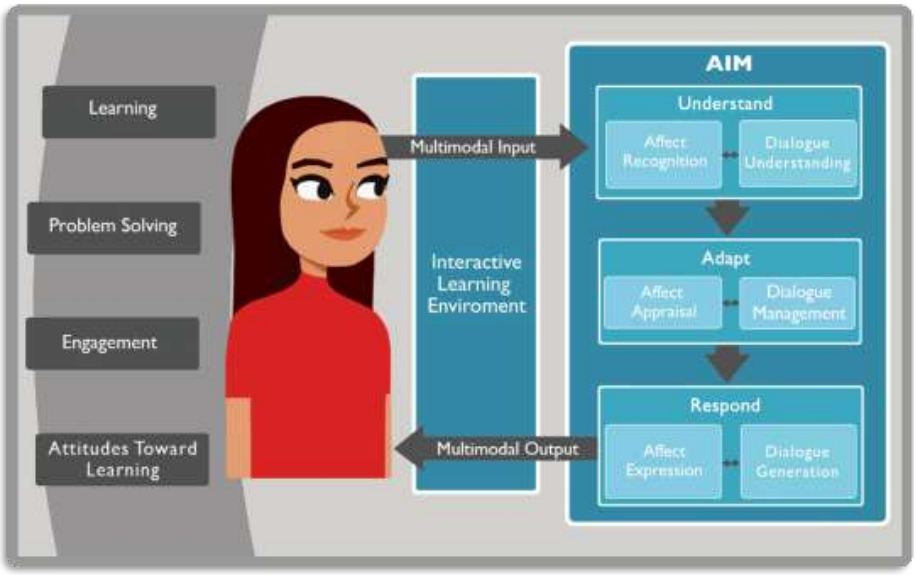


Concept Matrices



Multimodal Character Dialogues

Adapting to Affect in in Narrative-Centered Learning



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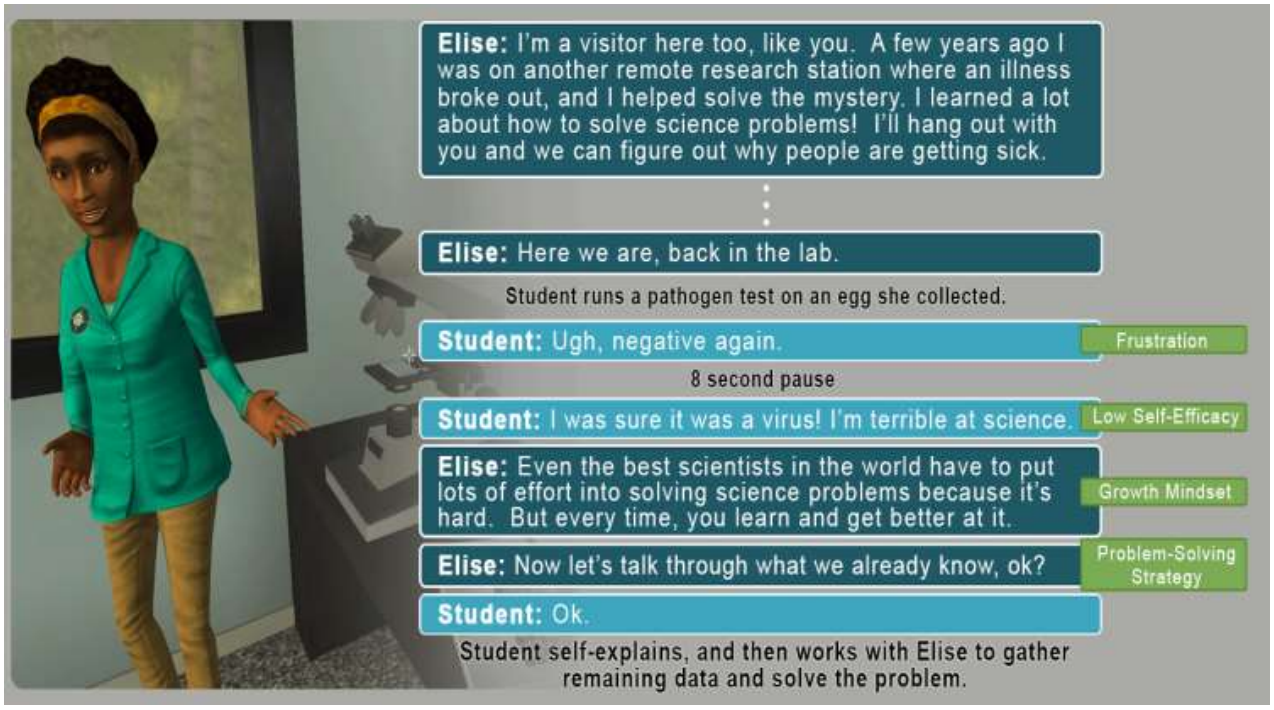
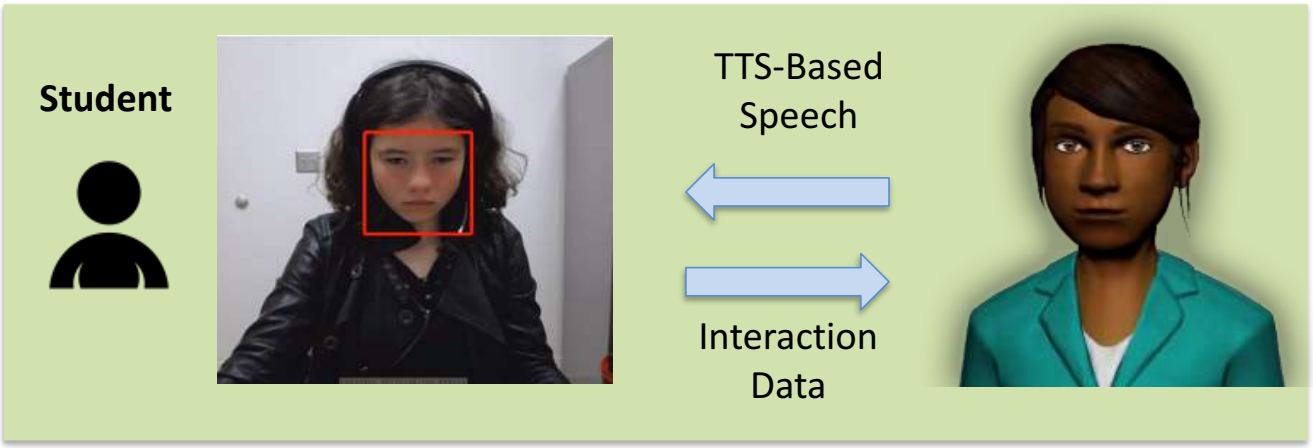
Empathetic Scaffolding in Narrative-Centered Learning



Wizard-of-Oz Narrative-Centered Learning Studies



Multimodal Sensors

- Facial video camera
- Galvanic skin conductance-recording bracelets
- Depth camera
- Gaze tracker
- Microphone

Dialogue Moves

- Wizard selects one of six dialogue act categories.
- Wizard chooses from a predefined set of utterances for the chosen dialogue act category.

