

Where will the standards for Intelligent Computer- Assisted Language Learning come from?

LARS BORIN

Reports from Uppsala Learning Lab —
Digital Resources in the Humanities (DRHum) project
Research reports (DRHumR)

DRHum — Digital Resources in the Humanities

“[T]he Wallenberg Global Learning Network [was] launched with the generous support of the Knut and Alice Wallenberg Foundation (KAW). In 1998, KAW donated \$15M over 5 years to Stanford University for the renovation of a campus building, Wallenberg Hall, and for a state-of-the-art center and network for global learning research associated with the Stanford Learning Lab. In 1999, this donation was supplemented with \$3M over 3 years for the establishment of a Swedish consortium of learning labs at Karolinska Institutet, the Royal Institute of Technology, and Uppsala University. These three institutions constitute the Swedish Learning Lab. The purpose of the network thus created around the Stanford Learning Lab and the Swedish Learning Lab is to promote learning across cultural and geographical bounds by developing human expertise and new learning technologies for education. [...]

The sub-project APE (Content archives, student portfolios & 3D environments) is an ongoing activity within the SweLL project "Meeting places for learning". The three tracks within APE:

Track A. Content and Context of Mathematics in Engineering Education (CCM),

Track B. Digital Resources in the Humanities (DRH)

Track C. 3D Communication and Visualization Environments for Learning (CVEL).”

(From the *Wallenberg Global Learning Network First Year Achievement Report*, 2001)

DRH—or DRHum, as we like to call it using a more easily pronounceable acronym (‘drum’)—consists of a set of interrelated activities investigating issues connected with the use of digital resources in humanities teaching and research at the university level. The members of the DRHum research team and their affiliations are:

PI: Lars Borin, Department of Linguistics, Uppsala University

PI: Jonas Gustafsson, Department of Teacher Education, Uppsala University

Karine Åkerman Sarkisian, Slavic Department, Uppsala University

Janne Backlund, Department of ALM, Aesthetics and Cultural Studies, Uppsala University

Camilla Bengtsson, Department of Linguistics, Uppsala University

Mattias Lingdell, Department of Linguistics, Uppsala University

György Nováky, Department of History, Uppsala University

John Rogers, Department of History, Uppsala University

Jan Sjunnesson, Department of Teacher Education, Uppsala University

We also collaborate with individuals and research groups inside and outside WGLN:

- Donald Broady, Director of Uppsala Learning Lab and scientific coordinator for APE
- Monica Langerth Zetterman, Uppsala member of the Swedish Learning Lab Assessment Team
- The Uppsala Learning Lab e-folio project led by Göran Ocklind
- The KTH Learning Lab Conzilla and Imsevimse APE CCM projects
- The LingoNet “web-based language laboratory” project at Mid-Sweden and Uppsala Universities
- The Nordic (Helsinki, Oslo, Stockholm/Uppsala) Squirrel project on corpus-based computer-assisted language learning

The main DRHum activities are:

- The development and evaluation of Didax, a web-based system for diagnostic language testing (Borin, Åkerman Sarkisian, Bengtsson, Lingdell)
- The use of digital picture archives and demographic databases in History courses (Nováky, Rogers)
- The use of biographical, historical and geopolitical databases and e-folios in teacher training (Gustafsson, Sjunnesson)
- The development of XML-based digital learning resources using emerging e-learning standards (Borin, Åkerman Sarkisian, Bengtsson, Lingdell, Backlund)

In the DRHumR (‘drummer’) research report series, the members of the DRHum team write about their work and their research findings. In the series, there will be status reports, technical documentation, evaluation reports, and preliminary versions of research articles which will appear elsewhere in a more polished format.

Where will the Standards for Intelligent Computer-Assisted Language Learning Come from?

Lars Borin

Computational Linguistics, Department of Linguistics,
Stockholm University, SE-106 91 Stockholm, Sweden

and

Department of Linguistics, Uppsala University,
Box 527, SE-751 20 Uppsala, Sweden

lars.borin@ling.su.se, lars.borin@ling.uu.se

Abstract

Intelligent computer-assisted language learning—Intelligent CALL, or ICALL—can be defined in a number of ways, but one understanding of the term is that of CALL incorporating language technology (LT) for e.g. analyzing language learners' language production, in order to provide the learners with more flexible—indeed, more 'intelligent'—feedback and guidance in their language learning process. However, CALL, ICALL and LT have been three largely unrelated research areas, at least until recently. In the world of education, 'e-learning' and 'ICT-based learning' are the new buzzwords. Generally, what is meant is some kind of web-based setup, where course materials are delivered via the Internet or/and learners are collaborating using computer-mediated communication (CMC). An important trend in ICT-based learning is that of standardization for reusability. Standard formats for all aspects of so-called 'instructional management systems' are rapidly gaining acceptance in the e-learning industry. Thus, learning applications will need to support them in order to be commercially viable. This in turn means that the proposed standards should be general enough to support all conceivable kinds of educational content and learning systems. In this paper, we will discuss how ICALL applications can be related to the various standards proposals, basing our discussion on concrete experiences from a number of (I)CALL projects, where these standards are used or where their use has been contemplated.

