Special Issue on Language Learning : Introduction

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Journal of Artificial Intelligence in Education, vol. 5, 4, 1994

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Articles

Special Issue Introduction

Language Learning

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This special issue of the *Journal of Artificial Intelligence in Education* is based on the workshop SCIAL'93 (Cognitive Science, Computer Science and Language Learning) held in October 1993 in Clermont-Ferrand, France (Chanier, Renié & Fouqueré, 1993). The workshop gathered researchers who consider the development of interactive language learning environments as a field of multidisciplinary collaboration. Researchers belonged to several disciplines from the domain of cognitive science: linguistics (in its broad meaning, including theoretical and applied linguistics as well as language teaching), computational linguistics, computer science, psycholinguistics. The workshop was directed by Thierry Chanier, University of Clermont 2, France, who is also the editor of this special issue. New versions of selected papers focusing on Intelligent Computer Assisted Language Learning (ICALL) more specifically have been assembled here so as to introduce JAIED readers to the current research interests in ICALL. The workshop version of the papers had been selected by its multidisciplinary program committee, and then new versions have been reviewed in the normal JAIED manner.

The domain of language acquisition

Whereas, in Artificial Intelligence and Education research, programming and mathematics are customary domains of application, language seems to have been much less addressed. For example, in the last AI-ED conference held in 1993 in Edinburgh only 2 papers out of 70 were concerned with language learning. As regards mathematics two main reasons are put forward to explain its prominent rôle (Nwana, 1993, p 5):

> << 1. Mathematics is highly structured and its algorithms are well defined, making it easier to concentrate on the features of the Intelligent Tutoring System (ITS) itself, rather than those of the domain.
>
> 2. Mathematics is an important educational domain because it underpins most of science and engineering. >>

The importance of the educational issue can obviously not explain the discrepancy between mathematics and language. Learning a language may be one of the first educational issues we face in our societies. From the early years till adulthood mastering language is a crucial problem when it relates, either to the first language, the mother tongue (think of the current expansion of illiteracy), or to a second or third language. Language barriers not only raise educational problems but sociological and political ones as well.

On the other hand, the first reason mentioned above points to the large gap that exists between mathematics and language. Before considering the learning of a language, language itself is hard to define and hence to structure. It is now well accepted among researchers and practitioners in language acquisition that being proficient in a language cannot be reduced to mastering a grammatical competence but, because language is intertwined with communication, *communicative competence* should also be acquired. Communicative competence includes:

- the formal/grammatical competence: ability to produce and understand correct syntactic, lexical, and phonological forms in a language. This competence is often also called the 'linguistic' one, but it then implies a very narrow interpretation of the coverage of linguistics.

- the sociolinguistic/sociocultural competence: ability to use a language appropriately in sociocultural contexts ; knowledge of cultural history and relationships among social actors.

- the discourse competence: ability to understand and produce discourses organised in different ways depending on the parameters of the communicative situation (oral/written discourse, academic letter vs. postcard, etc.).

- the referential competence : knowledge of experiential domains, of their objects and relationships ; ability to find the corresponding information.

- the strategic competence : ability to effectively transmit information to a listener, including the ability to use communication strategies, and to solve problems which arise in this process.

The fact that language is used to do many things and consequently that many learning situations should connect language use and problem-solving tasks is becoming well supported by language acquisition researchers and practitioners. The situation is very different in mathematics or physics where abstraction and heavy practice of symbol manipulations have almost obscured connections with the kind of reality they represent. Famous experiments show that this lack of connection may be of consequence in education: for example, learners in higher education may be proficient in handling formulae and unable to make correct predictions in simple experiments in dynamics.

One cannot help feeling that, confronted with such a variety of learning goals, trying to define the ideal type of ITS for language learning, as has sometimes been attempted in ICALL, is a wrong issue. There is space for very different kinds of learning environments according to the competence(s) aimed to be acquired (and also to the

learning situations as we will recall later on).