Dialogue Act Modeling in Narrative-Centered Learning

Story Interaction

Narrative trace logs

FACET

Action unit trace logs

Multimodal data stream

Dominant hand

Galvanic skin response trace logs

Embedded Assessment in Narrative-Centered Learning

Narrative-Centered Learning Analytics

- Real-time trace data
- Window into student motivation
- Triangulation: learning processes + outcomes
- Designing for scale

ENGAGE: Game-based Learning for Middle School Computational Thinking

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ENGAGE: Game-based Learning for Middle School Computational Thinking

Curriculum

- Middle school computer science education
- AP Computer Science Principles

Platform

- Unity game engine
- FLARE user interface toolkit [Mott et al., 2014]

Design Challenge Reformulated

Affect-Informed AI

Game-Driven Interactive Narrative

Highly Motivated, Highly Effective Learners

Intelligent Narrative-Centered Training

- Rich personalized story-centered training driven by AI
- Example: Collaboration with ARL and Columbia University
- Leverage machine learning to induce models
  - Integrate trace data, sensor data, and field observations of trainee emotions
  - Predict emotions accurately and efficiently

Source: www.ecsorl.com

Affect Detection in Combat Medic Training

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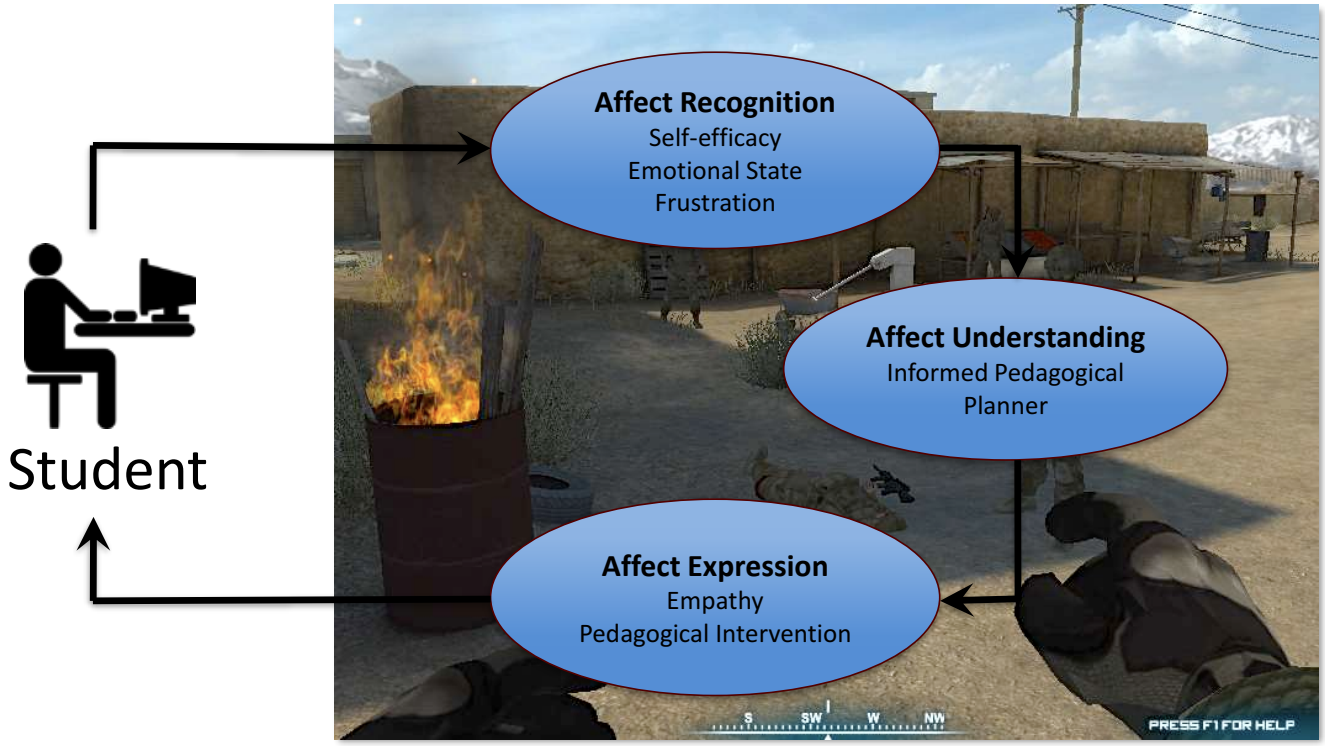
Affect-Informed Learning in Narrative-Centered Training



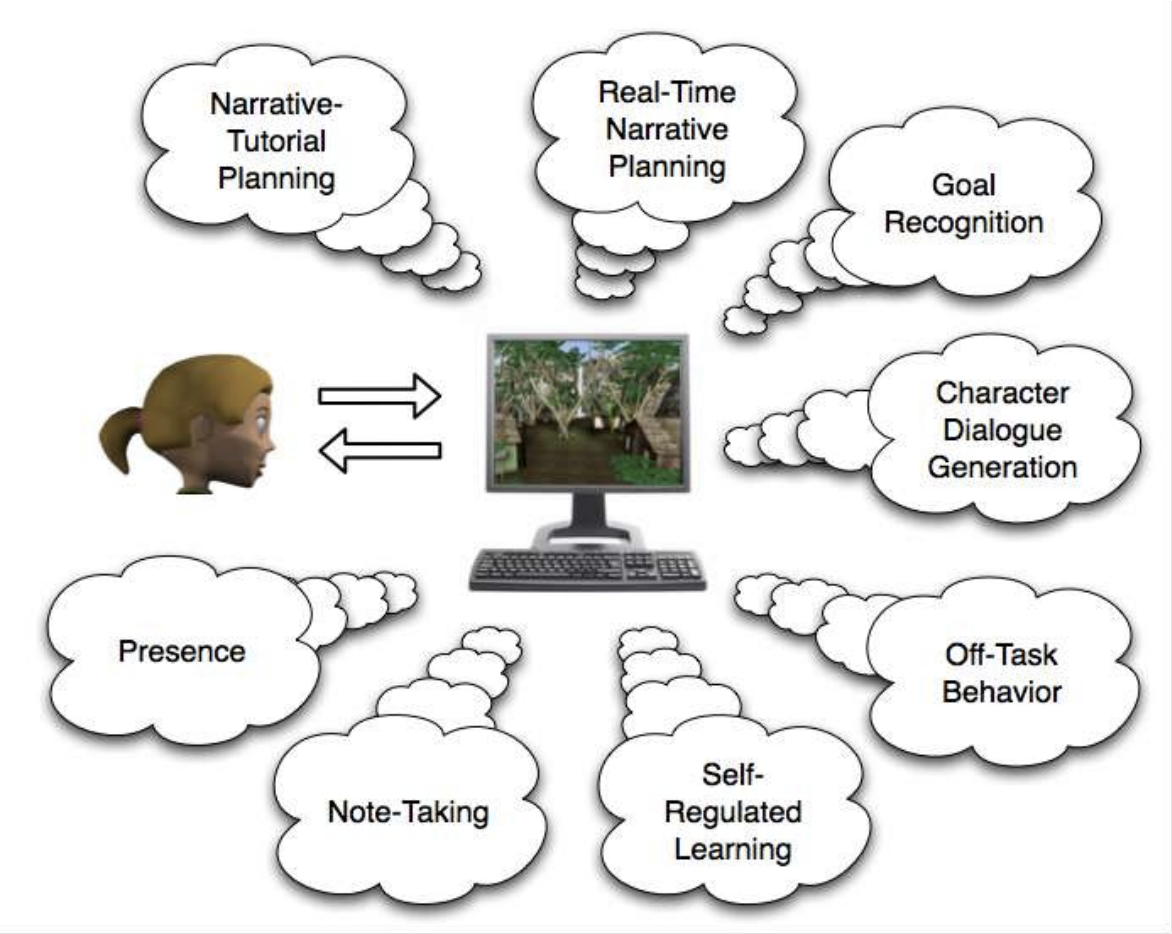
Narrative-Centered VR Training for First Responders