1. Introduction

For some years, I have been actively involved in trying to combine computer-assisted language learning (CALL) with language technology (LT) (a.k.a. computational linguistics (CL), language engineering (LE), or natural language processing (NLP)) into what is often referred to as "Intelligent CALL" (ICALL), both as a teacher of CALL to LT students at the university, and as a researcher involved in a number of research efforts dealing with CALL/ICALL (see below), and also with neighboring areas, such as computer support for lesser used and lesser taught languages (Borin, 2000a; Allwood and Borin, 2001; Nilsson and Borin, 2002), and contrastive linguistic studies using computational methods (Borin, 1999; Borin, 2000b; Borin and Prütz, 2001; Borin and Prütz, 2002).

The present paper flows from a desire to make ICALL benefit from, as well as inform, ongoing standardization efforts in the computational linguistics and e-learning communities.

The rest of the paper is organized in the following way. First, I will try to sort out the relationships between CALL, LT, artificial intelligence (AI), and ICALL. Then I will describe briefly ongoing standardization work in the e-learning and CL communities, and some of the standards proposals that this work has produced. Following that, I will turn to a description of some (I)CALL projects in which I have been or am currently involved, where these standards are used or where their use has been contemplated, namely the SweLL Didax project,

the LingoNet project, 'Corpus based language technology for computer-assisted learning of Nordic languages', the SVANTE learner corpus project, and 'IT-based collaborative learning in Grammar'. Finally, I will discuss the situation of ICALL with regard to this standardization work, in order to form an understanding of where we stand at the moment, but more importantly, of where we would like to go from here.

2. CALL, LT and ICALL

Intelligent computer-assisted language learning—Intelligent CALL, or ICALL—has been defined in a number of ways, but one understanding of the term relevant here is that of CALL incorporating LT techniques for e.g. analyzing language learners' language production or modeling their knowledge of a second/foreign language in order to provide them with more flexible—indeed, more 'intelligent'—feedback and guidance in their language learning process.

CALL, ICALL and LT have been three largely unrelated research areas, at least until recently:

1. The CALL 'killer apps' have been e-mail, chat and multimedia programs, developed and used by language teaching professionals with very little input from LT research (Pennington, 1996; Chapelle, 1997; Chapelle, 1999; Chapelle, 2001; Levy, 1997; Salaberry, 1999). The only kind of LT which has had any kind of impact on the CALL field is corpus linguistics, and even in this case it has been the Humanities Computing 'low-tech' kind of corpus linguistics,

rather than the kind pursued in LT (the latter is sometimes referred to as “empirical natural language processing”).

2. ICALL has often been placed by its practitioners in the field of artificial intelligence (AI), rather than in LT (e.g. Swartz and Yazdani (1992); Holland et al. (1995)), more specifically in the subfield of AI known as *intelligent tutoring systems* (ITS) (e.g. Frasson et al. (1996); Goettl et al. (1998)). Partly for this reason, work on ICALL has proceeded, by and large, without feedback into the LT community.
3. But on the other hand, in LT in general, (human) language learning has not been seen as an application area worth pursuing. In the recent broad *State of the art of human language technology* overview edited by Cole et al. (1996), ‘language learning’ does not appear even once in the index, and there is no section on CALL. Certainly there are some exceptions to this general trend; there have been occasional COLING (*International Conference on Computational Linguistics*) papers on ICALL, although few and far between (e.g. Borissova (1988); Zock (1996); Schneider and McCoy (1998)), and there is a research group in Groningen which has been working very actively on LT-based CALL applications for quite some time (Nerbonne and Smit, 1996; Dokter, 1997; Dokter, 1998; Dokter and Nerbonne, 1997; Dokter et al., 1997; Jager et al., 1998). The situation has been changing somewhat only in the last few years, however, with dedicated workshops on language learning applications of CL being arranged in connection with LT conferences and the like (e.g. Olsen (1999); Schulze et al. (1999); Efthimiou (2000)).

