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Simulation Gaming 2010 41: 72 originally published online 13 December 2009

DOI: 10.1177/1046878109355684

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Simulation & Gaming
41(1) 72–93

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DOI: 10.1177/1046878109355684

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Abstract

This article explores research on the use of computerized games and simulations in language education. The author examined the psycholinguistic and sociocultural constructs proposed as a basis for the use of games and simulations in computer-assisted language learning. Research in this area is expanding rapidly. However, to date, few studies have critically investigated this body of work. The author reviewed key findings from influential studies. The author's analysis reveals that, although these studies are subject to limitations, simulations and games present valuable opportunities for effective language learning. The contemporary literature on theories of language acquisition hypothesizes that simulations and games are beneficial methods for helping learners acquire another language. This article concludes by identifying potential areas for future research.

Keywords

CALL, computer-assisted language learning, computerized game, computerized simulation, effective language learning, gaming, meta-analysis, MMORPG, MOO, psycholinguistic construct, research, second language acquisition, simulation, sociocultural construct, theories of language acquisition, virtual world

Researchers have developed a body of work that explores the use of computer games and simulations to facilitate language learning. Early work involved the development of small-scale simulation prototypes (Coleman, 1990; Higgins & Morgenstern, 1990; Taylor, 1990). A further area of research focused on adapting commercial games and

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simulations for use in foreign and second language (L2) learning (Jordan, 1992; Meskill, 1990). With recent technological advances and developments in learning theory (Gee, 2003; Prensky, 2000; Steinkuehler, 2005), the use of these tools in education has increased significantly, and the field of foreign language education has been influenced by this trend. In recent years, prototypes of advanced games and simulations designed specifically to support language learning have emerged (Li & Topolewski, 2002; Mich, Betta & Giuliani, 2004; Sørensen & Meyer, 2007; Stubbs, 2003). However, the bulk of existing research has focused on the adaption of commercial platforms. New opportunities to produce computer-assisted language learning (CALL) games and simulations have arisen because of the emergence of low-cost authoring tools and the expansion of the Internet. A critical overview of current research is necessary in order to provide guidance for future work in this area. In order to provide a context for this evaluation, this article will first examine the major theories proposed as a basis for the use of computer-based games and simulations in CALL.

Simulation, Gaming, and Language Learning: Proposed Rationales

Psycholinguistic Research

Theories of second language acquisition (SLA) have been proposed as a basis for development work in the use of games and simulations designed to support language learning. Among these, psycholinguistic research focuses on internal mental processes and hypothesizes a number of optimal conditions in which SLA may be fostered. According to this account, SLA may occur when learners are provided with opportunities to actively engage in the restructuring of their interlanguage through participation in goal-based communicative activities (Gass, 2000).

These conditions can be achieved through exposure to comprehensible target language (henceforth TL) input and the production of, in particular, modified TL output obtained through interaction (Long, 1985). This latter process, called negotiation of meaning (Long, 1996), involves the use of communication strategies such as clarification requests and comprehension checks. This process is claimed to link together input, attention to L2 form, and output in a beneficial manner (Chapelle, 1997). Negotiation is perceived as playing a valuable role in facilitating the cognition involved in language development (Pica, 1994).

Although this account of SLA was developed to account for learning based in traditional classrooms, theorists have speculated that its central constructs are applicable to computer-based learning contexts. Chapelle (2001) claims that approaches to learning with computers based on the use of real-world communicative tasks are particularly effective in creating the conditions outlined above. In the context of game- and simulation-based learning, theorists have claimed that these tools support language

learning in a number of ways. For example, users of both games and simulations are involved in purposeful task-focused interaction and are exposed to a great deal of TL input. As has been noted in the literature, much of this input becomes comprehensible through the feedback that occurs between learners and their interlocutors (Garcia-Carbonell, Rising, Montero, & Watts, 2001). Moreover, in network-based games and simulations, learners are frequently involved in the real-time exchange of meaning involving TL negotiation with peers. This process can result in the production of modified TL output and ultimately enhance the development of communicative competence (Peterson, 2005). The contexts provided by games and simulations not only offer extensive opportunities to use the TL, they are also highly learner centered (Ang & Zaphiris, 2006). Research indicates that this enhances learner motivation, participation, and enjoyment (Baltra, 1990). The degree of control exercised by learners, coupled with the anonymity afforded, may act to reduce the influence of affective variables such as anxiety and low self-confidence that hinder learning in teacher-fronted classrooms (Krashen, 1985; Warschauer, Turbee, & Roberts, 1996).