NIST National Institute of Standards and Technology
U.S. Department of Commerce

DeepGen: Reinforcement Learning-based Trainining Scenario Generation

- Automated scenario generation is invisible to learners
- Training scenarios are dynamically tailored to learner traits, knowledge, and performance
- Scenario generation improves as more data is provided to DeepGen

Narrative-Centered Learning



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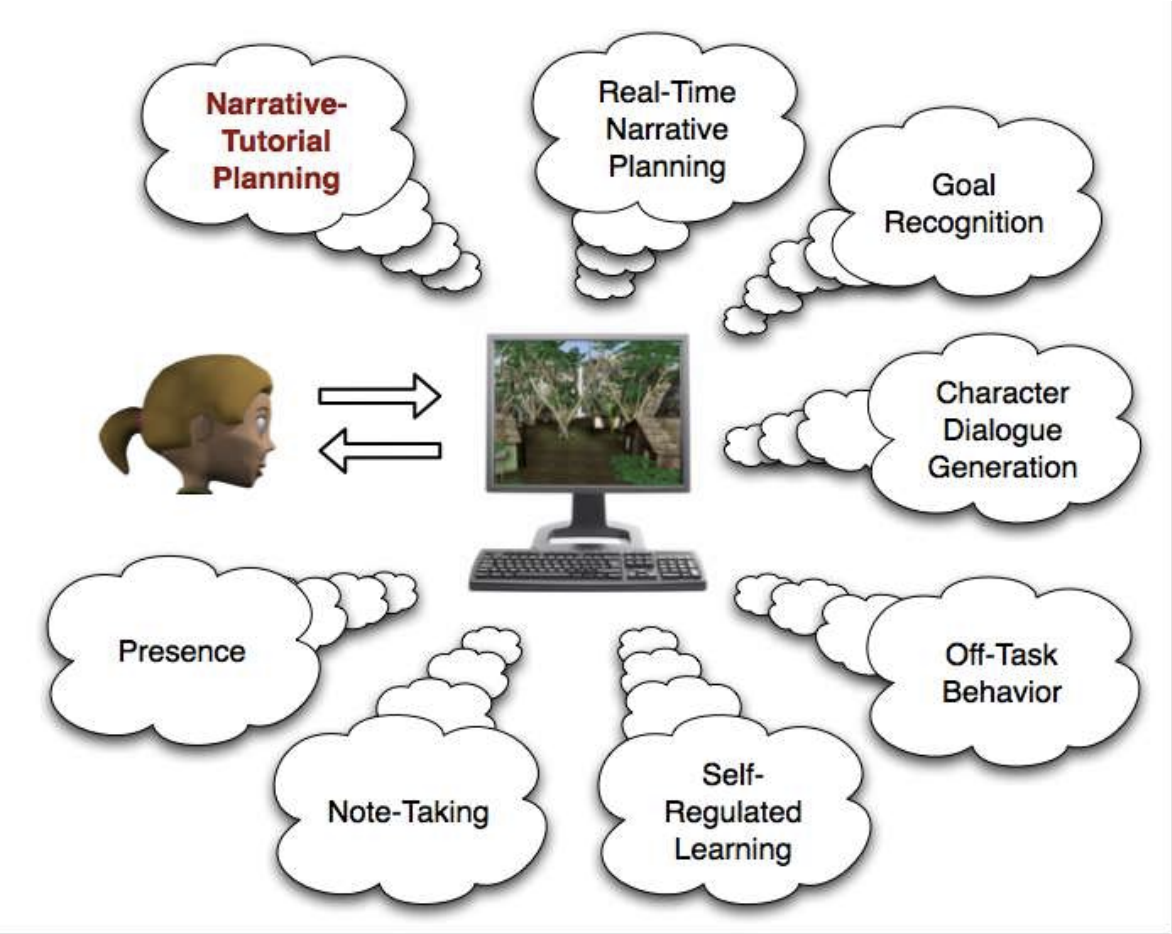

