

# Are Two Talking Heads Better Than One? When Should Use More Than One Agent in E-learning?

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## ABSTRACT

Recent interest in the use of software character agents raises the issue of how many agents should be used in online learning. In this paper we review evidence concerning the relative effectiveness of multi-agent systems and introduce a multiple agent system that we have developed for online instruction. A user test is carried out that compares one and two agent versions of the learning system. The results are interpreted in terms of their implications for selecting when and how more than one agent should be used in online learning. We conclude with some recommendations on when multiple agents may help online learners to interact with the learning environment more easily and efficiently.

## Categories and Subject Descriptors

H.5.2 [Information Interfaces and Presentation]: User Interfaces — Interaction styles, Theory and methods

## General Terms

Design, Experimentation

## Keywords

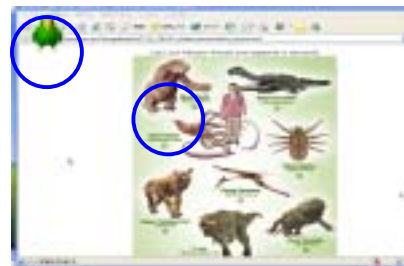
Character agent, multiple agents, tracing, eye tracking, e-learning, educational interface

## 1 INTRODUCTION

In real world interactions such as in restaurants, schools, and other settings, different roles are often carried out by different people. For instance, in a conference, a chairperson takes charge of the agenda, introduces the speakers, and manages the time. After introducing each speaker, the chairperson then hands off the responsibility for giving the presentation to the speaker. Many other examples can be presented of the multiple specialized roles that people perform in the systems and services that we interact with. There have been several attempts to use character agents to enrich interaction in online environments. However, there has been little discussion of how to efficiently and effectively assign roles to agents. Research guidance is needed on when and how multiple agents should be used to assist online interface users,

especially for online education. The interactions between multiple agents can facilitate information transmission. In many countries, items such as news, weather and sports presentation on television are distributed amongst multiple presenters, with a considerable amount of dialogue between the presenters as part of the information presentation. In education, young children frequently have a teacher as well as one or more teacher's aides in the classroom who may have a number of roles depending on the culture at the school as well as their abilities

In our multiple agent version, one agent is used to communicate with learners about their interests, and to ask about the topics they are going to learn, while one or more other agents present the educational content. An additional agent may act as the system mediator between learner and system to provide users with feedback concerning their concentration, etc. Debates and presentation of opposing views can also be used to facilitate in learning a topic. This type of format naturally encourages repetition, which reinforces learning, while appearing to be less monotonous and also being more likely to engage the learner's attention. Repetition of material when made between agents in a discussion is likely more acceptable than repetition of that material made by just one agent.



**Fig. 1.** Interface Appearance

In this paper we describe recent research on developing and initial testing of multiple agents in online learning, using scenarios in which the user observes (or overhears) a dialogue between several lifelike characters. (Figure 1)

## 2 BACKGROUND AND RELATED WORK

Character agents in e-Learning are somewhat similar to avatars in online games, and to bots in other applications. An agent functions as a communication interface by linking

a user with the information the user needs. An agent is not a video demonstration and neither is it a cartoon clip supplied for its entertainment value. Instead, an agent is goal-driven and has a built in element of interactivity that allows it to perform behaviors in response to the users' requests and in some cases, to user needs that it infers. Ideally, an agent provides a clear, insightful, rapid link to an information database, in a manner that is easy to understand. Cassell [1] suggested that character agents may be defined as having similar properties as humans in face-to-face conversation, including the ability to recognize and respond to verbal and nonverbal input, to generate verbal and nonverbal output, to deal with conversational functions such as turn taking, to give signals that indicate the conversation state. Craig [2] found that in tutoring sessions, users who overheard dialogues between virtual tutors and tutees, subsequently asked significantly more questions and also memorized the information significantly better. Nass [3] showed that subjects who watched news and entertainment segments on different TVs rated them higher in quality than the segments shown on just one TV.

### 3 SYSTEM STRUCTURE

Figure 2 shows an overview diagram of our system. The character agents interact with learners, exhibiting emotional and social behaviors, as well as providing instructions and guidance to learning content. In addition to input from the user and eye tracking information, feedback about past performance and behavior is also obtained from the student performance knowledge base, allowing agents to react to learners based on that information.

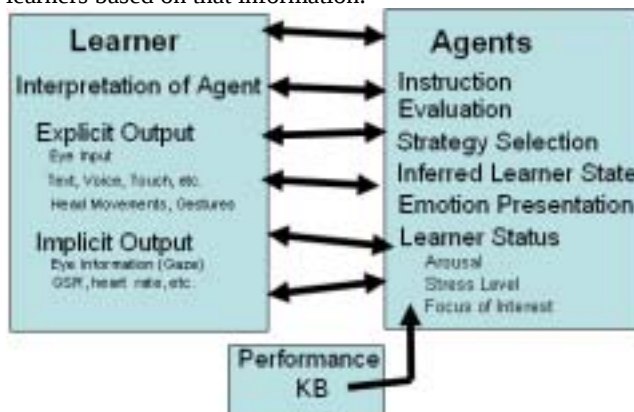


Fig. 2. System Structure

### 4 CHARACTER AGENT INTERFACE

Multiple agents present the contents of the educational interface using speech and deictic gestures. When multiple characters are used they have different roles in the interface and interact with each other. The characters are controlled by a version of MPML [8]. The single agent version uses a single agent to present and interact with learners. There are Primary Agent (Interaction Agent) and Secondary Agent (Student Monitoring Agent). The primary agent talks

with students and explains educational contents to users. (Figure 3,4). The secondary agent provides system-related information and manages the interaction based on if the learner is concentrating on the current topic and looking at the right content, or if the learner appears to be interested or bored by the current topic, etc. There are two kinds of interface, one being the topic interface and the other being the content interface, as shown in Figures 3 and 4.