Sociocultural Research

Another view of the cognition involved in language learning that has been proposed as a possible basis for development in game- and simulation-based CALL is provided by sociocultural theory. Within this body of work, conceptions of learning that emphasize the social nature of SLA processes are the focus of attention from researchers (Lantolf, 2000). This perspective draws on the work of Vygotsky (1978) and proposes a number of constructs hypothesized as playing an important role in learning. Central to this account is the concept of mediation, the process whereby higher mental activities are developed through social interaction involving the use of tools. According to this view, language and computers can be perceived as mediating tools that enable learners to acquire language through interaction with more knowledgeable peers (Donato & McCormick, 1994; Meskill, 1999). Language acquisition is facilitated by participation in collaborative dialogue involving coconstruction of the TL. This form of interaction involving peer support (known as scaffolding) is linked to the notion of the zone of proximal development. This concept, is defined as

the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (Vygotsky, 1978, p. 86)

In this interactive state, learners can perform functions that they would be unable to perform independently.

Researchers have observed that network-based games, for example, not only provide immersion in engaging contexts rich in exposure to the TL, they further

Table 1. Theories Proposed as a Basis for the Use of Gaming and Simulation in CALL

Theories of Language Learning	Hypothesized Advantages of Using Computer-Based Games and Simulations
Psycholinguistic SLA	Exposure to interaction-rich TL contexts that provide feedback and opportunities to negotiate meaning Opportunities to implement authentic tasks Learner-entered interaction supports a high degree of engagement and may reduce anxiety
Sociocultural SLA	Exposure to ZPDs where learners can engage in collaborative dialogue leading to co-construction in the TL Motivation enhanced Opportunities for experimental learning based on collaborative social relationships

Note: CALL = computer-assisted language learning; SLA = second language acquisition; ZPD = zone of proximal development; TL = target language.

provide learners with ample opportunities to develop their L2 competency through collaborative TL dialogue with peers (Ang & Zaphiris, 2007). Moreover, it has been claimed that online gaming communities and simulated network-based virtual worlds provide for motivating TL interaction that supports the development of autonomy (Ho & Crookall, 1995) and forms of experimentation such as play (Stanley & Mawer, 2008). Network-based games further present valuable opportunities for TL socialization based on collaborative goal-based social relationships that operate outside the restrictions of institutionalized learning contexts (Thorne, 2008).

This discussion draws attention to a number of constructs, such as negotiation of meaning and collaborative dialogue, proposed as a basis of a rationale for the use of games and simulations in CALL. As can be seen in Table 1, although these views of SLA differ in focus, they share a number of common themes. These include the beneficial effects of exposure to learner-centered TL interaction in an engaging environment. The literature emphasizes the motivating nature of games and simulations, the apparent reduction in affective barriers, and the new opportunities offered to learn outside traditional educational settings (Scarcella & Crookall, 1990). Central to these perspectives is the view that simulations and games offer a stimulating educational experience where learners are immersed in the TL and can mobilize their linguistic resources in a beneficial social context (Crookall, Coleman, & Versluis, 1990; Noel, Crookall, Wilkenfeld, & Schapira, 1987). Researchers have also noted their suitability for task-based learning (Garcia-Carbonell et al., 2001) and the development of cross-cultural skills and knowledge (Mak & Crookall, 1995).

The remainder of this discussion investigates research on the use of games and simulations to facilitate language learning. Seven studies covering the period 2001 through 2008 are the focus of investigation. These were selected as they represented a broad sample of recent research. Moreover, these studies, unlike the bulk of existing

Table 2. MOO Simulations: Key Design Features and Hypothesized Advantages

Design Features	Hypothesized Advantages
Permanent theme-based world modeled on the real world	Opportunities to develop knowledge of the TL culture (Shield, 2003)
User-created virtual spaces: "rooms"	Learners can create and manipulate personally meaningful artifacts (Schwienhorst, 1998)
Users can create unique online personae	Opportunities to develop cooperative interpersonal relationships and engage in play (Warner, 2004)
Real-time text-based communication	Reduction of social context cues may reduce anxiety, pronunciation concerns, and enhance risk taking (Ortega, 1997) Additional time facilitates monitoring the development of discourse management skills and autonomy (Donaldson & Kötter, 1999) Opportunities to engage in collaborative dialogue (Peterson, 2001)
Logging feature	Study of transcripts may raise error awareness (Peterson, 2004)

Note: MOO = multiuser object-oriented.

research, specifically examine learner behavior from a longitudinal perspective and thus offer the prospect of providing valuable new insights. Critical analysis of this research will be undertaken in order to establish if evidence exists that confirms the hypothesized benefits of utilizing gaming and simulation in CALL. This effort may further provide guidance for future research.