This enumeration shows the various kinds of cognitive skills and knowledge that language use mobilises. For example, linguistic knowledge is traditionally decomposed into phonology, morphology, syntax, semantics, pragmatics. Such a range of knowledge and savoir-faire has given birth to numerous linguistic schools and theories. The absence of consensus has had the drawback in the field of ICALL of over-emphasising the domain description (unlike the situation encountered in mathematics, as mentioned in Nwana's first comment). When modelling the expert and the learner's knowledge, researchers have often adopted the standpoint of some particular theory, used its abstract formalism (when it exists) for writing computational grammar, and also inevitably used its jargon, which rebukes readers not directly concerned with language, and even researchers whose prime concern is on language acquisition rather than formal linguistics. There exists some intermediate position between strong commitment to a theory and its total rejection. Researchers in Natural Language Processing (NLP) know that: constraints imposed by the application are of primary importance ; from there, one is free to base his/her approach on theoretical grounds or more pragmatical ones (see, as an illustration, the resumption of statistical and probabilistic approaches in NLP). Theories are interesting when then bring (as they should) coherent, and consistent solutions, and explanations to process and describe linguistic phenomena with a somewhat not too restricted coverage. They can be even more interesting when they have some claims about the way language is acquired.

If we now consider language learning, the multiplicity of existing learning situations also makes striking differences with the learning of mathematics. First language is acquired partly in natural, partly in institutional settings. A second language can be acquired either as a *foreign language*, i.e. a language which is taught as a school subject but which is not used as a medium of instruction in schools nor as a language of communication within a country (English is described as a foreign language in France, Japan, etc.) ; or as a second language, i.e. a language which is not a native language in a country but which is widely used as a medium of communication and which is used alongside another language (English is described as a second language in countries such as Singapore or Nigeria). In this issue, conforming to the current tradition in applied linguistics, the term "*second language*" is used as a generic term covering foreign and second language uses. But most of the situations dealt with in ICALL are in fact restricted to foreign language learning situations.

When learning a second language, the learner is generally (but not always, when s/he is a child) already proficient in his first language (L1), also called the native or *source language*, and aims at acquiring the second or *target language* (L2). The type of language produced by a L2 learner is often referred to as an *interlanguage*. Results of analysis of learner's errors give some evidence of his/her interlanguage system.

Processes that cause errors include:

- borrowing patterns from the mother tongue (transfer process)

- extending patterns from the target language, e.g. by analogy (over-generalisation process)

- expressing meanings using the words and grammar which are already known (communication strategies).

The existence of two systems in L2 learning and consequently of the process of transfer has no counter part in mathematics. To illustrate this fact, think what difficulties a European teacher in mathematics would encounter for teaching our traditional way of handling demonstration in algebra in India ... if children in this country had already been taught algebra conforming to the Indian mathematical tradition of the previous centuries !

But the process of transfer should not be over-emphasised. When Second Language Acquisition (SLA) researchers try to compare the resemblance, for a given language, of the natives' steps of acquisition with those of the L2 learners, they do not think that transfer is the major cause of problems in the acquisition process, at least when learners are no longer real beginners. Learning a second language is not more difficult than learning the first. The term "natural" used to qualify part of the learning situation in L1, does not imply that being proficient in his/her mother tongue is an easy task. In their early years children concentrate a large part of their cognitive abilities on understanding what language is, and on acquiring their mother tongue because it is the only way to be understood and to get access to the world controlled by adults. Experiments have shown that, in some linguistic tasks, L2 adult learners are more proficient than native children. But the limited amount of time of immersion in the target language may be the main cause of acquisitional problems. That is one reason for finding computing learning environments so attractive.

Not surprisingly such a variety of learning situations raises a large range of conflicting or complementing language learning theories, as the reader will notice in the following papers.

The purpose of this digression on language and language learning was to briefly introduce JAIED readers to the educational language field and to some of its terminology (some more information is given in the first part of Hamburger's paper). Problems raised should not be interpreted as being a sort of pretext to justify limitations of our current systems. Optimists would say that we are lucky in our multidisciplinary field of research, because ICALL researchers can rely on a large

body of research on linguistic knowledge, coming from linguistics, on how language is accessed and produced, coming from psycholinguistics, and on how language is acquired, coming from applied linguistics !