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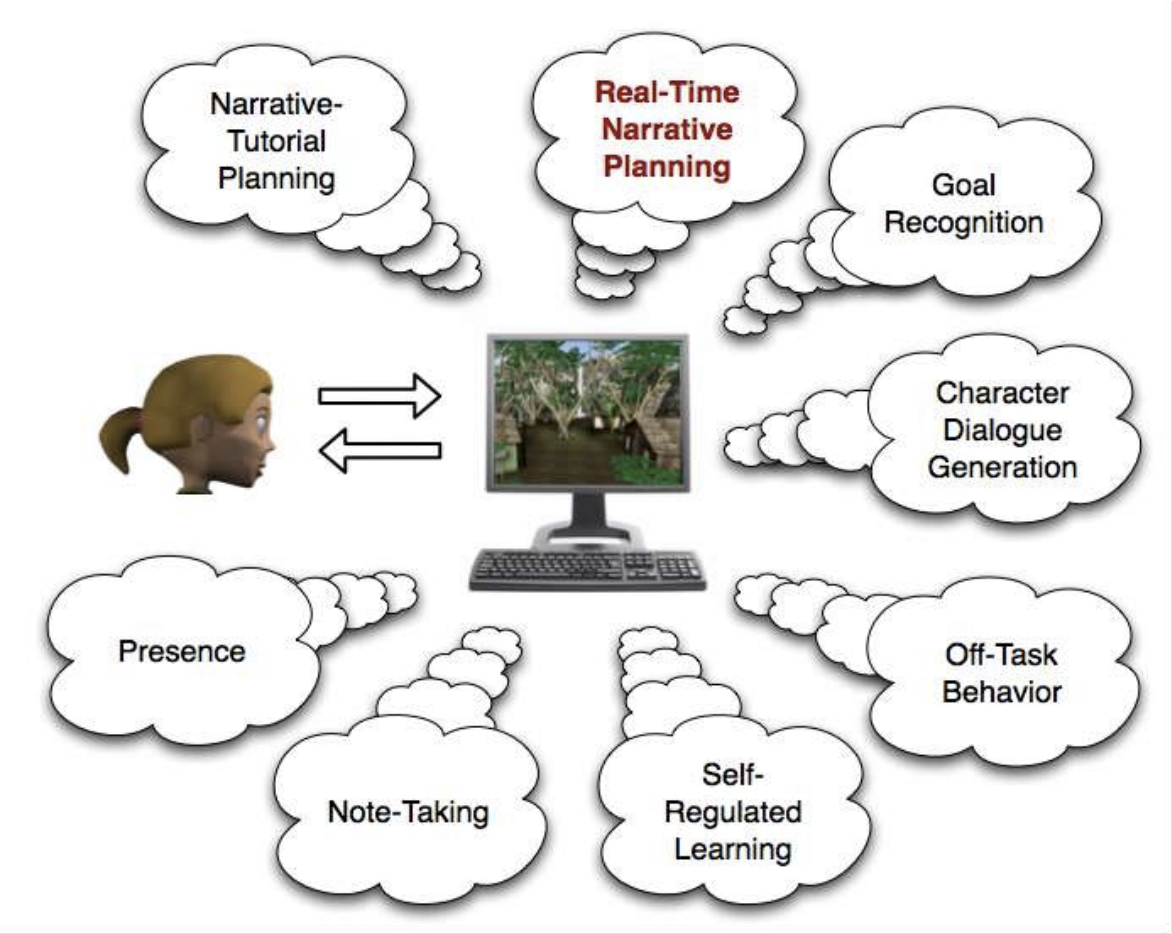
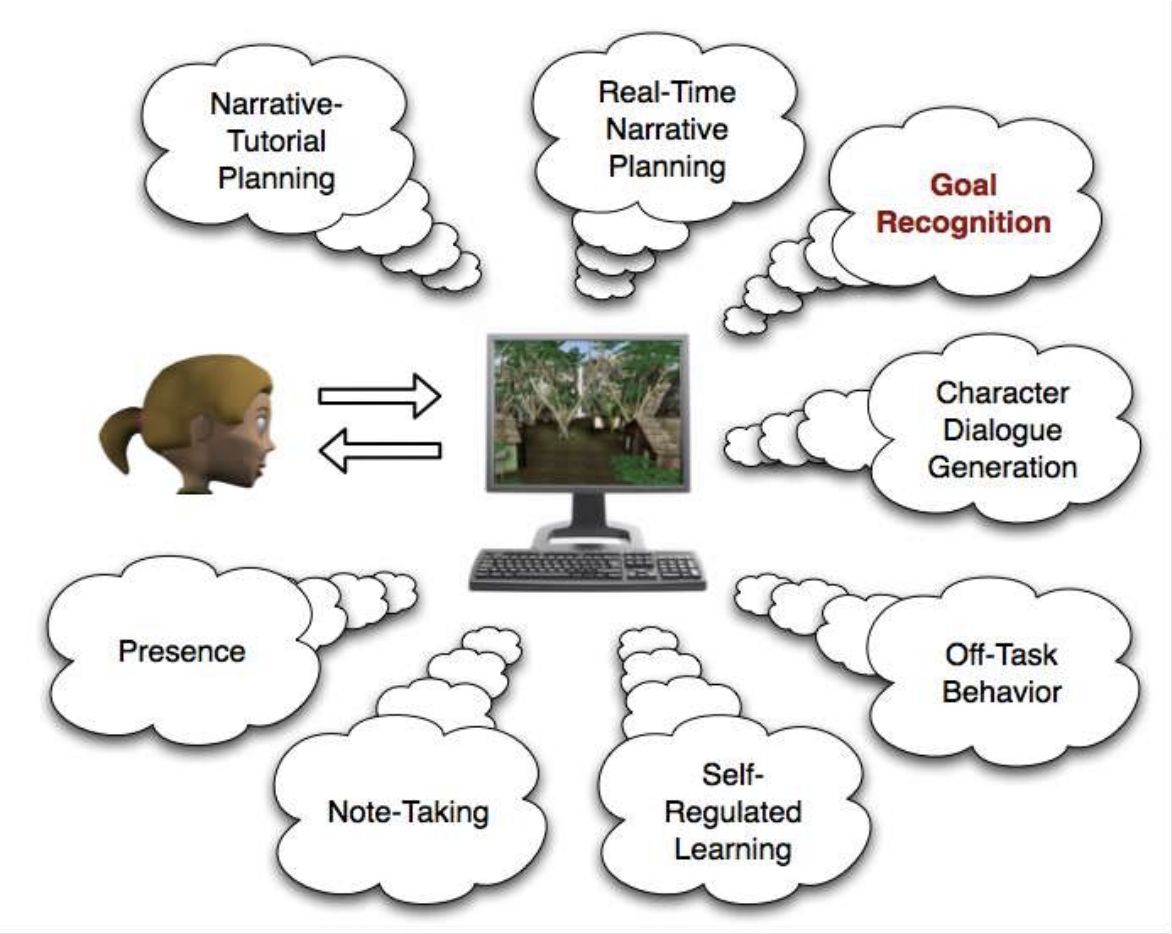
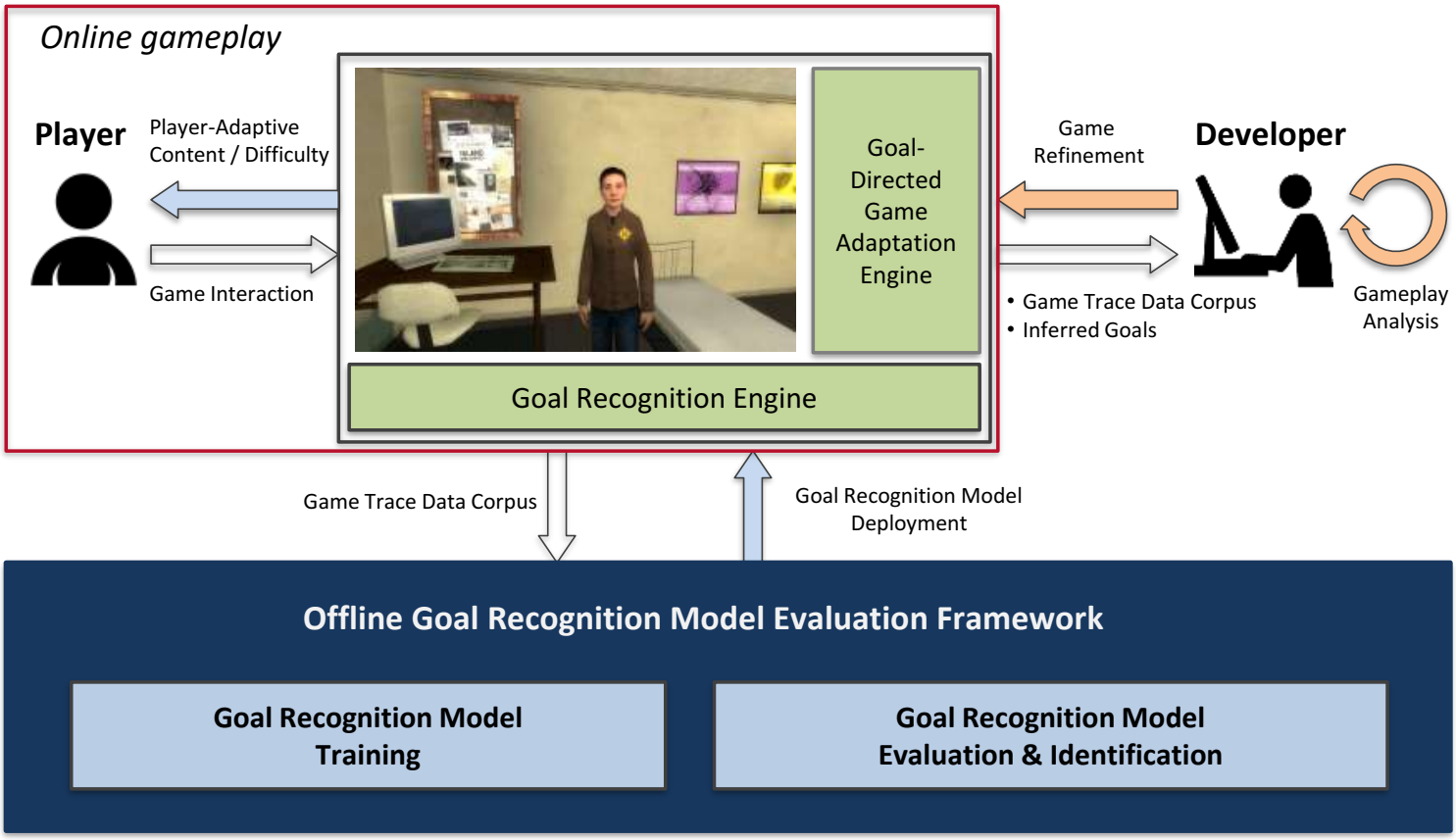