Research on the Use of Simulations and Games in CALL

Web-Based Simulated Virtual Worlds: MOO Domains

Of the simulations currently in use, multiuser object-oriented (MOO) domains represent one of the earliest applications of computer-based simulation in language learning. Early MOO domains were based on role-playing adventure games such as multiuser dimensions (MUDs). More recent MOO domains are browser based and facilitate real-time interaction within the context of a fully programmable theme-based virtual world. In the MOO domains used in CALL, learners are presented with a simulated recreation of a real-world environment such as, for example, a town or university campus that incorporates user-created social spaces known as rooms. Users of these simulations have opportunities to engage in text-based interaction, create unique online personae, manipulate virtual objects, and traverse virtual space through the use of specific commands. The key design features and hypothesized advantages of using MOO domains in CALL are described in Table 2.

Educational MOO domains have been the focus of substantial interest by researchers and represent one of the most extensively investigated areas in the use of simulation

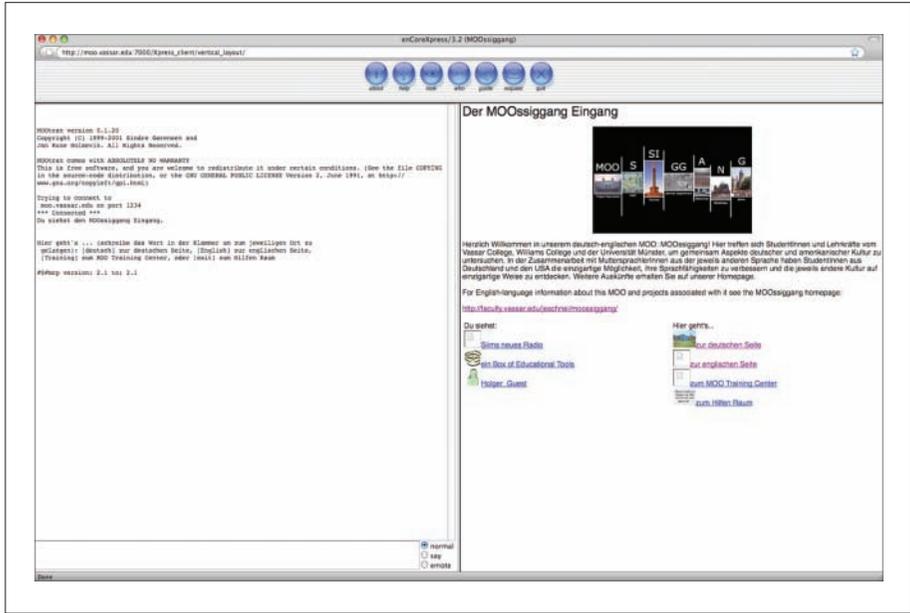


Figure 1. MOOSSIGGANG interface

in CALL (Peterson, 2004). The majority of this research has been conducted within the framework of tandem learning (Schwienhorst, 2002a).

An influential study on the use of a MOO simulation in CALL conducted by Von Der Emde, Schneider, and Kötter (2001) produced promising findings. These researchers reported on the semester-long interaction of undergraduate students of German based at a university in America and advanced German students of English studying at a university in Germany. The interaction took place in a browser-based MOO called MOOSSIGGANG (Schneider & Von Der Emde, 1998). As can be seen in Figure 1, this simulation is designed to provide a forum for collaborative interaction involving the study of German language and culture. MOOSSIGGANG contains over 100 student and faculty rooms and also provides online resources for learners. The authors of this research (Von Der Emde et al., 2001) reported a number of positive findings. They observed that, from an early stage, the subjects actively participated in the management of the project. As the project progressed, a supportive atmosphere was created and the participants' cross-cultural knowledge appeared to be enhanced, as they became active researchers into the TL and culture. Moreover, they gradually assumed management roles from the teachers, and the interaction was characterized by a high degree of learner input and control.

Analysis of the transcripts indicated that the interaction elicited a number of behaviors associated with language learning. Frequent instances of collaborative TL dialogue

occurred, and this involved peer teaching related to, for example, the meaning of new vocabulary. Researcher observation revealed the presence of autonomous learning. They found instances of role-play and other forms of experimental learning such as language play, made possible by the anonymity afforded by the use of online pseudonyms. The above researchers speculated that the degree of enthusiasm displayed by the participants was, in part, due to the degree of immersion in the TL culture provided by the simulated world. They also claimed that interaction in the MOO facilitated “significantly more intensive language practice than is available in the traditional classroom” (Von Der Emde et al., 2001, p. 222). The largely positive results of this study led the researchers to make the sweeping claim that immersion in MOO simulations presents “an opportunity to transform the language learning process itself” (p. 221). However, this research was subject to a number of limitations. The number of subjects was not specified, and no quantitative data on the frequency of collaborative episodes was provided, making the generalizability of the findings problematic. Although these factors represent limitations, overall the findings provide evidence for the presence of constructs proposed in sociocultural rationales for the use of simulations in CALL.

