

# Virtual Agents in the Classroom: Experience Fielding a Co-Presenter Agent in University Courses

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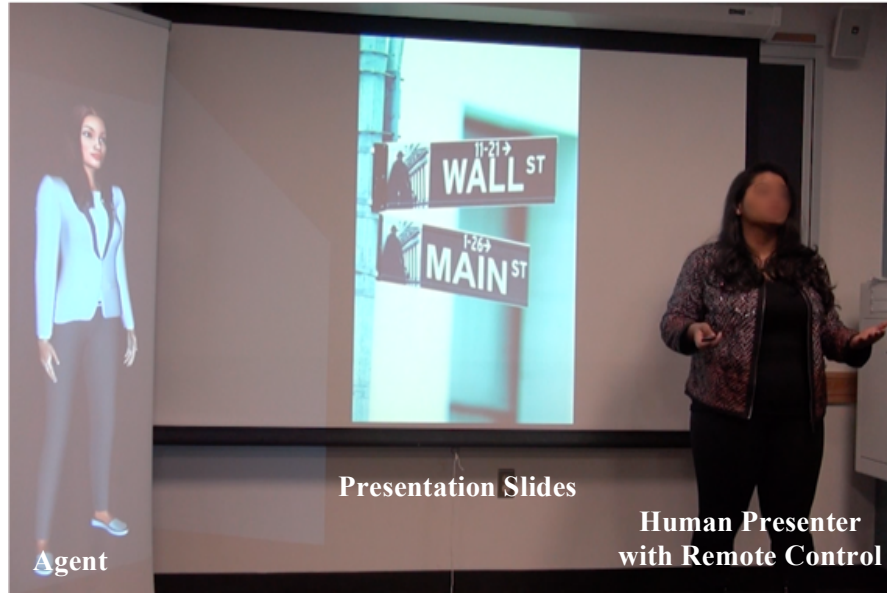
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**Abstract.** The design of a conversational virtual agent that assists professors and students in giving in-class oral presentations is described, along with preliminary evaluation results. The life-sized agent is integrated with PowerPoint presentation software and can deliver presentations in conjunction with a human presenter using appropriate verbal and nonverbal behavior. Results from evaluation studies in two courses—business and professional speaking, and computer science research methods—indicate that the agent is widely accepted in the classroom by students, and can serve to increase engagement in presentations given both by professors and students.

**Keywords:** embodied conversational agent, PowerPoint, slideware.

## 1 Introduction

Although contemporary scientific results are recorded in writing and disseminated through a variety of media, oral presentation of findings to an audience of peers continues to be a central feature of science today. Oral presentations at scientific conferences are where researchers, practitioners, the media, and the public hear about the latest findings, become engaged and inspired, and where scientific reputations are made. However, the state of the art in scientific presentations has not progressed in the last 30 years. The standard scientific presentation today still features a scholar standing in front of a projection screen, speaking from his or her notes or slides, with supporting images and text displayed for the audience. The typical quality of such presentations—across all professions—is very poor. An extensive survey of 2,501 professionals [1] revealed that 35% of respondents rarely or never rehearse for their presentations, and because of this and many other problems, respondents gave a “C-” grade (2.9 on a 1-to-5 scale) for all presentations they had attended. Poor presentations can result in scientists failing to engage, inform, and persuade their audience, can damage their credibility and professional standing, and can damage the reputation of the sciences in general. There are many reasons for these failures, including: deficiencies in language, speech, and presentation skills; lack of content mastery; time and resource constraints; lack of preparation and rehearsal; and public speaking anxiety (affecting at least 35% of the population [2]).



**Fig 1.** Student in Professional Speaking Class Giving Presentation with Co-Presenter Agent

Students learn to give scientific presentations by observing others give talks, by taking classes that cover public speaking, and by practicing public speaking as a skill. Unfortunately, most university curricula in the sciences provide few opportunities for training in public speaking, or offer it only as a minor elective. Professional scientists speaking at seminars and conferences often provide poor role models for public speaking and promote a perpetual cycle of stale presentation formats and poor quality performances.