Narrative-Centered Learning



Goal Recognition in Narrative-Centered Learning



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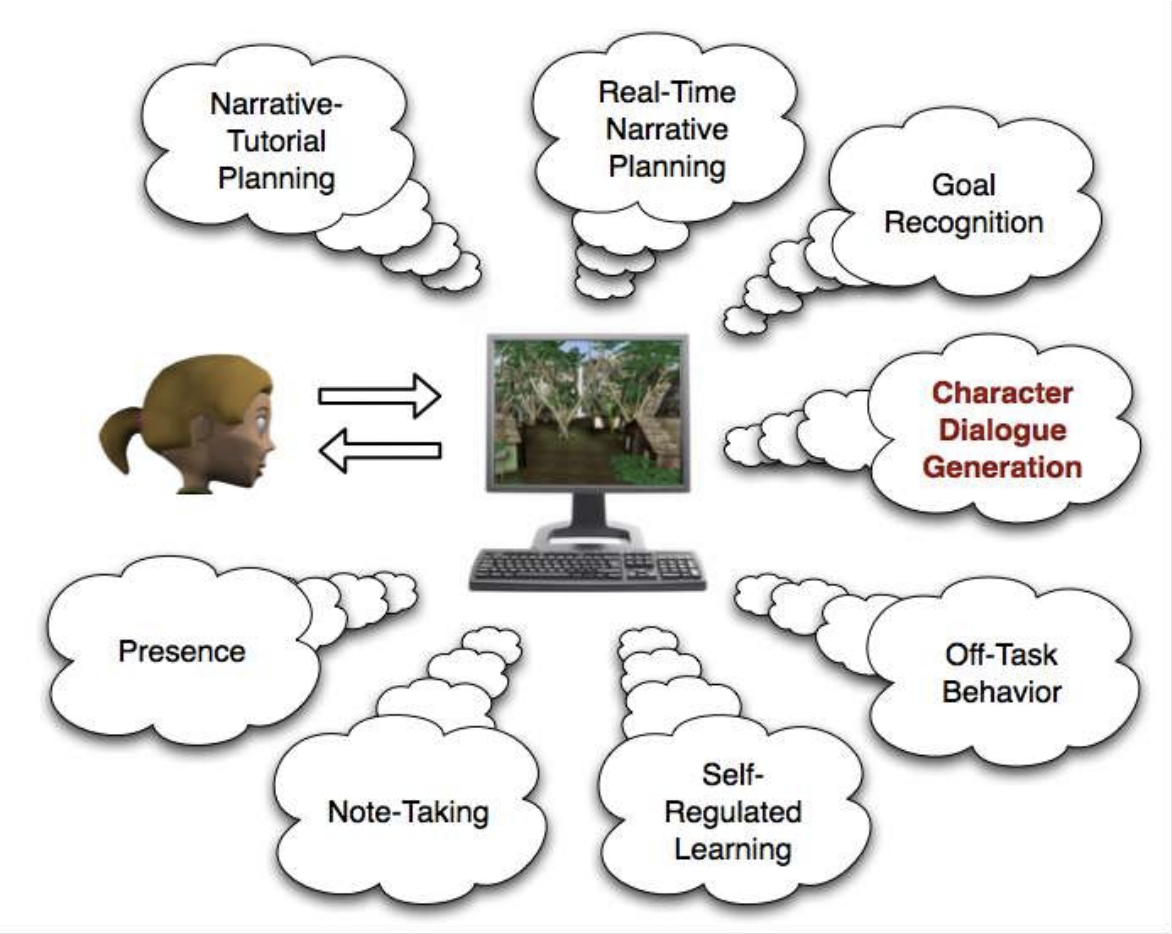

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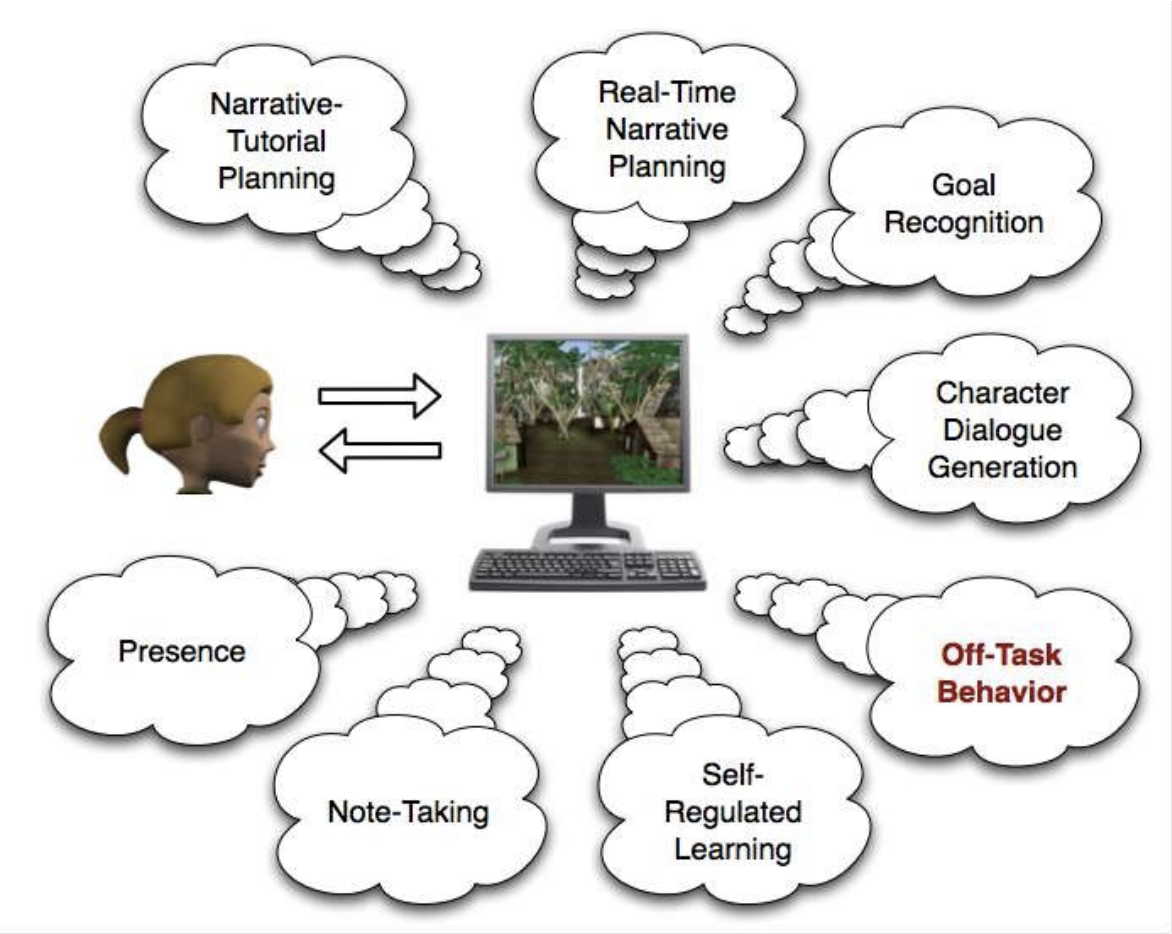

