

Dialogue-based CALL: an overview of existing research

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Abstract. Dialogue-based Computer-Assisted Language Learning (CALL) covers applications and systems allowing a learner to practice the target language in a meaning-focused conversational activity with an automated agent. We first present a common definition for dialogue-based CALL, based on three features: dialogue as the activity unit, computer as the interlocutor and negotiation of outcome through open learner production. We then report on a systematic literature review we conducted on the main scientific databases which, after filtering, resulted in 138 relevant papers which were analyzed and coded. Results show a scattered research field, with four different disciplinary approaches. We conclude with observations regarding the remaining challenges and opportunities for Intelligent CALL (ICALL) research.

Keywords: dialogue-based CALL, conversational agent, dialogue system, chatbot, ICALL, literature review.

1. Introduction

Second language acquisition theories have long advocated the need for meaning-focused activities, especially comprehensible interaction (Long, 1996). It has also been amply demonstrated that Synchronous Computer-Mediated Communication (SCMC), notably text-based chat, has a positive effect on the development of L2 proficiency, including speaking proficiency (Lin, 2015). Considering the lack of

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opportunities for practice with native speakers in most foreign language teaching contexts, there has thus been a steady interest in CALL systems that would allow learners to practice and develop their communicative skills through interactions in natural language with an artificial interlocutor.

Since the first attempts to tackle this problem, numerous researchers have experimented with Natural Language Processing (NLP) techniques to hold conversations with learners. However, research on this matter remains scattered across different disciplines, with only partial mutual awareness of previous works. Previous syntheses have only addressed part of the question, focusing either on speech-based applications (Eskenazi, 2009) or on text-based chatbots (Fryer & Carpenter, 2006), or mentioning it in ICALL in general (Gamper & Knapp, 2002).

The terms used to refer to the systems are not well established either, with important variations and multiple possible keywords. *Dialogue systems*, *conversational agents* and *chatbots* are sometimes differentiated on modal or technical criteria. Klüwer (2011) distinguishes *dialogue systems* from *chatbots* by their “use of more theoretically motivated techniques” (p. 3). Jokinen and McTear (2010) treat *dialogue systems* as necessarily spoken, and *conversational agents* as necessarily embodied, raising issues of multimodality and non-verbal communication; *chatbots* are “conversational systems” (i.e. designed for open-ended small talk) while *dialogue systems* are automatically task-oriented. However, the same authors recognize a growing convergence of all these systems, which blurs the boundaries (Jokinen & McTear, 2010, p. 129). As a result, the three terms are often used interchangeably, in an unspecified usage. Bearing in mind that the challenges for dialogue management and the opportunities for language learning remain essentially equivalent, this is the position we adopted, using *dialogue-based CALL* as an umbrella term.

More importantly, we first propose an operational definition of dialogue-based CALL. This definition served as the main inclusion criteria in the systematic literature review. Analyzing the existing research on the topic, we identified the most important trends and some challenges for future research.

1.1. Towards an operational definition

It is possible to define dialogue-based CALL in a minimal way as (1) **dialogue-based** (2) **interactions with a computer** for language learning purposes. The second element sets us inside *tutorial CALL*, in contrast with computer-mediated

communication, where interactions are with other humans *via* a computer. “Dialogue-based” makes the distinction with *item-based* approaches, which have been dominant in autonomous CALL applications. Nevertheless, this definition also applies to any form of interaction that takes the form of a dialogue, such as *branching dialogues* (conversation tree with a limited choice of utterances to select from, often used in adventure games) or systems that do not take into account what the user has previously uttered (certain question-asking systems). It is thus important to state a third characteristic: (3) the interactions must allow a certain **negotiation of outcome** (Young, 1988) through **open learner output**. It is this possibility to negotiate the outcome of the interaction, by uttering a free range of text or speech, that makes it, at the same time, complex to develop, regarding the required natural language processing in the background, and potentially very beneficial for language learning, as it enables the learner to freely build his own meaning.

