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Where to start?

https://www.isi.edu/isd/VET/vet-body.html
STEVE had a huge impact!

In truth... STEVE was revolutionary.

- Along with Adele, Herman the Bug, and others, this work set 20 years of research into motion.

- “This opens up exciting new possibilities; for example, agents can demonstrate complex tasks, employ locomotion and gesture to focus students’ attention on the most salient aspect of the task at hand, and convey emotional responses to the tutorial situation” (p.47, Johnson, Rickel, Lester, 2000).

- “pedagogical agents will further require the collaboration of communication theorists, linguists, graphics specialists, and animators” (p.74).
# Plan

<table>
<thead>
<tr>
<th>MOTIVATION</th>
<th>Why build PAs? What makes them interesting to study?</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHALLENGES</td>
<td>What makes building a PA difficult? What problems must be solved?</td>
</tr>
<tr>
<td>ROLES</td>
<td>What kinds of PAs exist? How do learners interact with them?</td>
</tr>
<tr>
<td>DESIGN</td>
<td>What decisions must be made when you create a PA?</td>
</tr>
<tr>
<td>RESEARCH</td>
<td>Are PAs effective? What do we know about their impact?</td>
</tr>
<tr>
<td>FUTURE</td>
<td>What is next for PAs? What further research is needed?</td>
</tr>
</tbody>
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## PAs expand communicative bandwidth

A pedagogical agent is an animated character that seeks to promote learning and enhance motivation to engage in a learning activity.

- **the agent can inhabit the space w/the learner**
- **provide navigational support**
- **direct attention; use gaze & gestures; give demonstrations**
- **be a part of the story; collaborate**
- **emote & send social signals**
- **build rapport & solidarity**
- **establish sense of presence**
- **ask questions and give explanations**
- **converse with learner**
- **give feedback & hints**

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PAs are interesting to design, build, & study

- Requires integration of wide-ranging expertise and technology
  - Art and animation
  - Natural language processing / speech
  - Gestures & nonverbal communication
  - Situation awareness; path planning
- Promotes a more nuanced view of pedagogy
  - Intersection of pedagogy, affect, gesture, and communication
  - Nearly impossible to treat these independently
  - Potential to advance understanding of human tutoring & teaching
- Enables fine-grained investigation of learning & interaction

Cognitive Load

- Common argument against PAs is that they overload the learner’s working memory capacity
- It certainly *can*:
  - Mayer found Herman the Bug’s presence increased extraneous cognitive load
  - Poorly designed PAs can be a *distraction*
- But it doesn’t have to:
  - Schroeder (2017) compared agent vs. narration and found no difference on learning & perceived self-effort.
  - Wouters et al. (2008) – similar message. Design carefully!
More challenges

- People only notice when you get it wrong.
- Identifying best role & design
  - Surprisingly huge decision space (more later)
- Potentially profound differences exist wrt to perception of agents
  - E.g., gender (Pezzullo et al., 2017)

Ada & Grace (Swartout et al., 2010)

Roles

<table>
<thead>
<tr>
<th>Tutor / coach</th>
<th>Role player</th>
<th>Peer / companion</th>
<th>Teachable agent</th>
<th>“Advocate”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embodied ITS</td>
<td>Simulation</td>
<td>Non-expert co-learner</td>
<td>Reciprocal teaching</td>
<td>Persuasive</td>
</tr>
<tr>
<td>Knowledgable / usually an expert</td>
<td>Agent is target of practice</td>
<td>Empathetic partner</td>
<td>human learner teaches agent</td>
<td>Focuses on attitudes, interest, and engagement</td>
</tr>
<tr>
<td>Monitors work</td>
<td>Common for social skills (language learning, interviewing)</td>
<td>Can make suggestions and/or learn from student</td>
<td>Protégé effect (Chase et al, 2009)</td>
<td>“Salesperson” for learning</td>
</tr>
<tr>
<td>Offers advice, hints, feedback, etc.</td>
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</table>