Kötter (2003) examined the interaction of 29 undergraduate learners of German in a tandem-learning project that used the MOOSSIGGANG environment. This large-scale longitudinal study focused on investigating the task-based interaction of the subjects, who were based at a German and an American university. The researcher collected chat transcripts from 16 sessions held twice a week over a semester. The corpus of learner data consisted of approximately 184,000 running words. Analysis of this corpus revealed the presence of constructs proposed in psycholinguistic accounts of SLA.

In a positive finding, evidence was found of subjects engaging in frequent instances of negotiation of meaning. Approximately 30% of all turns involved this type of interaction. However, a significant difference was found in how the subjects negotiated meaning in the MOO compared to the model proposed for face-to-face classroom interaction. Kötter (2003) observed that during the interaction, the subjects displayed a preference for clarification requests. These were far more frequent than the other types of communication strategy that have been identified in studies of learner-learner negotiation during face-to-face communication. This researcher could not provide a definitive explanation for this finding. However, Kötter speculated that possible explanations might lie in a complex interplay of factors. These included difficulties in overcoming communication problems caused by differences in proficiency levels and sociocultural concerns involving the use of avoidance strategies designed to save face. Kötter also noted the influence of medium-specific factors, such as the need to keep up with the real-time interaction. In further positive findings, researcher observation confirmed that the learners took active responsibility for their learning and undertook a great deal of collaborative TL interaction. These findings confirm the claims made by Von Der Emde et al. (2001) that frequent learner interaction in MOO simulations engenders engagement, collaborative TL dialogue, and a high degree of participation.

Table 3. Three-Dimensional Simulated Virtual Worlds: Key Design Features and Hypothesized Advantages

Design Features	Hypothesized Advantages
3D virtual world	Sense of engagement increased (Schroeder, 2002)
Presence of personalized avatars	Enhanced sense of telepresence supports motivation, increases interest and participation (Svensson, 2003) Learners provided with an ability to display, in real time, a range of nonverbal communication cues and emotional responses (Peterson, 2005)
Availability of real-time text and voice chat	Learners gain valuable practice in both oral and written TL communication in an authentic context (Peterson, 2006)

Note: TL = target language.

Three-Dimensional Web-Based Simulated Virtual Worlds: **ACTIVE WORLDS**

Researchers have explored the potential of three-dimensional (3D) network-based simulations in CALL. These provide for real time text chat and voice-based communication within theme-based simulated worlds that are user created. These simulations incorporate personalized avatars that are capable of traversing virtual space and can display nonverbal communication cues such as waving. Avatars are further designed to signal a limited range of emotional states such as happiness. Network-based 3D simulations are viewed as arenas with potential for language learning, as they provide an engaging social context suitable for task-based interaction (Peterson, 2006; Schroeder, 2002). The presence of personalized avatars is hypothesized as supporting telepresence and is further seen as facilitating enhanced participation, interest, and motivation (Svensson, 2003). These simulations may also be designed to provide immersion in the TL culture (Stanley & Mawer, 2008). The key design features and hypothesized advantages of using 3D simulated virtual worlds in CALL are described in Table 3.

An influential study, conducted by Toyoda and Harrison (2002), investigated the TL interaction of Japanese language learners based in Australia and native speakers of Japanese located in Japan and the United States. The interaction took place over a semester and involved the use of text chat. The venue for this research was a purpose-built environment modeled on a real-world university campus created within the ACTIVE WORLDS (1997) simulation. A screen capture of this simulation can be seen in Figure 2. A goal of the researchers was to categorize the TL output of the participants who were novice users. Discourse analysis of the transcripts revealed that the venue and format of the interaction elicited extensive TL use. Communication problems occurred, and instances of negotiation of meaning involving unknown vocabulary were identified. Although instances of negotiation were not always resolved successfully, this represents a positive finding.

