



Institute for Intelligent Systems
THE UNIVERSITY OF MEMPHIS



The role of ChatGPT4 in developing adaptive artificial learning companions

Art Graesser



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Early Intelligent Conversational Agents in Learning Sciences



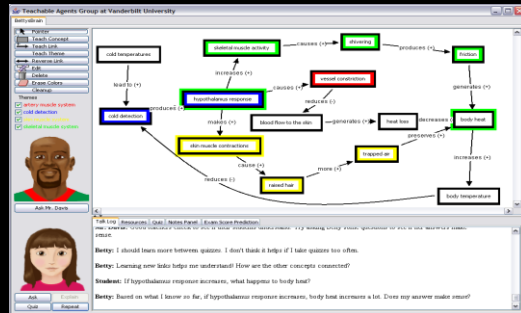
STEVE (procedural training, Johnson & Rickle)



iSTART (reading, McNamara)



Tactical Language and Culture System (Johnson)

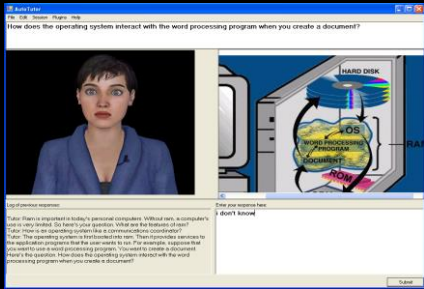


Betty's Brain (biology mental models, Biswas)



Herman-the-Bug (biology VR, Lester)

Memphis Intelligent Conversational Agents



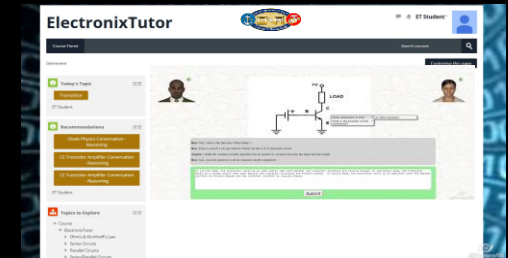
AutoTutor
(computer literacy)



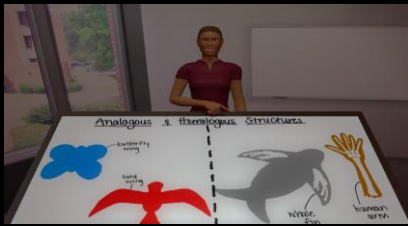
AutoTutor (reading comprehension)



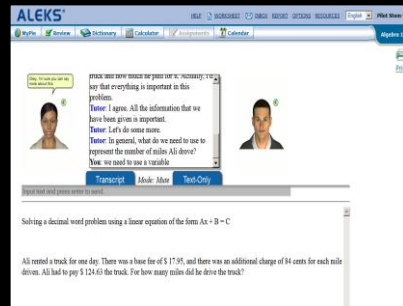
ARIES (scientific reasoning)



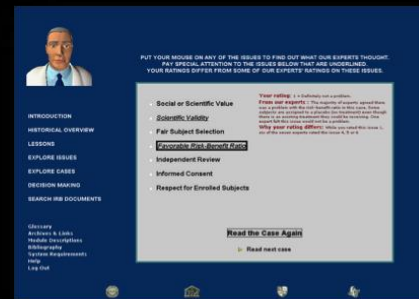
ElectronixTutor



Guru (biology)



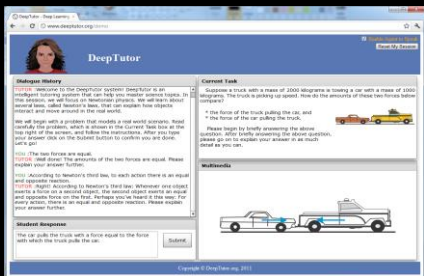
AutoTutor (with ALEKS algebra)



HURA Advisor
(research ethics)



Personal Assistant for Lifelong Learning (PAL3)



DeepTutor (physics)