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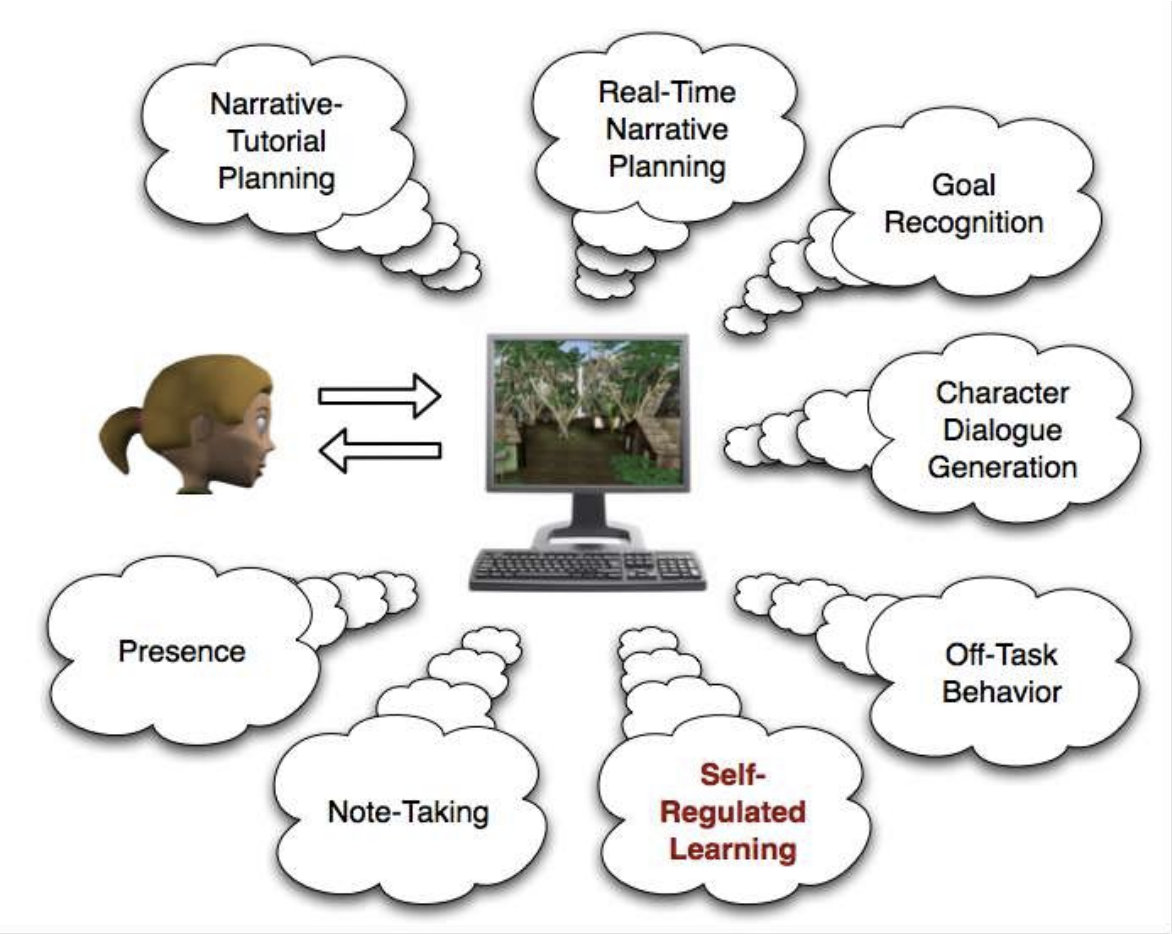

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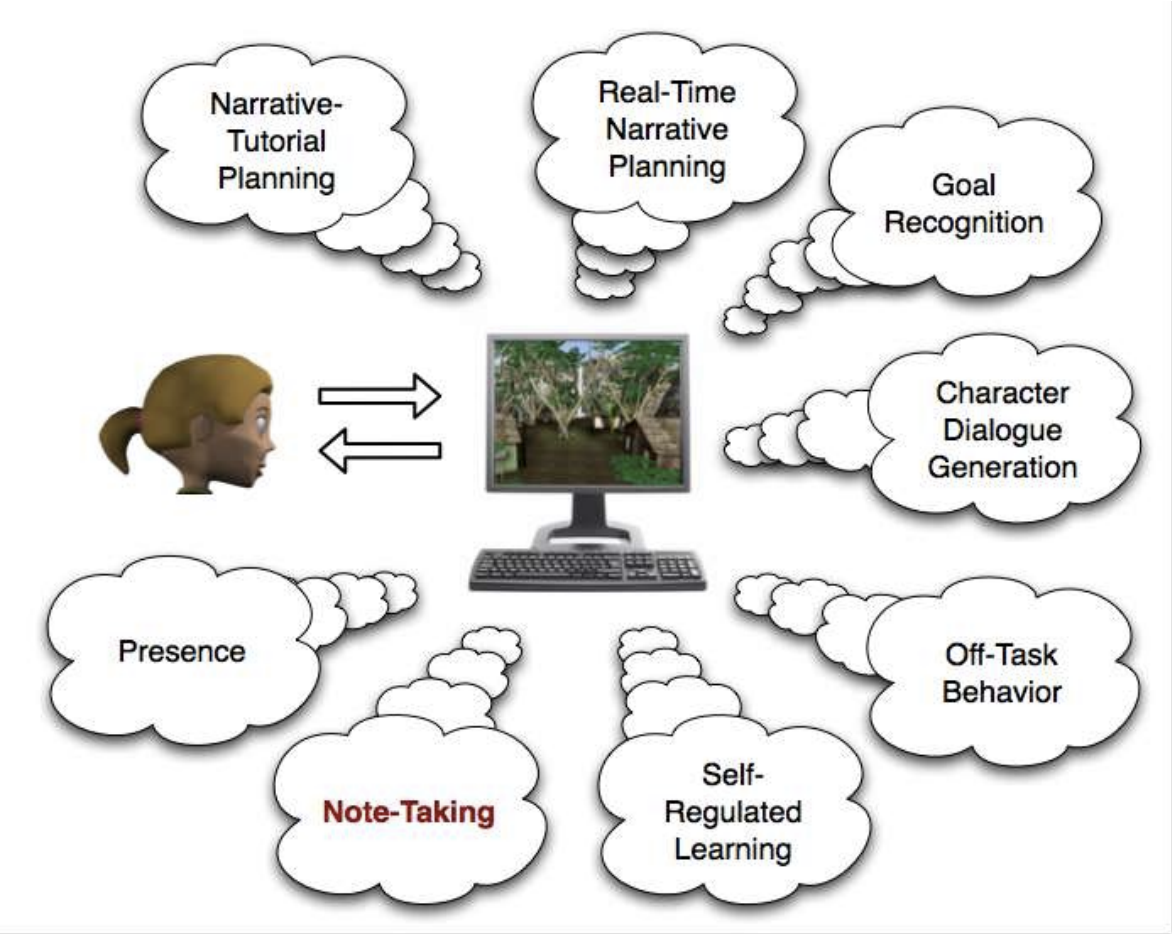