The field of Intelligent Computer Assisted Language Learning

CALL is becoming widely spread. For well over ten years schools, a large minority of the higher education sector of some countries, and, more recently, training institutions have been exploiting the possibilities of computers to enhance language learning (Thomson & Chesters, 1992). The CALL milieu is well organised thanks to its:

- journals such as Computer Assisted Language Learning (CALL), System, Computer Assisted Language Learning and Instruction Consortium (CALICO) and ReCALL,

- associations and annual conferences (CALICO, European Association for CALL (EUROCALL) or the Exeter conference in UK),

- resources centres, like the CTI Centre for Modern Languages of Hull in the UK, which provide information, training, evaluation of software,

- European programmes (DELTA, LINGUA, COMETT) or national ones (like the consortium TELL - Technology Enhanced Language Learning - in the UK) which concentrate and unify software developments.

Such a situation represents for ICALL both an opportunity and a challenge. Since CALL is no more the concern of a restricted set of enthusiasts but has gained a large audience, since it is now a marketable area, the necessity of supporting advanced research is overtly legitimated. At the same time it is also a real challenge for ICALL researchers, who have to prove that their systems can be usable, either directly or indirectly, and that their educational aims are consistent with the range of interests, mentioned in the previous section.

ICALL in the early years, i.e. in the eighties, has not been very convincing because its educational aims were not innovative, and because it was based on computing techniques inspired from NLP and AI that now reveal themselves to have been a too narrow extraction from the range offered by these disciplines and to have led to nearly intractable computations (in the way they were handled). Most AI-ED environments for language learning were computational-error systems. A *computational-error system* aims at practising or at evaluating grammatical competence. It puts the emphasis on the implementation of the expert module, built around a computational grammar reflecting the expert knowledge of the linguist. Procedures, directly

influenced by the "bug/mal-rules" approach, are added to the computational grammar for handling error diagnosis. These procedures update the learner model and are supposed to inform the system of the learner's state of knowledge and competence. Most of the time, the system interacts with the learner through utterances that had been isolated from a real communication situation (a more detailed presentation may be found in (Chanier & al, 1992)). Some of the weak points of this approach are its lack of foundation on real acquisition data, its lack of cognitive motivation, its distorted presentation of language which ignores the other communicative competences, and its over-emphasise of parsing techniques to handle ill-formed input sentences. We hope the reader will not interpret this criticism as a full rejection of research on computational-error systems (indeed some papers of this issue bring new insights on this topic). We just do not want ICALL to be confused with only this concern as AI-ED research cannot be reduced to the development of environments based on the bug/mal-rule approach, however important it may have been historically.

From, approximately, the early nineties, many papers presented in specialised international workshops show that the focus of attention and aims have changed in ICALL research. In order to serve as a kind of reference when reading the papers of this special issue, we repeat nine key desiderata for ICALL, which are largely motivated by general language learning and teaching concerns, and include points familiar, in several respects, to JAIED readers (Oxford, 1993):

1. Communicative competence must be the cornerstone of ICALL.

2. ICALL must provide appropriate language assistance tailored to meet student needs.

3. ICALL must offer rich, authentic language input.

4. The ICALL student model must be based in part on a variety of learning styles.

5. ICALL material is most easily learned through associations, which are facilitated by interesting and relevant themes and meaningful language tasks.

6. ICALL must involve interactions of many kinds, and these interactions need not be just student-tutor interactions.

7. ICALL must provide useful, appropriate error correction suited to the student's changing needs.

8. ICALL must involve all relevant language skills and must use each skill to

support all other skills.

9. ICALL must teach students to become increasingly self-directed and self-confident language learners through explicit training in the use of learning strategies.