Adaptive Trialogues

Expert



Fellow Student

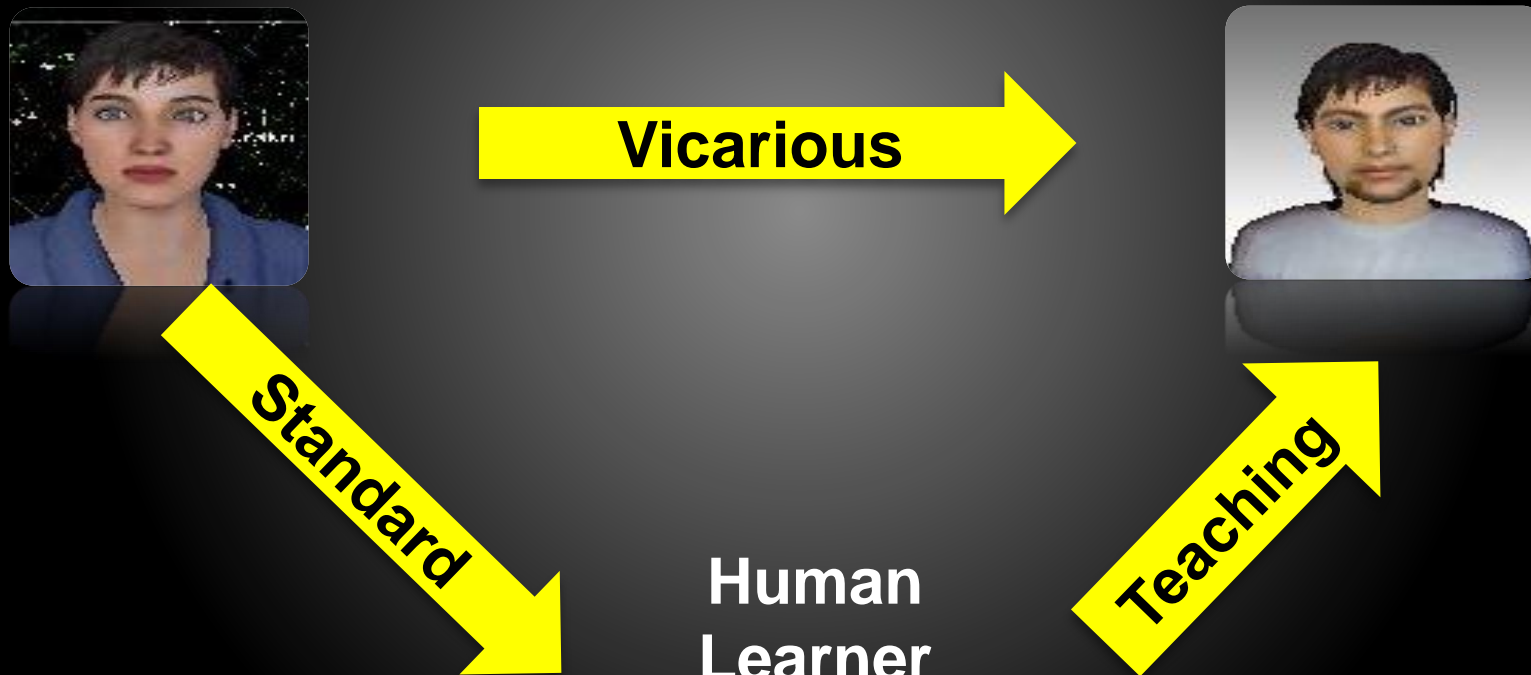


Vicarious

Standard

Human
Learner

Teaching



Discourse Mechanisms of the AutoTutor family

- AutoTutor doesn't lecture. Instead, it gets the student to talk and do following the principles of active, constructive, interactive learning.
- **Expectation and misconception tailored** dialog.
- Important AutoTutor dialogue moves are:
 - deep questions, pumps, hints, prompts for a specific answer, requests for summaries, feedback, corrections.
- It may take dozens of turns to covering an answer to a deep reasoning question or a difficult problem to solve.