To assist students and professionals in delivering more engaging presentations, we have developed an automated virtual agent that plays the role of a co-presenter [3]. The co-presenter appears in the form of a life-sized human character that can present part of a talk given with conventional presentation software (Figure 1). The co-presenter agent uses verbal and nonverbal behavior for content delivery, highlighting and emphasis, speaker hand-offs (turn-taking), and attentive listening when the human presenter is speaking. We also developed an authoring tool to allow human presenters to easily control the verbal and nonverbal behavior of the agent. In a lab-based controlled study ( $N=12$ ), we demonstrated that the use of the co-presenter helped reduce public speaking anxiety for non-native English speakers, while improving the overall presentation quality for all participants [3].

In this paper we describe our experiences deploying the co-presenter agent in college courses to help students learn how to give oral presentations. The agent was evaluated in two courses during the Spring 2016 semester: a business and professional speaking course, specially designed around use of the co-presenter agent, and a computer science research methods course. In these courses, we evaluated lectures given by the professor with and without the agent, and presentations given by students, with and without the agent. Our aim was to assess the acceptance and effectiveness of the

system when participants were exposed to different ways of using the co-presenter agent in realistic settings over a long-term period.

### 1.1 Related Work using Virtual Agents as Presenters

A number of studies have explored the potential of virtual agents to support presentation delivery. One of the earliest attempts is the WebPersona system [4], which uses an animated cartoon character to present hypermedia information automatically generated from the World Wide Web. In a controlled study comparing presentations of technical content with and without the agent, participants rated the presentations delivered by the virtual presenter as significantly less difficult and more entertaining. However, such effect was not found for presentations of non-technical content.

In addition to fully automated presentation systems, other systems [5, 6] have been developed to enable virtual agents to present manually authored speech text on behalf of a human presenter. However, these systems often require users to learn highly technical scripting languages to annotate the presenter’s speech text with various gesture commands, which could then be performed by an animated computer character capable of non-verbal behavior and synthesized speech. To date, there has been very little report on the acceptance and effectiveness of these virtual presenter systems, especially when being deployed in real settings outside of the lab.

Although all of these agents acted as virtual presenters, their main goal was to replace the human presenters instead of augmenting their performance through human-agent collaboration. It is this human-agent *collaboration*, which, we argue, can deliver both analytical and emotional content, while enabling a dialogical mode of presentation, which is impossible in single-speaker talks. Moreover, the presence of a co-presenter could also help decrease public speaking anxiety, as indicated by social impact theory [7] and demonstrated in empirical studies [8].

### 1.2 Related Work on Presentation Technologies

A number of research projects have proposed methods to support various presentation activities, from authoring [9] to rehearsal [10] and delivery [11, 12]. Of particular relevance to our work is the PitchPerfect system [10], which provides an integrated rehearsal environment for structured presentation preparation. The system enables presenters to break down their speaking notes into a series of ‘note segments’ which correspond to specific visual elements on slides. It also includes a special note segment called the ‘transition note,’ which encourages presenters to speak between slides, explaining transitions and relations between different slides.

## 2 Design of the Co-Presenter Agent System

Implemented as an add-in to PowerPoint 2013, our co-presenter agent system consists of three primary components: (1) a *life-sized co-presenter virtual agent* that exhibits a range of verbal and non-verbal behaviors; (2) a *collaborative note authoring* tool that