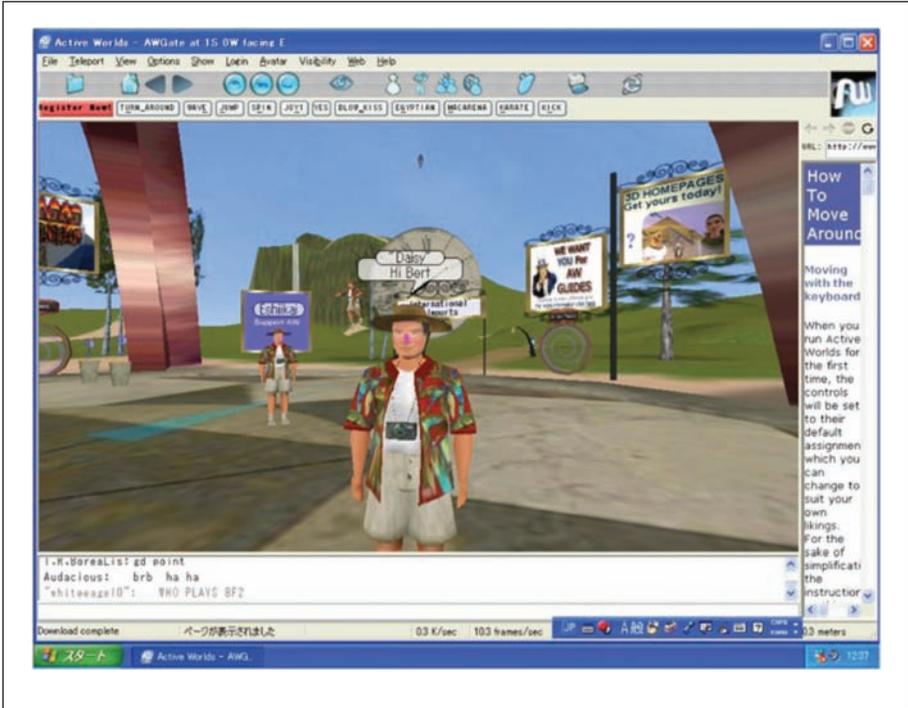


Figure 2. ACTIVE WORLDS interface

The researchers (Toyoda & Harrison, 2002) also identified a number of problematic findings. As a result of limited typing skills, the subjects produced frequent errors in their TL output, which in many cases appeared to go uncorrected. Moreover, due to limited language proficiency and the intermixing of messages on-screen, some of the learners had trouble tracking turns and keeping up with the interaction. In a surprising finding, although many of the nonverbal cues that influence turn taking in face-to-face communication were absent, little use was made of the communication features of the avatars. The participants chose instead to focus almost exclusively on using the text chat. Moreover, intercultural communication problems frequently occurred. The limited duration of the sessions, coupled with the small sample size, limits the generalizability of the findings. The absence of data on the use of specific task types and their possible role in eliciting beneficial types of TL interaction represents a missed opportunity. This study draws attention to the need for learner training in CALL projects involving the use of simulations. Furthermore, although this research was subject to restrictions, it also provides evidence that learner interaction in 3D network-based simulations supports collaborative dialogue and generates the production of modified TL output.

Table 4. Stand-Alone Commercial Simulation Games: Key Design Features and Hypothesized Advantages

Design Features	Hypothesized Advantages
Realistic virtual environment	Immersion enhanced (Meskill, 1990) Opportunities to acquire L2 forms in an authentic context (Schwienhorst, 2002b)
Game scenario	Motivation and participation increased (Jones, 1982) Opportunities for meaningful discovery learning (Baltra, 1990) Provision of simultaneous feedback raises awareness of the TL (Jones, 1986)
TL interface and commands	Exposure to the TL and opportunities to develop reading skills and vocabulary knowledge (Purushotma, 2005)

Note: L2 = second language; TL = target language.

Stand-Alone Commercial Simulation Games: SIMCOPTER

Stand-alone simulation games are perceived as potentially valuable for language learning. The literature on the use of these games in CALL, though limited, draws attention to a number of advantages. These advantages, along with significant design features, are shown in Table 4.

A stand-alone commercial simulation game that has been adapted for use in CALL is SIMCOPTER. As Figure 3 shows, this helicopter flight simulator package uses a 3D interface that provides immersion in a virtual city, incorporating a game scenario whereby an individual user assumes the role of a pilot who must navigate and respond to various emergencies such as traffic jams, riots, and fires in order to accumulate points and cash bonuses.

The adaptive use of the demo version of this simulation in a freshman language class was investigated in an experimental project reported by Coleman (2002). In this study, the subjects were divided into crews and required to undertake a two-stage task that involved a member of each crew adopting the role of a pilot who must locate a specific building within SIMCOPTER by helicopter. The other members of each crew were required to assist the pilot in finding the required destination and cooperate in producing a set of accurate written directions that would guide a VIP to that specific location at a later date. In the second stage of the task, the pilot adopted the role of the VIP who is faced with the challenge of locating an unknown destination in a different city on foot, following directions provided by other participants. At all stages of the project, the subjects were provided with opportunities to revise their directions and rehearse possible journeys using the simulation.

Coleman (2002) reported that the goal-oriented nature of the tasks elicited the production of considerable TL output. Another positive finding was that the production of written directions appeared to raise awareness of the importance of writing accuracy.