ChatGPT arrived 1 year ago

- **How can ChatGPT and other Large Language Models help us build adaptive, intelligent learning companions?**
- **ChatGPT generates information in response to a prompt (e.g., question, request). It delivers information very impressively.**
- **ChatGPT has no model of what the student knows so it does not systematically participate in multi-turn conversation threads.**
 - **Can clever prompt engineering emulate conversations that help students learn in spite of ChatGPT's limitations?**
 - **What is the half-life of a coherent conversation with ChatGPT as a tutor?**

Towards Automated ITS Induction



Robin Schmucker
CMU



Meng Xia
CMU/Texas A&M



Amos Azaria
Ariel University



Tom Mitchell
CMU

Ruffle&Riley

A step towards **automated** and **domain-independent** conversational ITSs

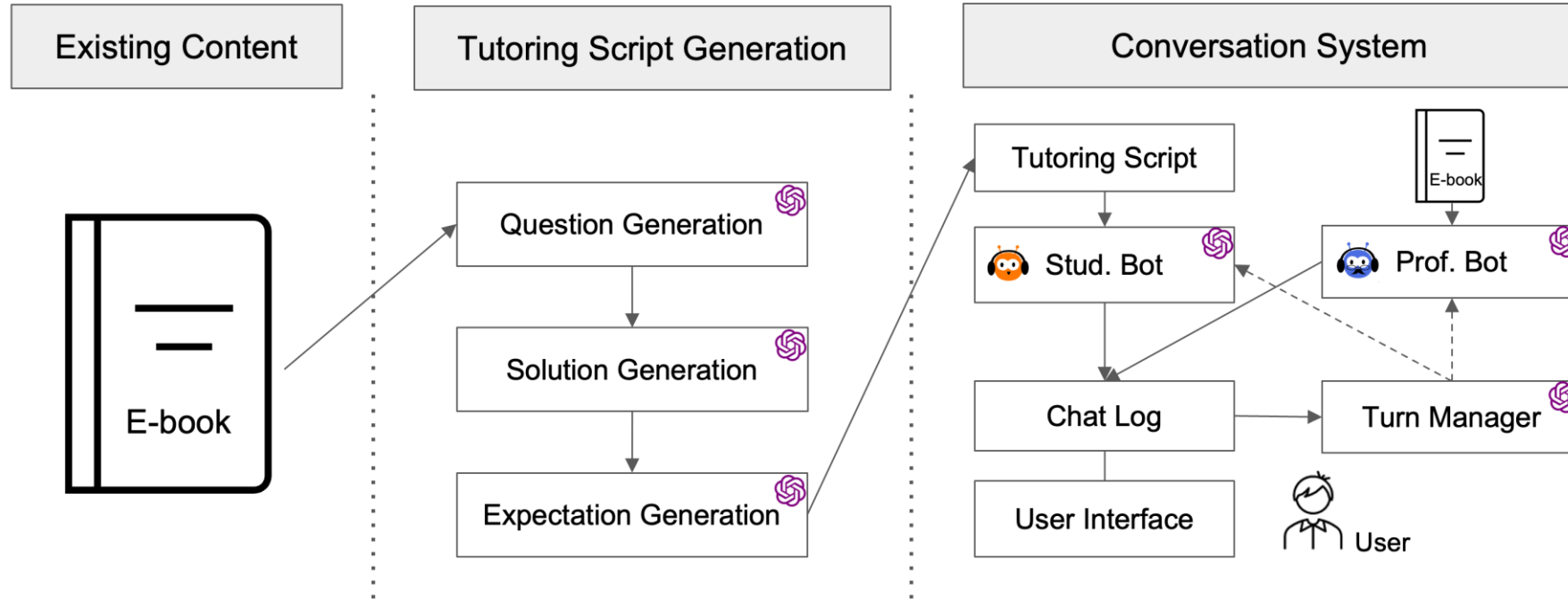
- Generates tutoring workflow *automatically* around existing content
- *Free-form* conversational tutoring in *learning-by-teaching* format
- Two *LLM-based agents* with the roles of student and professor
- Uses *Expectation Misconception Tailoring* (EMT) to structure dialogs



Paper Link

Ruffle&Riley: Architecture

Employ GPT-4 for tutoring **script generation** and **orchestration**



System Architecture

Ruffle&Riley: User Interface

Pre-existing
textbook content

Free-form
dialog

Student Chat:

a

Nice to meet you, Teacher! I am Ruffle. Thank you so much for helping me study biology. I love to learn!