2. Method

2.1. Collection of a corpus of studies

We performed an extensive search on the leading scientific databases (Web of Science, Scopus, Proquest), using all the possible keywords referring to dialogue systems for language learning, obtaining 604, 494 and 1003 hits respectively (with important overlap). We completed this retrieval process through forward citations and ancestry search from the previous relevant hits. Only peer-reviewed scientific documents (journal papers, conference papers and edited book chapters) and doctoral dissertations were included in our corpus. We then used the above-stated defining features to select papers about dialogue systems only. We discarded papers not directly related to language learning (e.g. only mentioning it as a potential application). At the end of the inclusion/exclusion process, 109 relevant papers remained.

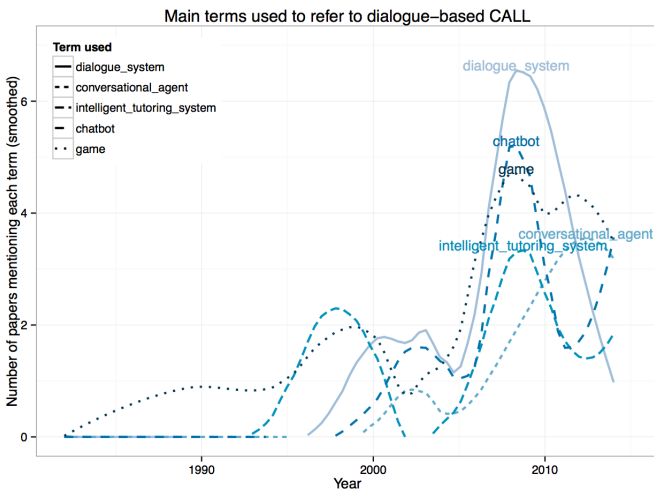
2.2. Analysis

All remaining papers were manually assessed for system, technological and evaluation aspects, as well as bibliographical information. These characteristics were coded and analyzed mainly in a qualitative manner (see section 4), but also in a quantitative way. The frequencies of all the terms referring to dialogue systems were computed and used as variables in a Principal Component Analysis (PCA). The resulting graph (Figure 2) shows the main variation tendencies, the relationships between terms and the projection of the papers on this variation space.

3. Results

As mentioned above, there is a wide diversity of terms used to refer to dialogue-based CALL. Out of 109 papers, we identified 49 different terms, ranging from *agent-mediated language-learning environment* to *voice-interactive CALL*. Some papers use more general keywords, which tend to conceal the specificity of the system (e.g. *virtual world*, *game*), while others coin their own (28 terms are used once). The most discriminant terms are *intelligent tutoring system*, *chatbot* (or *chatterbot*), *conversational agent*, and *dialogue system*. As shown in Figure 1, *dialogue system* is the most frequent (58 papers mentioned it), probably because it is associated with an important research strand in natural language processing (Jokinen & McTear, 2010). However, what does not appear here is the divergence between papers in the use of certain terms.

Figure 1. Chronological evolution of main key terms used in papers

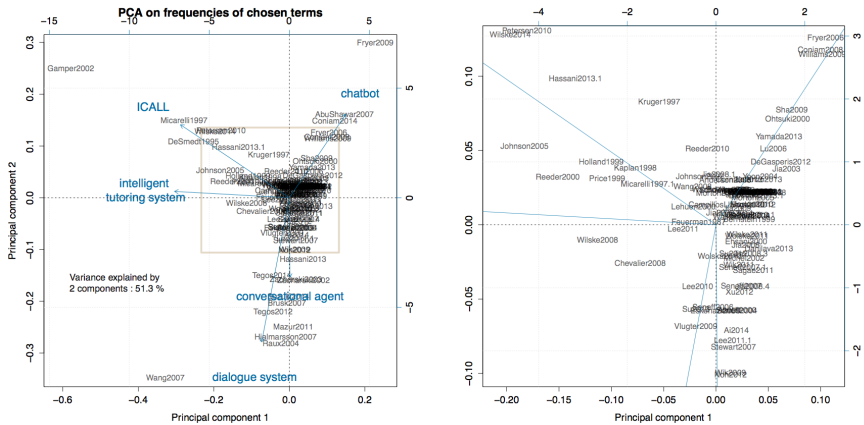


The results from the PCA, presented in Figure 2, help us distinguish different tendencies and clusters among papers. The fact that *chatbot* and *dialogue system* are on opposite sides of the y-axis indicates a negative correlation on the second principal component: papers mentioning one usually do not (or very rarely) mention the other. On the contrary, *conversational agent* is used globally in a similar way as *dialogue system*.