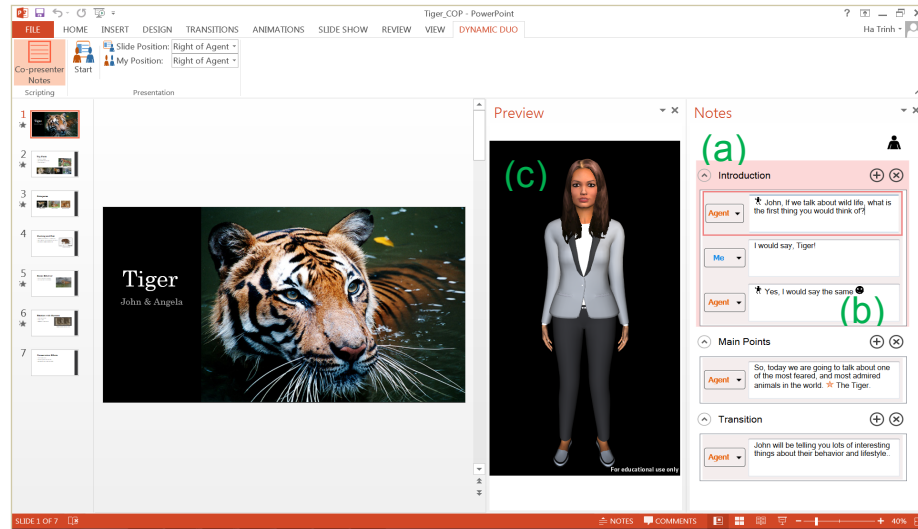
enables human-agent note scripting at slide level; (3) a *collaborative presentation environment* that is integrated into the PowerPoint’s slideshow delivery mode. Our system enables presenters to author and deliver their dual presentation using a simple visual interface seamlessly integrated into PowerPoint

**The Virtual Presenter.** Our virtual presenter, Angela, is a life-sized, animated human-like character developed using the Unity game engine (Figure 2). The agent talks using synthetic speech and synchronized nonverbal behavior, including affective facial expressions (smile, neutral, concern), eyebrow movement, directional gazes, head nods, posture shifts, as well as contrastive, beat (emphasis), and deictic gestures (e.g. pointing to a slide).

**Co-Presentation Authoring.** To prepare a co-presentation, the human presenter starts by creating slides as usual, then activating the *Co-presenter Notes* side pane to enter human-agent speaking notes (Figure 2). For each slide, the system automatically creates placeholders for three note sections: *Introduction*, *Main Points*, and *Transition* (Figure 2a). Every note section is further divided into a series of note segments, each of which can be assigned to either the co-presenter agent or the human presenter.

The majority of the agent’s nonverbal behaviors are automatically generated using BEAT [13], but the human presenter can explicitly insert nonverbal behavior commands into the agent’s note segments using the behavior context menu. The menu consists of 10 presentation-specific behavior options, including: *gazing* towards the audience/ towards the human presenter, *pointing* to slides/ to the human presenter, *turning* towards the audience/towards the human presenter, *facial expressions*, and *playing selected animation* on the current slide. Each inserted behavior is represented by a visual icon in the note segment (Figure 2b).

To determine appropriate directions of gazes, posture shifts and deictic gestures, the presenter can specify their spatial position and the slide’s position in reference to



**Fig. 2.** Collaborative note authoring interface with: (a) human-agent note segments; (b) icons representing manually added non-verbal behaviors; (c) agent speaking preview.

the agent's position for a given presentation room (i.e. either at the left or right to the agent), using appropriate controls on the PowerPoint ribbon (Figure 2).

While authoring the agent's notes, the presenter can preview her verbal and non-verbal behavior from the *Preview* side pane (Figure 2c).

**Presentation Environment.** Once the presentation environment is started, PowerPoint projects its standard slideshow view to the first external display and optionally displays the standard presenter view (with timing and speaking notes) onto to presenter's computer screen (Figure 1). The speaking notes are arranged and clearly labeled, so as to differentiate between the speaker's note segments and the agent's segments. The co-presenter agent is projected onto a second external standing display, allowing the agent to appear life-sized, as shown in Figure 1.

During delivery, the human presenter controls the presentation flow using a custom RF remote control with four buttons: Next Slide, Previous Slide, Speak, and Stop. The Speak button cues the agent to present the next available agent segments on the current slide. Once cued to speak, the agent presents her segments while automatically advancing the slides and playing pre-specified animations, and stopping when she reaches the next note segment of the human presenter. The agent performs a posture shift to turn and gaze toward the human presenter as an indicator of turn-giving. At any point during the presentation, the human presenter can pause the agent's speech using the Stop button.