Hello! I'm eager to learn about cell biology. Could you please explain what the phrase "form follows function" means in this context?

The structure of cell components and organelles evolved to support their specialized functions.

Thank you for your explanation! So, "form follows function" in cell biology means the structure of cell components and organelles supports their specialized functions.

Could you provide an example to illustrate this concept?

type here

Professor: [Request Help](#)

Please help the student learn the material.

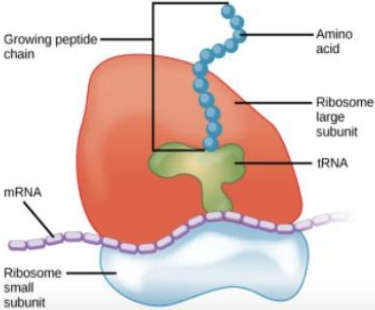
Organelles in Eukaryotic Cells **b**

"Form follows function" is a philosophy that many industries follow. In architecture, this means that buildings should be constructed to support the activities housed within them. For example, a skyscraper should include several elevator banks. A hospital should have an easily accessible emergency room.

Our natural world also utilizes the principle of form following function, especially in cell biology. The structure of cell components and organelles evolved to support their specialized functions. For example, in the pancreas there are cells that are responsible for producing digestive enzymes, which are specific types of proteins that help with food digestion. In these cells, ribosomes, the organelle responsible for protein synthesis, are found in high numbers. Here the form (high number of ribosomes) follows the function (protein production). Apart from ribosomes, cells have numerous other organelles. These organelles are specialized compartments inside the cells, and similar to the organs in your body, each organelle has a unique role. In this lesson, we will dive into several examples of organelles and discuss their specific functions.

Ribosomes

Ribosomes are the cellular structures responsible for protein synthesis. They may group together into clusters (polyribosomes) or individual ribosomes may float freely in the cytoplasm. They may be attached to the plasma membrane's cytoplasmic side or the endoplasmic reticulum's cytoplasmic side and the nuclear envelope's outer membrane. Ribosomes are large protein and RNA complexes, each consisting of two subunits, one large and one small (Figure 1). Ribosomes receive their "orders" for protein synthesis from the nucleus where the DNA transcribes into messenger RNA (mRNA). After transcription, the mRNA exits the nucleus and travels to the ribosomes located in the cytoplasm. The ribosomes then translate the code provided by the sequence of the nitrogenous bases in the mRNA into a specific order of amino acids linked together to form proteins. Amino acids are the building blocks of proteins.



The diagram illustrates the structure of a ribosome during protein synthesis. It shows a large red ribosome subunit and a smaller blue ribosome subunit. A green rRNA molecule is embedded within the large subunit. A purple mRNA strand is positioned between the two subunits. A blue growing peptide chain is attached to the large subunit, with individual amino acids (represented as small blue spheres) being added to the chain. Labels include: Growing peptide chain, Amino acid, Ribosome large subunit, rRNA, mRNA, and Ribosome small subunit.

User Interface

c

I don't know.

No worries at all! If you could request help from the professor, that would be fantastic. I'm really interested in understanding this concept better with an example.


Intelligent
Feedback

Professor: [Request Help](#) **d**

Of course! You could use the example of ribosomes in the pancreas cells. These cells have a high number of ribosomes because they are responsible for producing digestive enzymes, a type of protein. Here, the form (high number of ribosomes) follows the function (protein production).

On demand
assistance

Enzymes that are produced by mitochondria **e**

 Revision required

type here

Professor: [Request Help](#)

It seems there's a small mistake in your response. Mitochondria are actually responsible for producing ATP, not enzymes. Could you please revise your response?