The Special Issue

Henry Hamburger's paper opens this issue because, firstly, in its first part it provides an introduction to language learning from the standpoints of cognitive science and of pedagogy. The reader unfamiliar with the domain is recommended to start here. The second reason for starting with this article is that Hamburger's system, named FLUENT, is both a heavy user of AI techniques and an educational system based on principles that break the ICALL tradition of the eighties. No stress on accuracy is sought. The system behaves like a conversational partner with a beginning student in L2, without any recourse to his/her mother tongue. The learner-system communication is oriented towards the doing of simple actions encountered in everyday life. This communication relies on two media, natural language and animated graphics. For example, in a kitchen micro-world, the learner, when wishing to move objects can either produce an utterance or accomplish a graphical action. On its turn, when the system reacts, it can either run an animated graphical sequence or generate sentences. This bi-modal approach may be of interest for building interfaces of learning environment in other domains. FLUENT involves interactions not restricted to the student-tutor one. The system can also act as a tutee/servant, as a kind of sportscaster, or as a tourguide.

The second paper, by Greg Lessard, Michael Levison, Daniel Maher, Ivan Tomek, lays on more traditional grounds because it refers to grammatical errors analysis. But here the aim is not to distort a computational grammar and its parser in order to try to extract a learner's errors from an answer. Following a long tradition in applied linguistics (but quite new in ICALL), the authors consider learners' errors as a sign of creativity, as an external manifestation of their interlanguage. In order to extend SLA research on the nature of knowledge and strategies related to the interlanguage, they have designed the VINCI environment. Errors are manually studied from a large corpus of L2 learners' productions. Presumed learner's rules are then modelled in the VINCI format and a natural language generator reproduces standard and deviant learners' productions. VINCI can then be re-used as a test environment in order to check hypotheses on interlanguage by putting individual learners in a production situation, where various parameters influencing the task can be controlled. Thus VINCI provides more an off-line student modelling system, than an on-line one (Ohlsson, 1992). At this point, it is worth adding some extra comments. The VINCI approach may look very similar to the bug library technique, often criticised, but still much used in learner modelling. The major argument against this technique is not its

building cost, nor its high computational complexity in on-line student modelling, but that in several domains it has been proved that it cannot be transferred from one student population to the next (Ohlsson, op. cit.). Is that true in language learning ? A large part of what we know about the various stages of knowledge traversed by L2 learners has been drawn out by error analysis in SLA. Thus many experiments on the analysis of deviant forms used by a population have been proved to be extensible. And VINCI can be helpful for building, what we could call, stereotypes of learner models (with respects to the grammatical competence). However, at present, it does not provide any answer on the way to achieve individual leaner modelling in a tutoring environment. We try to bring some insights on this problem in (Chanier & al 1992), and we may expect that, if such techniques as the constraint-based one is applicable to language learning, relevant constraints could be extracted from the learner stereotypes.

Michael Harrington addresses, in the third paper, the question of L2 vocabulary acquisition. Since the mid-eighties, vocabulary teaching has regained a large popularity among SLA researchers and teachers. Gaps in lexical knowledge may seriously hinder the development of L2 proficiency for advanced learners (like learners of Japanese, who are considered here in the COMPLEX system). More positively, the acquisition of L2 lexical units (either made up of single word or multi-words) and the various kinds of knowledge attached to them bring fundamental information to the learner that helps him/her structure sentences that s/he wants to comprehend or produce. We also now know that the learner's mental lexicon is not made up of a mere list of vocabulary items but is a set of rich networks coupled with special processes that handle lexical access or production. Consequently, as recommended in the desiderata listed in the previous section, several ICALL environments support the learning of vocabulary through associations. What distinguishes COMPLEX from other systems, is that the learning space is restricted to previously learned items. Harrington thus discusses the problem of developing and reorganising part of the learner model.