While not actively presenting, the agent turns toward the human presenter and goes into an attentive listening mode. While in this mode, the agent randomly performs one of four nonverbal behaviors every 10 seconds. These behaviors include smiling, head nodding, turning toward the audience and gazing at the main slideshow display.

### 3 Pilot Lab-based Evaluation Study

We conducted a laboratory-based experimental evaluation of the co-presenter agent, comparing presentations given with and without the agent by the same participants (previously reported in [3]). The study involved 12 students and professionals. Participants were asked to deliver two 7-minute presentations on comparable topics using prepared PowerPoint slide decks and notes, one with the co-presenter agent and one without (counterbalanced, within-subjects experiment). There was a significant interaction effect of study condition (human-agent vs. human-only) and native language (native vs. non-native English speakers), with the agent significantly decreasing public speaking anxiety,  $p=.014$ , and increasing speaker confidence,  $p=.006$ , for non-native English speakers. In a subsequent study in which 12 judges rated the pairs of presentations, judges rated the human-agent presentations significantly better on note reliance ( $p<.05$ ), speech quality ( $p<.01$ ) and overall presentation quality ( $p<.05$ ).

### 4 Use of the Co-Presenter Agent in a Research Methods Class

Although results of our pilot evaluation study were promising, we wanted to investigate use of the co-presenter agent in a real environment, and as a teaching tool to help

computer science students give better oral presentations. We conducted our evaluation within the context of a mixed graduate and undergraduate-level university course on research methods, which covers the basics of experimental design for human subjects studies, along with statistical analysis techniques. The class met 26 times in the Spring, 2016 semester. In addition to 100-minute lectures by the instructor, three class meetings were set aside for students to present results from team-based field studies they conducted in the latter part of the course. The co-presenter agent was used both by the instructor for a subset of his lectures and by the students for a subset of their study presentations.

Students were recruited at the beginning of the semester and were asked to evaluate a subset of the instructor's lectures and student presentations, including those given with and without the agent, and offered the option of giving their presentations with the agent. At the end of the semester students were interviewed about their experience.

**Participants.** Three undergraduate and seven PhD students agreed to participate in the study. Participants were 22-34 years old, and 70% male. Of these ten participants, three were categorized as high competence public speakers and seven were categorized as moderate competence public speakers, according to the Self-Perceived Communication Competence Scale [14].

**Measures.** Students were asked to rate lectures and presentations using the scale measures shown in Table 1. Students who volunteered to give their in-class presentations with the co-presenter agent were also asked to complete the co-presenter agent satisfaction questionnaire shown in Table 2.

**Quantitative Results.** Table 1 shows study participant ratings of lectures and student presentations given with and without the co-presenter agent. Students found lectures by the professor given with the agent significantly more novel (5.2 vs. 4.8, Mann-Whitney  $U=55.5$ ,  $p=.001$ ), exciting (5.8 vs. 4.8,  $U=77.5$ ,  $p<.01$ ), and entertaining (5.9 vs. 4.7,  $U=65.0$ ,  $p<.01$ ), compared to the comparison lectures given without the agent. There were trends for students to rate the professor as more competent without the agent (6.8 vs. 6.4,  $U=104.0$ ,  $p=.06$ ), but they preferred to see future lectures given with the agent (5.8 vs. 5.1,  $U=103.5$ ,  $p=.09$ ).

Students found that in-class project presentations given by other students with the agent were significantly more novel (5.2 vs. 4.8,  $U=150.0$ ,  $p<.05$ ), compared to those given without the agent. There was also a trend for students to rate other student presenters as more entertaining with the agent (5.1 vs. 4.8,  $U=158.5$ ,  $p=.06$ ).

Table 2 shows ratings of the co-presenter agent system by students who used it to give their in-class presentations. Overall, students expressed high levels of satisfaction (6.6 on a 7-point scale) and desire to use the agent for future presentations (6.6 on a 7-point scale).

**Qualitative Findings.** We identified three main themes in exit interviews with students related to audience engagement, collaboration models, and presenter's anxiety.