Misconcept.
Correction

Xianguen Hu's **Socratic** Playground for Learning

- Prompt engineering for different tutoring styles and pedagogies

University of Memphis and Moving to Hong Kong Polytechnical University



The Playground has different resources to help students learn

The image shows a screenshot of the 'Socratic Playground for Learning' interface. On the left, there is a profile for an AI character with a bust of Socrates. Below the profile are buttons for 'What?', 'Why?', 'How?', 'Which?', and 'When?'. A dropdown menu labeled 'Socratic Interactio' is open, showing a list of activities: 'Select Activity', 'Bloom', 'TIMSS', 'Socratic Interaction' (highlighted in blue), 'APA 20 principles', 'CbITS', 'Teachable Agent', 'Self-Reflection', 'Game of 20 Questions', and 'the Jeopardy Game'. The main chat area contains three messages from the AI character, each with a small icon of Socrates. The first message says: 'Hello! I'm an AI programmed to help in your knowledge-seeking quest. In our Socratic-style interaction, I'll answer questions subtly by posing reflective questions back, prompting critical thinking. Are you ready to start our Socratic dialogue?'. The second message says: 'Socratic teaching is a teaching method that fosters critical thinking through dialogue, questioning, and reflecting. Based on Socrates' teaching style, it encourages students to question their preconceptions and explore ideas logically by themselves, thus promoting intellectual independence.'. The third message says: 'In Socratic teaching, I'll guide you through a process of inquiry and discussion. Instead of direct lecture, I'll ask you questions designed to stimulate critical thinking and illuminate ideas. This method encourages active participation, self-discovery, and the development of your own thoughts and perspectives on the topics we explore.'. At the bottom of the chat area, there is a footer: 'Socratic Playground for Learning. the University of Memphis, All rights reserved'. On the right side of the interface, there is a large list of activities: 'Select Activity', 'Bloom', 'TIMSS', 'Socratic Interaction' (highlighted in blue), 'APA 20 principles', 'CbITS', 'Teachable Agent', 'Self-Reflection', 'Game of 20 Questions', and 'the Jeopardy Game'. At the bottom left of the interface is a 'Login' button and at the bottom right is an 'About' button.

What?

Why?

How?

Which?

When?

Socratic Interactio

Select Activity

Bloom

TIMSS

Socratic Interaction

APA 20 principles

CbITS

Teachable Agent

Self-Reflection

Game of 20 Questions

the Jeopardy Game

Hello! I'm an AI programmed to help in your knowledge-seeking quest. In our Socratic-style interaction, I'll answer questions subtly by posing reflective questions back, prompting critical thinking.

Are you ready to start our Socratic dialogue?

Socratic teaching is a teaching method that fosters critical thinking through dialogue, questioning, and reflecting. Based on Socrates' teaching style, it encourages students to question their preconceptions and explore ideas logically by themselves, thus promoting intellectual independence.

In Socratic teaching, I'll guide you through a process of inquiry and discussion. Instead of direct lecture, I'll ask you questions designed to stimulate critical thinking and illuminate ideas. This method encourages active participation, self-discovery, and the development of your own thoughts and perspectives on the topics we explore.

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Select Activity

Bloom

TIMSS

Socratic Interaction

APA 20 principles

CbITS

Teachable Agent


Self-Reflection

Game of 20 Questions


the Jeopardy Game

Login


About



To answer the question, read the paragraph and scroll down to the bottom.



Hi!



Theory and Hypothesis

Information

Descriptive Statistics

Inferential Statistics

Measurement Scale

Normal Distribution

Hypothesis Testing


P-Value

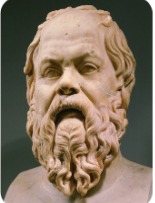
Correlation

Regression Analysis

ANOVA

Factorial Design





Hi, I'm your AI partner. I'm here to help you learn in a Socratic style, meaning we'll uncover new knowledge through probing questions and critical thinking.

Are you ready to commence this interactive journey?

assess their s, which

ch as hints or next

out how an

What?

Why?


How?

Which?

When?

Self-Reflection ▾

Ask a question



Socratic Playground for Learning. the University of Memphis, All rights reserved

Generative AI interactions can be easily presented by Avatars

Research Questions for the Future

- **Can clever prompt engineering emulate conversations that help students learn in spite of ChatGPT's limitations (e.g., no student model)?**
- **What is the half-life of a coherent conversation with ChatGPT as a tutor?**
- **Is ChatGPT more useful for training students for inquiry learning and self-regulated learning?**



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Thank you!

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