Ruddy Lelouche, in the next paper, turns his attention to the learning of the sociolinguistic competence. Whereas grammatical competence has been thoroughly studied by theoretical linguistics and applied linguistics, there is no such large body of expertise available for this kind of pragmatic knowledge, despite the importance attributed to this competence in L2 acquisition. Consequently, at present, it is up to ICALL researchers to develop by themselves the domain expertise. Lelouche explains how his system PILÉFACE aims at making explicit the implicit relevant knowledge, why several knowledge bases and several inference engines are needed. He argues that , even if his concern is to design a full learning environment in the spirit of AI-ED the first unavoidable step is the description of the expert knowledge. But, interestingly, the lack of existing theoretical expertise and the necessary inclusion of many parameters of the socio-cultural learning situation forces the system into

modelling the competence of the native speaker. It makes a striking difference with many ICALL systems, centred around the practice of grammatical competence, where the expert knowledge referred to is the linguist's one, and where the grammar presented to the learner is, much too often, far remote from pedagogical grammars used by teachers and from language structures really used by native speakers.

In his paper, Matthews addresses the question of which grammar framework might best form the basis of the syntactic component of an ICALL system. He thus extends the discussion about the domain description we introduced in the first section. Matthews reacts against the original tendency in ICALL to proceed in an ad hoc fashion and argues for a principled framework. In order to illustrate the debate, he opposes two frameworks, of very different nature, that are often applied to write computational grammars, the DCG formalism (that every reader of books about AI and Prolog has heard of) and the Chomskian PPT theory. In computational linguistics, the DCG formalism has always been presented as an easy way of implementing grammars of various sorts and has thus never been claimed to be connected to any linguistic theory. But in ICALL, where DCG have also often be used, such a 'pragmatic' approach may be questionable if the linguistic description is not principled or does not reflect acquisitional data. On the contrary, the PPT framework offers both a theoretically based description of syntactic knowledge and a theory on grammar acquisition. Although Matthews supports the Chomskian approach, his main aim is to identify the main criteria for choosing a computational grammar formalism that could directly account for the nature of the expert knowledge and of the learner's interlanguage.

Contrastingly, the last paper, by Annie Chambreuil, Michel Chambreuil, and Chihab Cherkaoui, shows that language learning may not always be primarily concerned with linguistic issues. Language acquisition cannot be fully understood without addressing the interaction between language and cognition. Their paper illustrates this statement by presenting AMICAL, a system conceived to support the learning of one of the four main language skills, i.e. reading. Whereas all the previous papers of this issue discussed vary points of second language acquisition, here the learning situation tackled is the typical learning-to-read situation, faced by pupils during their early stage of first language acquisition. The topic of the paper, instructional planning, will sound familiar to JAIED readers. Individualised teaching and adaptation to the learner's own process are sought through the capacity of the system to build up student's representations and to handle the dynamics of instructional planning. The teacher's standpoint is central, i.e. a teaching objective is not defined in terms of the advancement of the learner's knowledge but in terms of the advancement of the teacher's knowledge about the student's knowledge. AMICAL is also a system interesting for AI-ED in general because it is based on a highly sophisticated AI architecture, consisting of a multi-agent system relying on a multi-layer blackboard structure.

Thanks to the higher level of requirements now applied in ICALL, all the systems presented in this issue are motivated, cognitively or pedagogically, in agreement with current interests in SLA research. The reader will certainly note that we have only presented prototypes which have actually been implemented, none of which have yet been used in real learning situations, but upcoming experiments will involve most of them in evaluating their relevance, either as learning environments, or as environments that can support fundamental research on language acquisition through interaction with the computer.

We hope you will enjoy reading this special issue, and find that many problems arising in language learning environments are not domain specific but common to AI-ED in general. Conversely, we are convinced that it will help ICALL researchers convince people belonging to language acquisition research of the importance of AI-ED.

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List of Abbreviations

CALL: Computer Assisted Language Learning.

CV: Consonant, Vowel.

DCG: Definite Clause Grammar, a computational grammar formalism.

FLA: First Language Acquisition.

ICALL: Intelligent CALL.

L1: First Language, also called the source language. It is the learner's mother tongue.

L2: Second Language, also called the target language.

NLP: Natural Language Processing.

NP: Noun Phrase.

PPT: Principles and Parameters Theory, i.e. the Chomskian Universal Grammar.

SLA: Second Language Acquisition.

VP: Verb Phrase.