**Theme 1: Increasing Audience Engagement.** In addition to the novelty effects of the new technology, most participants also reported certain benefits of the dialogical presentation formats in keeping their attention, especially during long lectures: *"I like*

**Table 1.** Audience Self-Report Presentation Rating Questions and Responses (mean (sd)) (all tests non-parametric using Mann-Whitney U)

Audience Ratings (by 10 Students)			Lectures by Professor			Student Presentations		
Question	Anchor 1	Anchor 7	No-Agent (N=2)	Agent (N=2)	p	No-Agent (N=15)	Agent (N=5)	P
Overall quality of the presentation	Very poor	Very good	6.06 (0.73)	5.82 (0.73)	.34	5.74 (0.54)	5.60 (0.62)	.74
Were you engaged by the presentation?	Not at all	Very much	5.56 (1.25)	6.06 (0.75)	.19	5.50 (0.59)	5.55 (0.61)	.71
Could you understand the presentation?	Not at all	Very well	6.00 (0.77)	5.88 (0.93)	.75	5.78 (0.53)	5.79 (0.69)	.74
How novel was the presentation?	Very routine	Very novel	4.39 (1.24)	5.88 (1.11)	<b>.001</b>	4.84 (0.63)	5.21 (0.57)	<b>.04</b>
How exciting was the presentation?	Very boring	Very exciting	4.83 (1.10)	5.82 (0.88)	<b>.009</b>	4.93 (0.68)	5.16 (0.50)	.14
How entertaining was the presentation?	Not at all	Very much	4.67 (1.19)	5.94 (0.90)	<b>.003</b>	4.83 (0.75)	5.14 (0.63)	.11
How competent was the presenter?	Not at all	Very much	6.78 (0.43)	6.41 (0.62)	.06	5.91 (0.49)	5.80 (0.66)	.67
Did the co-presenter help the presentation?	Not at all	Very much		5.35 (0.86)			5.23 (0.57)	
How entertaining was the presenter?	Not at all	Very much	4.83 (1.25)	5.47 (0.94)	.11	4.83 (0.75)	5.14 (0.63)	.06
Like to see another presentation like this?	Not at all	Very much	5.06 (1.16)	5.76 (1.03)	.09	4.93 (0.71)	5.20 (0.70)	.13

**Table 2.** Co-presenter Agent Rating Questions and Responses by Student Presenters

Question	Anchor 1	Anchor 7	Agent
How satisfied are you with the co-presenter agent?	Not at all	Very satisfied	6.6 (0.55)
How much would you like to give future presentations with the co-presenter agent?	Not at all	Very much	6.6 (0.55)
How much do you like the co-presenter agent?	Not at all	Very much	6.2 (0.84)
How easy was it to use the co-presenter agent?	Very easy	Very difficult	3.0 (2.35)
How much do you feel you trust the co-presenter agent?	Not at all	Very much	6.8 (0.45)
How much do you feel the agent helped you?	Not at all	Very much	6.8 (0.45)

*the dynamics of going back and forth... It's more like a conversation between two experts in the area. I would say that it is more engaging*" [P6]. Breaking up the content into digestible human-agent segments was reported to be *"a lot more helpful in trying to learn information"* [P8]. The changes of voice and pace between the co-presenters also helped the audience stay focused: *"Having two voices that are speaking at you makes you perk up every time that it changes"* [P8]. Creative uses of the agent, such as incorporating jokes in the dialogue, also made the presentations *"a lot more likeable, which is not something you can do with just one presenter"* [P8]. Enabling the agent to directly interact with the audience (e.g., by asking questions) also increased their engagement and anticipation: *"I was very excited when she called out my name... I didn't expect her to do it but I found it very interesting"* [P2].

While the dyadic interaction formats were positively received, the audience could, however, *"get distracted if there is a lot of interaction"* [P7]. Thus, further work is needed to assist presenters in designing a balanced and meaningful interaction model of co-presenters to avoid disrupting the presentation flow.