MOTIVATION CHALLENGES ROLES DESIGN RESEARCH FUTURE
Coach Mike

MOTIVATION  CHALLENGES  ROLES  DESIGN  RESEARCH  FUTURE
HARRY: Now, are you telling me that's not worth twenty shekels?
BRIAN: No.
HARRY: Look at it. Feel the quality.
BRIAN: All right. I'll give you nineteen then.
HARRY: No, no, no. Come on. Do it properly.
BRIAN: What?
HARRY: Haggle properly. This isn't worth nineteen.
BRIAN: Well, you just said it was worth twenty.
BRIAN: Huh. All right. I'll give you ten.
HARRY: That's more like it. Ten?! Are you trying to insult me?! Me, with a poor dying grandmother?! Ten?!
BRIAN: All right. I'll give you eleven.
HARRY: Now you're gettin' it. Eleven?! Did I hear you right?! Eleven?! This cost me twelve. You want to ruin me?!
BRIAN: Seventeen?
HARRY: No, no, no. Seventeen.
BRIAN: Eighteen?
HARRY: No, no. You go to fourteen now.
BRIAN: All right. I'll give you fourteen.
HARRY: Fourteen?! Are you joking?!
BRIAN: That's what you told me to say!!

Coaching + Role playing can be tricky!

https://www.youtube.com/watch?v=51_Qs8tq5c8
(youtube search: "life of brian haggle")

VCAT (Virtual Cultural Awareness Trainer)

http://www.alelo.com/
PA Design space

- Decision space is large:
  - Global / medium / detail (Heidig & Clarebout, 2011)

- Possible hidden complications
  - Biases
  - Unintended consequences

- Baylor & Kim (2017)
  - Expert / Motivator / Mentor

PA Research findings mostly mixed

- Some suggest evidence is limited:
  - Review showing gaps in studies, limited emphasis on motivation & learning outcomes (Heidig & Clarebout, 2011)
  - Learning not enhanced by image of agent (Moreno, et al., 2001)
  - Methodological flaws (Clark & Choi, 2007)

- Many studies use PAs to investigate precise questions
  - Confusion induction / trialogues (D’Mello, et al., 2014)
  - Cultural alignment (Finkelstein,...., Cassell, et. al., 2013)
  - Impact of gesture (Craig, et al., 2015; Cook, et al., 2017)
  - Impact of enthusiasm (Lane, et al., 2013)
Schroeder et al. (2013) Meta-analysis

| • Of 500+ found, 28 papers qualified (N=3088, k=43) |
| • Overall positive effect on learning (g = .19) |
| • Agent features: |
|   • Appearance did not matter |
|   • Animated > static |
|   • Text > Voice* |
| • Context |
|   • K-12 learners see greatest benefit |
|   • Gains seen most often in STEM areas* |
|   • Classroom > Lab* |

For More Information: [http://werpa.ict.usc.edu/](http://werpa.ict.usc.edu/)
What’s next?

- Methodological rigor – are we asking the right questions?
- Long term support for learning (PAL3 at USC ICT)
- Excitement/passion
  - generating interest / informal learning
- Emphasize need for precision with gesture
- Account for learner perspectives/perceptions
- Address potential concerns of teachers – fear of AI
  - Remind everyone of the supporting role of PAs
  - “Armies of PAs:” that can help address student needs

PAL3: Personal Assistant for Lifelong Learning (USC ICT / ASU / Memphis)

http://ict.usc.edu/prototypes/personal-assistant-for-life-long-learning-pal3/
Thanks to

- NSF
- CIRCL
- Scotty Craig
- Art Graesser
- Lewis Johnson
- James Lester
- Ben Nye
- Noah Schroeder
- Bill Swartout

Quiz answers

- Vault Boy (Fallout)
- Dog (Duck Hunt)
- Claptrap (Borderlands)
- Wheatley (Portal 2)
- RaY (Fortnite)
- Science Advisor (Civ5)
References


References continued