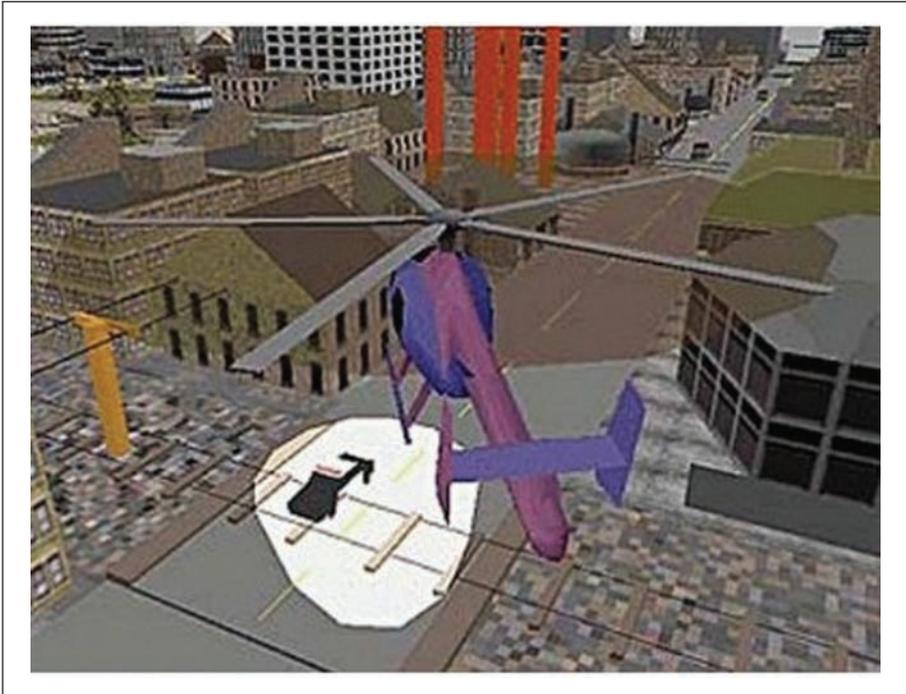


Figure 3. SIMCOPTER interface

Moreover, participation in the tasks focused learner attention on the concept of audience in writing. Coleman claimed that the simulation provided access to a realistic environment involving extensive communicative language use in an engaging context that would be challenging to reproduce using conventional methods.

Stand-Alone Commercial Simulation Games: THE SIMS

A further innovative use of a stand-alone commercial simulation game in a learner-based CALL project was reported in Ranalli (2008). This study involved THE SIMS, a computer game in which players guide the fortunes of a virtual family through the challenges of everyday life. A screen capture of this simulation game is shown in Figure 4. Ranalli claimed that as this environment provides users with exposure to written language in an engaging and realistic sociocultural context, it provides a useful platform for a CALL project when accompanied by supplementary Web-based materials. In this study, intermediate-level university English language learners, working in dyads, were invited to play the game while at the same time undertaking a number of exercises related to vocabulary used in the game. These focused on a list of 30 low-frequency vocabulary items. In playing the game and undertaking the exercises, the learners had access to Web-based instructions and culture notes. In order to raise awareness of the



Figure 4. THE SIMS interface

target vocabulary and measure learning, the subjects undertook online quizzes after each gaming session. Mixed methods were used in data collection; these included pre- and post-project surveys and paper tests.

This study produced a number of encouraging findings. The researcher claimed that the combination of the game plus the supplementary materials appeared to enhance acquisition of the target vocabulary. Evidence for this claim was found in test results that revealed statistically significant gains in vocabulary knowledge of the 30 words that were the focus of the investigation. In another positive finding, responses to the poststudy questionnaire indicated that, for the majority of the subjects, playing the game was perceived as a challenging and enjoyable experience. Furthermore, the participants made active use of the supplementary materials and viewed them to be useful, particularly with reference to the learning of new vocabulary. Although these findings were broadly positive, this research was subject to a number of limitations. Only five sessions appeared to have been held. Moreover, the number of subjects was small, with data being collected from nine students. The researcher acknowledges the possibility that some of the learner feedback may have been overly positive. This candid admission draws attention to the risks associated with learner self-reporting. The learner feedback also indicated that, in CALL projects involving games designed for native speakers, an orientation period is needed in which learners can receive training. Although the scope of this study was limited, it nonetheless demonstrates the potential of structured game playing in combination with carefully designed support materials.

MMORPGs: WORLD OF WARCRAFT

Researchers have recently attempted to explore the use of massively multiplayer online role-playing games (MMORPGs) in CALL. As these platforms bring together users for challenging real-time gaming and role-play within network-based simulations,



Figure 5. WORLD OF WARCRAFT interface

they have been identified as platforms with potential in language learning (Bryant, 2008). A well-known example that has been used in CALL is WORLD OF WARCRAFT (2001). As Figure 5 shows, in this game, users must adopt a fantasy character (avatar) within a simulated world, such as an elf or a dwarf and are required to complete a specific task known as a quest. For example, this can involve engaging in battle or solving a puzzle. In order to complete a quest and gain monetary or status rewards, a user must interact in the TL with nonplayer agents controlled by the games software, explore the environment, and communicate with other players through text chat (Bryant, 2006).