**Theme 2: Diversifying Presentation Forms through Different Collaboration Models.** Participants demonstrated various methods of collaboration with the agent, such as: iterative turn-taking at bullet point and slide levels, assigning the introduction and transition sections to the human presenter as a way to control the presentation flow, or embedding a question-answering dialogue to introduce new topics and transition between presenters. Several presenters also used the agent creatively to add humor, and to deliver content that would otherwise be uncomfortable for them, for example: *"I had some criticism for the project and I had her point out all the negative things instead of just saying it myself"* [P1]. The audience generally preferred a balanced distribution of content between the co-presenters, and responded negatively when the agent was underused.

Choosing an appropriate collaboration model can, however, be a difficult process that requires trial and error as well as creativity. Thus, several participants expressed the need for more instructions or *"interactive templates"* [P7] to scaffold this process.

In order for the agent to become a more effective collaborator, most participants wanted the agent to have more human qualities, including emotions, knowledge, and the ability to dynamically adapt to the presentation environment.

**Theme 3: Reducing Presenter's Anxiety.** In line with the results of our lab-based study, participants felt that presenting with the agent helped decrease anxiety, due to four key factors. First, preparing a co-presentation forced the presenters to invest time on planning and rehearsing their speech. As a result, they *"had a better understanding of the presentation"* [P4], felt *"more prepared"* [P2] and thus became *"more confident"* [P4] during their delivery. Second, the presence of a co-presenter agent helped reduce stage pressure through shared attention: *"having her there made me less nervous because not all the attention is on me"* [P2]. Third, taking turns to present with the agent allowed the presenter to *"take a break"* [P4] while the agent was speaking to *"think about what is coming next"* [P4]. Finally, the distribution of content reduced the human's memorization load, making them feel assured because the agent *"wasn't going to forget anything"* [P5]. This benefit could be of particular importance for presentations of technical content with large amounts of statistical data.

To summarize, our qualitative findings showed that the co-presenter agent was positively received by students, and was able to improve the presentation experiences for both audiences and presenters. One of our participants commented on the overall benefit of the agent: *“I was more engaged with the class. I felt that I got more out of the class when she was there”* [P8].

## 5 Use of the Co-Presenter Agent in a Public Speaking Class

The co-presenter was also used in a public speaking class (“Business and Professional Speaking”), offered in the Communication Department of our university in the Spring, 2016 semester. One section of the course was specially modified to incorporate the co-presenter agent in all student presentations, by setting aside class sessions for training on the co-presenter system, presentation preparation, and rehearsal. Twelve students enrolled in the course, aged 18-24, 54% male. All students volunteered to give their initial presentation using the agent, and 66% volunteered to give their second in-class presentation with the agent.

Overall, students were accepting of the agent, and felt that it helped them learn to give better presentations. Use of the agent forced students to prepare and rehearse more than they otherwise would have done, and to think more carefully about their presentation content and how it would be delivered. As in the methods course, students (and the instructor) felt that the co-presenter agent increased variety, engagement, and energy level, and that presenting in a team increased confidence and decreased anxiety, even when the teammate is artificial. On the negative side, initial exposure to the new technology was an initial challenge and was a source of more anxiety among students than using existing presentation technology.

## 6 Conclusion

We designed a virtual agent that helps individuals give oral presentations, and evaluated it in two university classroom settings. Overall, students were accepting and very positive regarding this use of agents, and felt that the agent increased the novelty and engagement of the speaker, for presentations given by both students and a professor.

**Limitations and Future Work.** Our studies used very small convenience samples of students, and thus are likely not representative of all college students. The studies also lacked the rigorous controls of a laboratory environment (e.g., participants were not randomized across study conditions). However, the classroom environment provided a more realistic setting to test acceptance and use of the co-presenter agent.

There are many directions of future research for this work. Students requested greater control over agent appearance, a larger repertoire of nonverbal behavior and prosodic control, and more flexible interaction methods. They also expressed the need for more instructions and templates to facilitate the creation of more engaging human-agent co-presentations. We are currently exploring the use of automated speech recognition for the agent to track where the human presenter is in his or her talk so

that the agent can take over at any point or can fill in important points the human presenter may have forgotten. We also plan to employ technologies to assess both the human presenter's performance and audience interaction, allowing for spontaneous support by the virtual presenter through its ability to dynamically adapt to the presentation environment when needed.

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