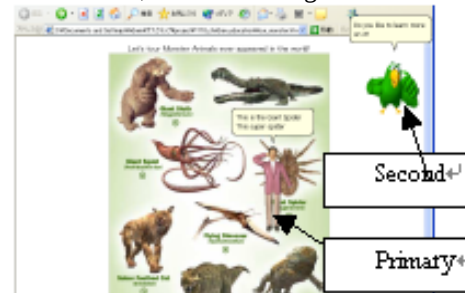


Fig. 3. Topics Interface

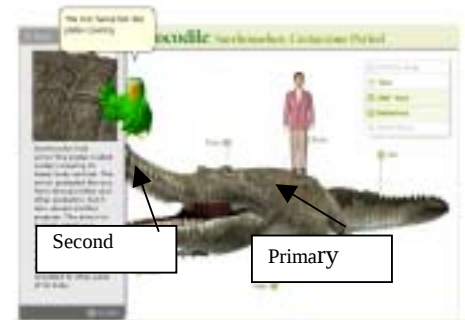


Fig. 4 Contents Interface

### 5 PRELIMINARY TESTS AND FINDINGS

We performed a preliminary study comparing the use of our research prototype system when applying a single agent interface versus a two-agent interface. For the comparison, the recorded eye position data were first divided into individual scenes. Eye movement data were separately superimposed on the table of contents view of the main topics interface and on the interface for describing the animals. Initial trends in this study were then observed based on visual inspection of the resulting screens that were annotated with the eye movement data.

We measured the numbers and locations of the eye dots (eye positions) of the learner in different interface and compared the data in both interfaces. Figure 5 shows screens that have been annotated with eye moment data, the blue dots. Both the single and two agent interfaces appeared to help focus user attention on the knowledge contents. However, in the two-agent interface, the eye positions which are the eye dots in the figures appeared to be more focused on the current topic, suggesting that a two-agent interface may help in keeping the learner's attention on what is being taught.



**Fig. 5** Multiple-Agent VS Single-Agent

Some participants also felt that the character agent provided too much information at one time. They suggested using multiple agents to solve this problem, where each agent deals with different types of information and only one agent communicates at a time.

## 6 DISCUSSION OF RESULTS

The user testing focused on the subject's impression of the roles and ability of the agents, and on usability problems that students encountered in using the system. Of particular interest was how involved the students were in the learning process, and how aware the students were of the emotional state of the agents. Compared to the one agent interface, the two-agent interface was judged to be easier to get information from. The subjects indicated that with only one agent in the interface, they felt that they were learning by rote (like being lectured to), but with two agents they could listen to the interaction between the two agents and this made them feel that they could be more active participants in the learning process. As an example of the beneficial effect of inter-agent interaction in the two agent interface, one agent sometimes asked the other agent a question which was responded to. This type of interaction helped make the learning process seem more natural and provided the students with more time to think.

One problem with assigning more than one role to the agent in a single-agent interface is that the student may get confused when the same agent presents different types of information during the same session. In contrast, switching between agents in a multiple-agent interface provides a strong that a different type of information is being presented.

## 7 DESIGN ISSUES FOR MULTI-AGENTS

Designing for multiple agents adds a certain amount of complexity to the task of developing online content. Roles and contents need to be assigned to the agents, and issues such as pacing and sequencing need to be considered. There is also the issue of how alternations between agents will be signaled so that transitions are smooth and natural. The agents should also have awareness of how the student is reacting so that they can adjust the pacing of their presentation and perhaps even their tactics in guiding the user. For instance, when the user slows down to concentrate on a topic, the agents might be less active, or offer encouraging comments or suggestions relative to that topic. Another idea would be to allow the use of humor by agents (sparingly perhaps) so as to motivate the students and keep them interested in the material. Some participants also suggested alternative roles for the multiple agents. They suggested that the agents could also behave as study partners and talk between themselves to provide the student with an alternative way of learning. Another idea the authors had after observing people in this study is to make the learning more naturalistic by making agents fallible, where one agent corrects misunderstandings by the other agent. The design issue here will be to provide enough of this type of correction to make students realize that misunderstandings occur naturally during the learning process and that they should not think of themselves as stupid or slow if they don't already understand the content. However, such interaction will have to be designed carefully so that the student does not end up remembering the incorrect information.

## 8 CONCLUSION

In this paper, we introduced a system that can use multiple agents to supplement content presentation in online education by dealing with feelings and nuanced information during a learning process. We reported the results of preliminary usability testing of one and two-agent versions of the system. Our preliminary findings suggest that the interaction between the agents is an important part of the learning interface, and that further exploration of the role of affective multi-agent interfaces in e-learning is warranted.

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