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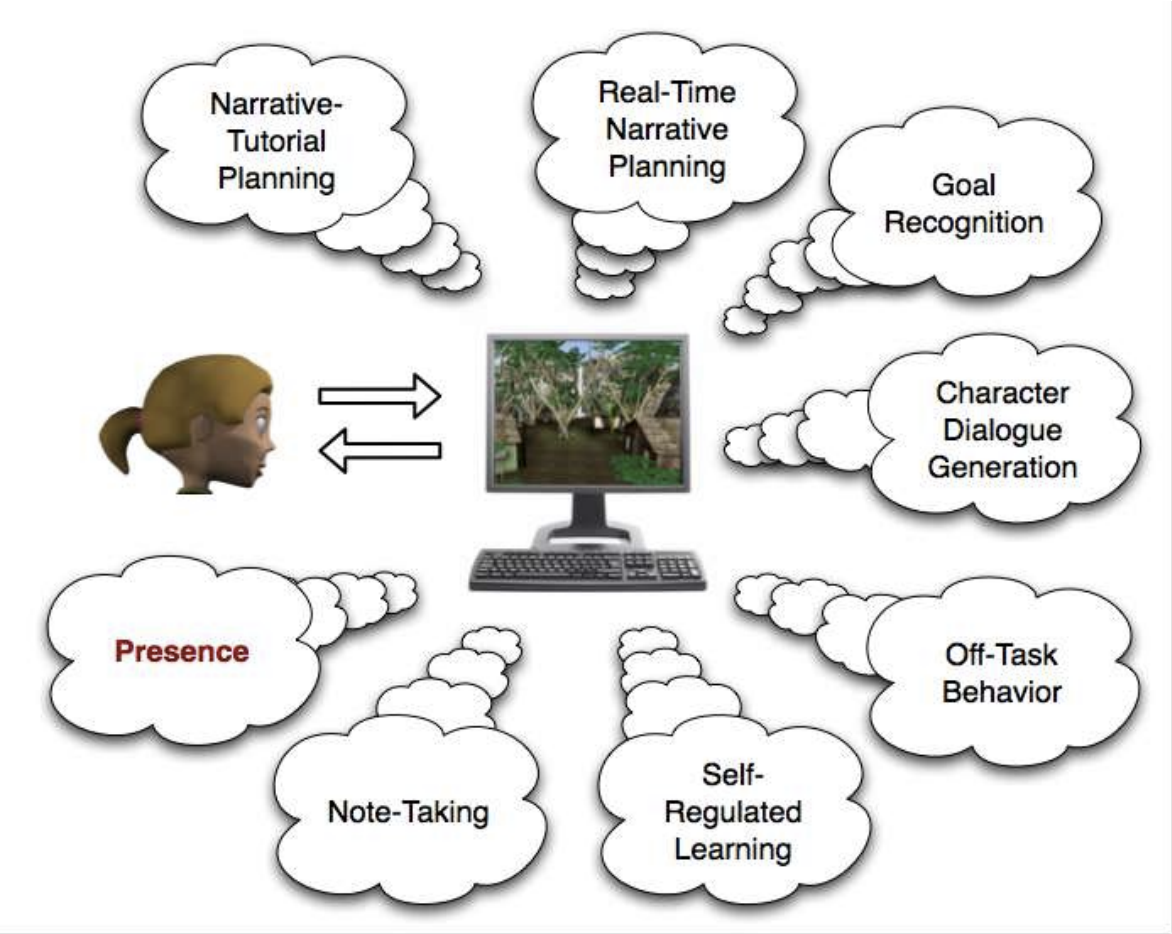

Narrative-Centered Learning in Informal Learning Contexts

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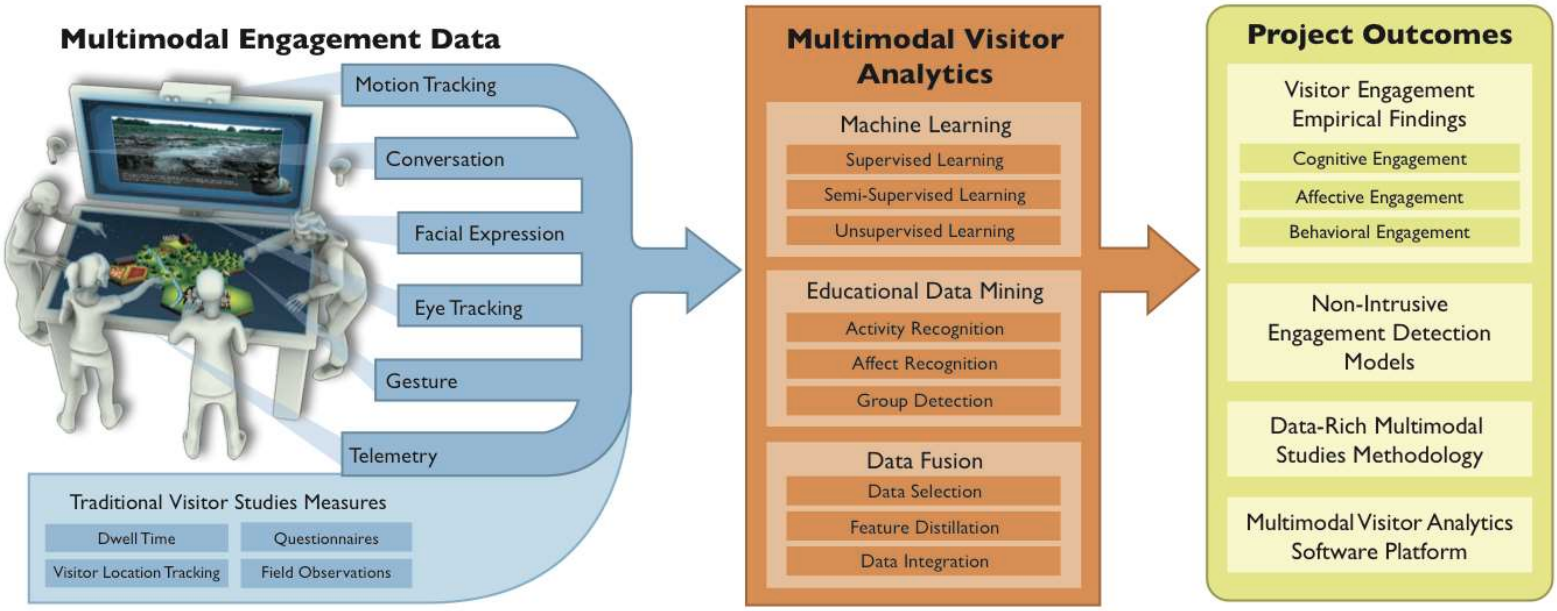
Multimodal Narrative-Centered Learning Analytics

- Science centers and museums
- Investigating visitor engagement
  - Cognitive
  - Affective
  - Behavioral
- Multimodal sensor streams