Meanwhile, the first principal component (x-axis) seems to correspond to the importance of the application for language learning: papers on the positive side

of the axis tend to be mostly focused on the technological aspects, while those on the left tend to attribute more importance to the analysis of the language learning process. In this sense, the latter commonly use terms like *tutoring systems* and *ICALL*.

Figure 2. Projection of variables (terms frequencies, as lines) and observations (papers) on a bidimensional plot with two principal components (out of 5)



These exploratory analyses show there are different clusters of research on dialogue-based CALL. Through an interpretative and qualitative analysis, we identified four groups of papers, coming from different disciplines. They are presented in Figure 3.

The first group embraces research on Intelligent Tutoring Systems (ITS). ITS existed previously as item-based activities for form-focused practice, but the 1980s and 90s saw many efforts to develop more communicative, dialogue-based activities as part of ITS. Most papers published in this trend show a particular attention to the provision of automated corrective feedback to the learner, but little consideration for dialogue management and natural language generation.

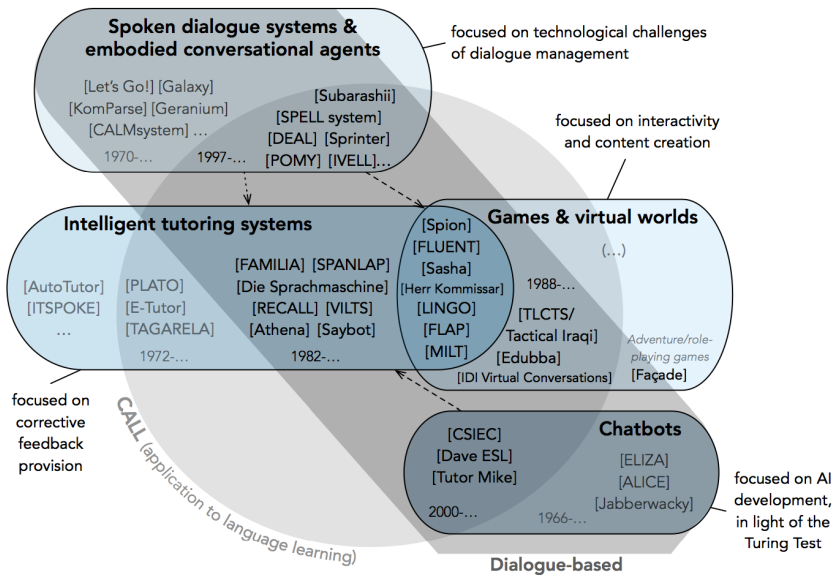
The second group to emerge is related to **games** and **virtual worlds**. Many efforts are contiguous to ITS, with various systems qualifying as both. The gaming side of dialogue systems for language learning has also led to the most important commercial applications (e.g. Johnson, 2007).

The third group encompasses research on (spoken) **dialogue systems** and (embodied) **conversational agents**. It arises mainly from researchers in NLP who

decided to apply these techniques to L2 learning (e.g. Morton, Gunson, & Jack, 2012). Here, the focus is predominantly on the technological challenges that such an endeavor poses. It is probably the research area that presents the most significant technological advances and, consequently, it is also the most active.

The last group, focusing on **chatbots**, is the most different. Chatbots, the descendants of ELIZA (Weizenbaum, 1966), are text-based conversational systems. The diffusion of an accessible framework for programming chatbots, AIML, and the popularity of chatbots' competitions, emulating the Turing test, contributed to the creation of countless amateur chatbots. Some research on their application for language learning has been conducted (e.g. Coniam, 2014), but research on this area regularly fails to connect to the parallel work carried out on dialogue systems.

Figure 3. Research on dialogue systems for language learning which appeared in four different disciplines



4. Conclusions

We have presented an operational definition of dialogue-based CALL, as dialogue-based interactions with a computer allowing negotiation of outcome through open learner. Such systems have been investigated under various terms and from various perspectives in the past, with complementary interests, bridging CALL, natural

language processing, games and artificial intelligence. However, no common framework has been made available, and studies of the effectiveness on L2 learning lack generalizability. Therefore, there is a crucial need for more research and development on this topic.

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