MMORPGs are seen as promising for language learning and their unique designed features and hypothesized advantages as CALL platforms are described in Table 5.

An experimental case study reported in Thorne (2008) investigated learner interaction in WORLD OF WARCRAFT. Thorne observed the interaction of two gamers: one from the United States and the other from the Ukraine. Analysis of the chat transcripts showed that the subjects engaged in collaborative TL dialogue during interaction relating to the game. Negotiation of meaning involving requests for assistance, comprehension checks, and corrective feedback occurred. The interaction was goal

Table 5. MMORPGs: Key Design Features and Hypothesized Advantages

Design Features	Hypothesized Advantages
Real-time fantasy gaming context	Immersion in a TL environment facilitates purposeful TL use and learning by doing (Bryant, 2006)
Presence of agents and personalized avatars	Anonymity may reduce affective barriers (Freiermuth, 2002)
Availability of network-based text chat	Opportunities for interaction with native speaker interlocutors and the development of collaborative interpersonal relationships (Thorne, 2008)

Note: MMORPG = massively multiplayer online role-playing game; TL = target language.

directed, and the learners displayed behaviors associated with autonomy and exploratory learning. Thorne observed that the participants appeared to enjoy the informal interaction and formed a collaborative social relationship based on their shared experiences in the game. Although this research was exploratory in nature and limited in scope, it draws attention to the potential of MMORPGs as venues for language learning outside of institutional settings.

Game- and Simulation-Based Training Systems: TACTICAL IRAQI

The TACTICAL LANGUAGE AND CULTURE TRAINING SYSTEM (2003) represents one of the most ambitious recent attempts to apply advanced game and simulation technologies in CALL (Johnson, 2007). This platform is designed to support training for American military personnel in less commonly taught languages. The system utilizes a 3D game engine and combines three main elements. The *skill builder* uses natural language processing, speech recognition, and artificial intelligence agents to provide interactive lessons and quizzes based on communicative tasks. This element of the system enables users to engage in real-time TL dialogue with nonplayer characters in various realistic simulated contexts. This feature further provides real-time feedback on a user's TL spoken input. Reference materials including glossaries and grammar explanations are supplied. The system also provides access to *mission game* and *arcade game* components that provide opportunities to undertake mission-based game scenarios designed not only to improve spoken language proficiency but also to raise awareness of the intercultural and pragmatic issues involved in TL use. The most widely used version TACTICAL IRAQI provides users with intensive training in Iraqi Arabic. A screen capture of the user interface is shown in Figure 6. The key design features and advantages of this training system are identified in Table 6.

A recent learner-based study on the use of TACTICAL IRAQI was reported in Surface, Dierdorff, and Watson (2007). This study, which was based an early version of TACTICAL IRAQI, produced a number of encouraging results. A significant result was that all three learner groups that participated demonstrated statistically significant increases in their knowledge of Iraqi Arabic. The group that undertook the most



Figure 6. TACTICAL IRAQI interface

Table 6. The TACTICAL IRAQI Game- and Simulation-Based Training System: Key Design Features and Hypothesized Advantages

Design Features	Hypothesized Advantages
Purpose-built system combines language tasks, games, and simulations in a single training platform	Learners gain practice in the four skills and can apply new knowledge in realistic games and simulations (Johnson & Wu, 2008)
Access to speech recognition technology	Opportunities to develop pronunciation skills (Johnson, 2007)
Access to supplementary reference materials	Opportunities to enhance cross-cultural knowledge and skills (Johnson, 2007)
Presence of agents and personalized avatars	Access to real time feedback on TL output (Johnson & Wu, 2008)
Individualized AI-based training in the four skills	Training may be adapted based on learner performance (Johnson, 2007)

Note: AI = artificial intelligence.

training using the system recorded the greatest improvement. Approximately one third of the subjects in one of the learner groups reported that their speaking and listening skills had improved. A majority of the participants claimed that the training enhanced their understanding of the TL. These subjects reported a generally favorable attitude toward the system, in terms of both its usability and its appropriateness. The authors of this study claimed that these results showed that TACTICAL IRAQI would be most effective when used as a supplement to a language training program. They acknowledged some technical issues arose during the evaluation and observed that the system is under continuous development. The researchers further note that future versions will offer enhanced design features and training in a wider range of languages (Surface et al., 2007, p. 4).