Multimodal Narrative-Centered Learning Analytics



Narrative-Centered Learning for Health Behavior Change

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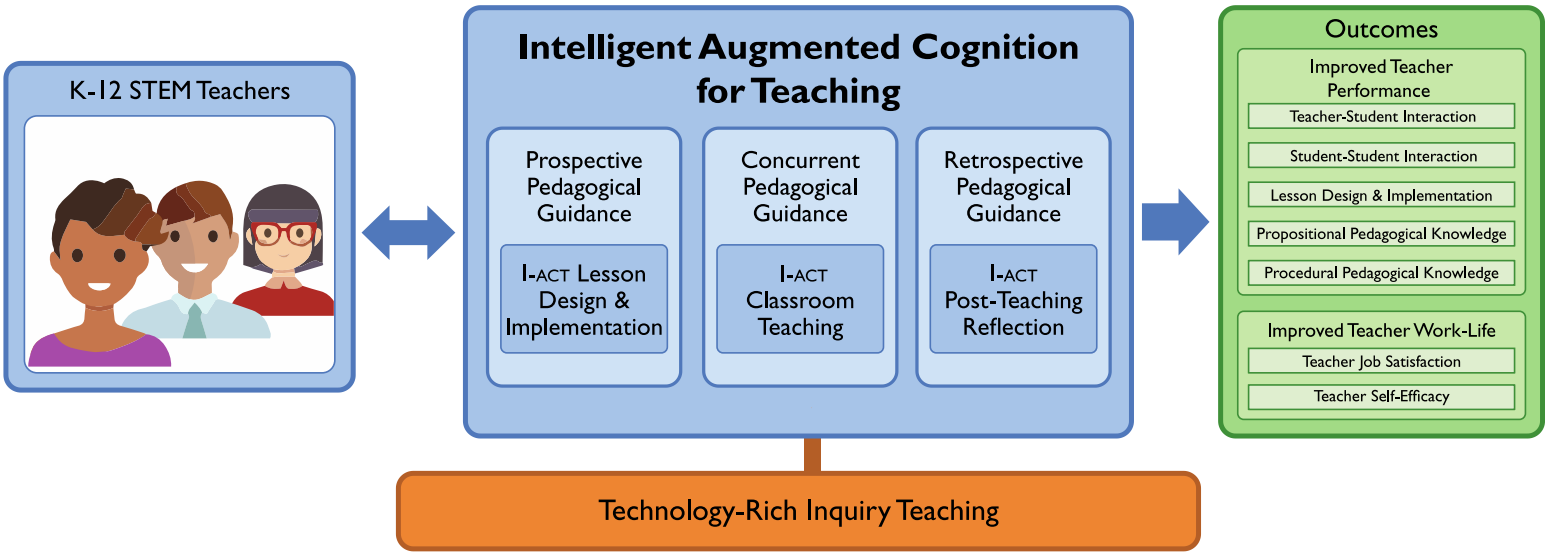
Intelligent Narrative-Centered Classrooms of the Future

I-ACT: Intelligent Augmented Cognition for Teachers



Intelligent Narrative-Centered Classrooms of the Future

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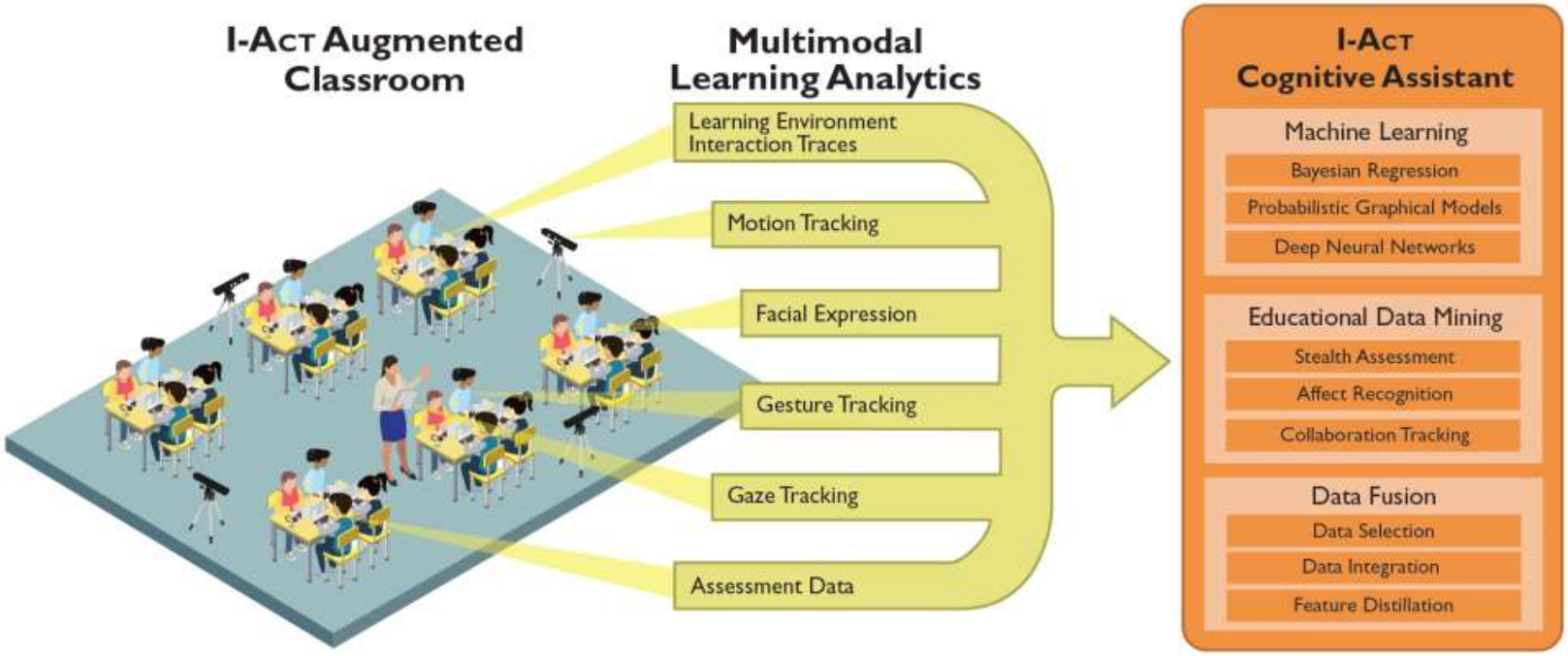
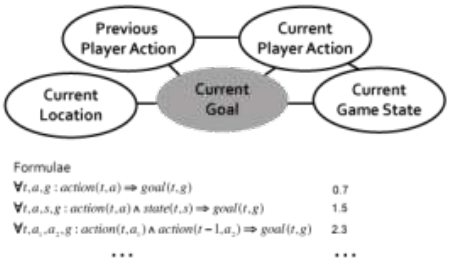
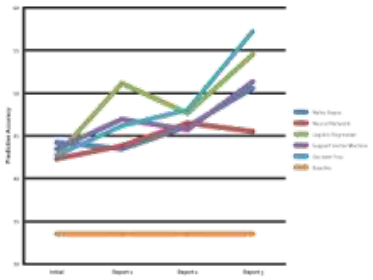


Future of Narrative-Centered Learning

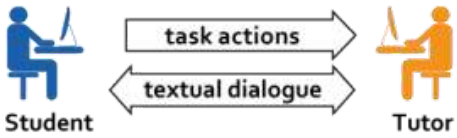
Intention Recognition



Self-Regulated Learning



Tutorial Dialogue



Affect Modeling

Scaling Narrative-Centered Learning

- Goal: Design robust story-rich pedagogical support for learner-adaptive interactions
- Potential Impact: Narrative-tutorial planning generalized from training populations to unseen students for high engagement

Conclusions

- Personalized learning poses significant computational challenges.
- Designing narrative-centered environments holds considerable promise for fine-grained, real-time in-classroom and out-of-classroom learning.
- Integrating rich cognitive student modeling and affective student modeling offers considerable potential for personalized learning.
- Narrative-centered learning with adaptive scaffolding offers promise for supporting engaging learning experiences on a broad scale.

Acknowledgements

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