Learning with Cyber-Tutors

Art Graesser
Digital Tutor History In a Snapshot

Sleeman & Brown (1982)

Woolf (2009)

Conferences, proceedings, journals (1988 to present)


Army Research Lab
Intelligent Tutoring Systems that Improve Learning

Cognitive Tutor

Andes

AutoTutor

Sherlock

ASSISTments

SQL Tutor

Digital Tutor
Adaptive Intelligent Conversational Agents

STEVE
AutoTutor Trialogs
Guru (biology)
iSTART (reading)
DeepTutor (physics)
Betty’s Brain
Herman-the-Bug

Tactical Language and Culture System
AutoTutor Trialogs with ALEKS algebra (ONR STEM Challenge)
Mission Rehearsal

ONR STEM Challenge
Generalized Intelligent Framework for Tutoring
Army Research Lab and University of Memphis

www.gifttutoring.org


• Learner modeling (2013)
• Instructional strategies (2014)
• Authoring Tools (2015)
• Domain knowledge (2016)
• Assessment (2017)
• Teams (2018)
Generalized Intelligent Framework for Tutoring (GIFT)

Diagram:
- Local tutoring processes
  - Sensor Module
  - Learner Module
  - Pedagogical Module
  - Domain Module
  - Tutor-User Interface
- Services:
  - Learning Management System (LMS)
  - Service-Oriented Architecture
  - Gateway(s)
  - Training App Client
  - Training App Server

Connections:
- to/from LMS
- to/from gateway(s)
- to/from Training App Server
- to/from Training App Client
- to/from Domain Module
Digital Tutor Learns with Experience

- Content created with authoring tools
- Content modified with experience, data, and machine learning
The Total Learning Architecture is a collection of specifications for accessing and making use of learning-related data.

Sae Schatz
• Train sailors out of boot camp on electronic circuits
• Integrate multiple resources developed by partners in the ONR STEM Challenge:
  University of Memphis
  Arizona State University
  Worcester Polytechnic Institute
  BBN/Raytheon
  University of Southern California
  Other resources

Office of Navel Research Program Officers
Ray Perez
Commander Brent Olde
NEETS Training documents, Navy

AutoTutor Trialogs, Memphis

Dragoon mental models Arizona State

BEETLE simple circuits Edinburgh, Navy

Point & Query, Memphis

LearnForm Circuit problems, BBN/Raytheon

ASSISTments skill builders, WPI
15 Topics

<table>
<thead>
<tr>
<th>Topic #</th>
<th>Topic Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ohm's Law &amp; Kirchhoff's Law</td>
</tr>
<tr>
<td>2</td>
<td>Series VS Parallel Circuit</td>
</tr>
<tr>
<td>3</td>
<td>Series + Parallel Combination</td>
</tr>
<tr>
<td>4</td>
<td>Filter</td>
</tr>
<tr>
<td>5</td>
<td>PN Junction</td>
</tr>
<tr>
<td>6</td>
<td>Rectifier</td>
</tr>
<tr>
<td>7</td>
<td>Power supply</td>
</tr>
<tr>
<td>8</td>
<td>Diode Limiter &amp; Clamper</td>
</tr>
<tr>
<td>9</td>
<td>Zener Diode &amp; Regulator</td>
</tr>
<tr>
<td>10</td>
<td>Transistors</td>
</tr>
<tr>
<td>11</td>
<td>CE Amplifiers</td>
</tr>
<tr>
<td>12</td>
<td>CC Amplifiers</td>
</tr>
<tr>
<td>13</td>
<td>CB Amplifiers</td>
</tr>
<tr>
<td>14</td>
<td>Multistage Amplifiers</td>
</tr>
<tr>
<td>15</td>
<td>PushPull Amplifiers</td>
</tr>
</tbody>
</table>

Knowledge Component (KC) Labeling

- Devices
- Circuits
- Structure
- Behavior
- Function
- Parameter

KC list (Partial)

- Clamper Structure
- Clamper Function
- Resistor Structure
- CE Transistor Fixed Bias Function
- CE Transistor Fixed Bias Structure
- CB Transistor Amplifier AC Behavior
- CB Transistor Amplifier DC Behavior
- CB Transistor Amplifier Function
- CC Transistor Amplifier Function
- CC Transistor Amplifier AC Behavior
- CC Transistor Amplifier DC Behavior
- CC Transistor Amplifier Parameter
- CC Transistor Amplifier Structure
- CE Push Pull Amplifier AC Behavior
- CE Push Pull Amplifier DC Behavior
- CE Push Pull Amplifier Function
Learning Record Store

- Repeat Topic
- Unmotivated Bottom Dweller
- Motivated Bottom Dweller
- Focus on Low KCs
- Pushing Envelope
- Reading
- Circuit Basics
- Electronic Laws
- Knowledge Check
- Circuit Reasoning
- Deep Reasoning
- Simulation and Modeling

Recommendation

Students

Conflict Resolution

Item Sorting based on difficulty level

Topic Performance

Knowledge Component Performance
Personal Assistant for Life Long Learning (PAL3)

PAL3 is a computerized personal assistant to a learner to:

- Keep a life-long learning record of performance & goals
- Prevent skill decay across transitions
- Estimate learner progress and mastery
- Adaptively sequence different learning resources
Learning Continuum and Performance Aid (LCaPA:2018)

Supervisor

Performance Tracking Tool

Instructor

LMS / LMR

External Training Resources

Intelligent Instructional Systems

Training Objectives and Modules

Simulations

KSA Lists

Career Path Tool

PAL3

Selection / Job Fit Tests

User
PAL3 – Four Loop Adaptivity

Meta-Adaptive

Change System

Macro-Adaptive

Change Problem

Step-Adaptive

Change Step

Micro-Adaptive

Select Task

Problem

Help/Feedback

"Sorry, that’s not quite right."

Input/Events

Data-Optimized

OR

Interaction/Style

"B is right because..."

OR

"Why is B right?"

OR

(Highlights Answer B)
PAL3 Features

Personalized Recommendations

Guided Models & Simulations

Existing HTML Links & Videos

Interactive Computer Tutoring

Competitive Leaderboards

Achievements to Encourage Effort
Critical Next Steps

• Investments in research & development
• Rapid content development
• Data science
• Recommender systems
Thank you!

graesser@memphis.edu