Discussion

As Table 7 shows, the studies analyzed in this discussion have been consistent in demonstrating that many of the constructs hypothesized in psycholinguistic SLA research are present in learner behavior in network-based simulations. Research by Kötter (2003) confirms that interaction in the MOO simulation MOOSSIGGANG elicits extensive TL use involving the production of comprehensible TL input and modified TL output. This leads, in turn, to frequent instances of meaning negotiation. The findings reported by Von Der Emde et al. (2001) draw attention to the presence of factors seen as central in sociocultural accounts of L2 learning. These include collaborative TL dialogue involving peer support and experimental learning characterized by language play. These studies further highlight the effectiveness of implementing the tandem learning approach. The above findings were mirrored to a degree in the research conducted in ACTIVE WORLDS by Toyoda & Harrison (2002). However, the issues identified by these researchers emphasize the need for learner training. This study also shows the importance of utilizing pedagogically appropriate tasks.

The findings reported on the use of the stand-alone simulation games SIMCOPTER and THE SIMS are equally encouraging. Coleman's (2002) findings show the benefits of utilizing engaging simulation-based tasks as a means to engender purposeful communicative TL use while at the same time raising awareness of writing for an audience among beginner-level learners. The results provided by Ranalli (2008) draw attention to the value of combining participation in a simulation game with carefully designed supplementary materials. This study demonstrates that significant gains in TL vocabulary can be achieved through this approach. The positive feedback shows that this result may have been due, in part, to the subject's perception that playing the game was enjoyable and a useful means to develop their communicative competence. Taken together, these findings suggest that the use of stand-alone games combined with carefully designed support materials may be an effective means to develop vocabulary as a supplement to regular coursework.

Table 7. Key Research Findings on the Use of Games and Simulations in CALL

Tool	Study	Key Findings
MOO	Von Der Emde et al. (2001), Kötter (2003)	Extensive TL use, frequent instances of collaborative TL dialogue, and experimental learning involving language play; frequent instances of meaning negotiation
SIMCOPTER	Coleman (2002)	Use of a simulation combined with a task produced TL-focused interaction that raised awareness of writing for an audience
SIMCITY	Ranalli (2008)	Use of a simulation combined with supplementary materials led to statistically significant gains in vocabulary knowledge, learners reported a high degree of engagement
ACTIVEWORLDS	Toyoda and Harrison (2002)	Negotiation of meaning occurred, limited computer skills and difficulties in turn tracking led to the production of frequent errors, need for training
WORLD OF WARCRAFT	Thorne (2008)	Negotiation of meaning occurred, the subjects formed collaborative social relationships
TACTICAL IRAQI	Surface et al. (2007)	Subjects TL knowledge increased, one third of the subjects reported that their speaking and listening skills had improved

Note: CALL = computer-assisted language learning; MOO = multiuser object-oriented; TL = target learning.

The findings reported by Thorne (2008), although provisional in nature, indicate that participation in online gaming offers expanded opportunities to engage in language learning in informal settings that are not subject to the limitations of traditional classrooms. The interaction afforded by WORLD OF WARCRAFT appears to facilitate access to a beneficial social context for language use that combines a number of factors that play a role in language learning. These are extensive exposure to the TL within a motivating, goal-driven, and learner-centered environment. This environment appears conducive to negotiation of meaning, collaborative dialogue, and the development of the interpersonal relationships necessary for effective language acquisition in online contexts.

TACTICAL IRAQI represents not only an impressive technical achievement, it also shows the future of development in the use of games and simulation in CALL. The findings presented by Surface et al. (2007), though provisional, provide evidence that significant learning gains are possible by combining state-of-the-art games and realistic simulations within a comprehensive goal-based training system that utilizes virtual agents, speech recognition, and artificial intelligence techniques. As this system is under continuous development, future studies may provide increasing evidence for the benefits of applying these technologies in CALL.

Conclusions

The analysis conducted in this article indicates that the use of games and simulations in CALL represents a promising research area rich in possibilities. Taken as a whole, the body of research examined here, though subject to limitations, provides compelling evidence that participation in gaming and simulation may facilitate aspects of SLA and the development of communicative competence. The discussion draws attention to the urgent need for more large-scale longitudinal studies that explore a number of key areas. These include the influence of factors such as task, training, proficiency level, and affective variables on learner language development. The findings further emphasize the important role that individual educators can play in supporting learning, including the careful design of motivating tasks and supplementary materials based on learner needs. They also highlight the need to provide the focus on form that is essential for sustained learning gains through, for example, the use of transcripts. Future research in this area offers the prospect of enhanced understanding of the complex processes involved in language learning and opens up new possibilities to investigate how SLA may be facilitated in the dynamic learning environments made possible by computer simulations and games.

Acknowledgments

I would like to thank Bernard Susser, David Crookall, and an anonymous reviewer for their insightful feedback on earlier drafts of this article.

Declaration of Conflicting Interests

The author declared no potential conflicts of interests with respect to the authorship and/or publication of this article.

Funding

The author received no financial support for the research and/or authorship of this article.

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