3. Standardization in e-Learning and Language Technology

3.1. E-learning standardization efforts

In the world of education, ‘e-learning’ and ‘ICT-based learning’¹ are the new buzzwords (see, e.g., European Commission (2000)). Generally, what is meant is some kind of web-based setup, where course materials are delivered via the Internet or/and learners are collaborating using computer-mediated communication (CMC) methods.

An important trend in ICT-based learning is that of standardization for reusability. Standard formats are defined for all aspects of so-called ‘instructional management systems’. Thus, not only educational content formats are agreed upon, but also course structure formats, test formats, as well as how their interaction with recordkeeping systems used in education should take place. There is a number of organizations working on standards in the e-learning area, the most important ones being IMS (Instructional Management System Inc. <http://www.imspjproject.org/>), IEEE’s LTSC (Learning Technology Standards Committee; <http://ltsc.ieee.org/>), the American Department of Defence ADL (Advanced Distributed Learning; <http://www.adlnet.org/>) initiative, and the

¹ICT is to be read out “Information and Communication Technologies”.

European ARIADNE project. Standards being developed by these and other bodies include educational metadata (Learning Objects Metadata – LOM; Anderson and Wason (2000)), test formats (IMS Question and Test Interoperability – QTI; Smythe and Shepherd (2000)), content packaging formats (IMS Content Packaging; Anderson (2000)), modular courseware (ADL SCORM; Dodds (2001)), and others (see, e.g. the IMS and LTSC websites referred to above). At least some of these standards are rapidly gaining acceptance in the e-learning industry. Thus, learning applications will need to support them in order to be commercially viable. This in turn means that the proposed standards should be general enough to support all conceivable kinds of educational content and learning systems.

The general idea is to create standards which are

“pedagogically neutral, content-neutral, culturally neutral and platform-neutral”
(Farance and Tonkel, 1999, 9),

and which support . . .

“common, interoperable tools used for developing learning systems [. . .]”

a rich, searchable library of interoperable, “plug-compatible” learning content [. . .]”

common methods for locating, accessing and retrieving learning content”
(Farance and Tonkel, 1999, 14)

One may certainly entertain doubts as to the general attainability of these goals, but one cannot afford to ignore the huge amount of time and labor invested in pursuit of their fulfillment by the organizations mentioned above and others. This being so, it is of course not unimportant if learning and teaching within a particular field—such as language learning—is adequately covered by the proposed standards or not.

3.2. Standardization in Language Technology/Computational Linguistics

In the LT world, too, standardization efforts are legion, and a recurring theme at the LREC (Language Resources and Evaluation Conference) series of conferences.

There is LT standardization work going on at least in the areas of

- resource storage and exchange: TIPSTER (Grishman et al., 1997), ATLAS (Bird et al., 2000), XCES (Ide et al., 2000);
- resource annotation: XCES (Ide et al., 2000), EAGLES (e.g., tagsets: see Monachini and Calzolari (1996));
- resource metadata: OLAC, ISLE (Wittenburg et al., 2000);
- resource presentation and manipulation, and software integration: THISTLE, GATE (Cunningham, 2001), KABA (Olsson, 2002).

To the best of my knowledge, however, the work within LT on resource markup and annotation has not been informed by language learning applications or by the work done on compiling and investigating so-called learner corpora by applied linguistics researchers (see, e.g., Granger (1998)).

4. (I)CALL Case Studies

In this section, we will look at some CALL research projects, where the issue of combining (I)CALL applications with e-learning standards has arisen in various ways.

4.1. Didax

Didax – the Digital Interactive Diagnostic Administering and Correction System, is a project in the framework of the *Swedish Learning Lab* (SweLL), a research effort funded by the Knut & Alice Wallenberg Foundation as part of the larger *Wallenberg Global Learning Network* endeavor, where a number of centers—or “nodes”—worldwide receive funding for exploring the use of ICT and other new technologies in higher education.

At present, there are three nodes in the WGLN: (1) SweLL, with three participating institutions of higher education, (1a) the Royal Institute of Technology and (1b) Karolinska Institutet in Stockholm, and (1c) Uppsala University, (2) the Stanford Learning Lab (SLL), at Stanford University, California, USA, and (3) Learning Lab Lower Saxony (L3S), at the University of Hannover, Germany. SweLL research is currently organized into a multi-tiered structure, with two top-level ‘projects’ subdivided into a number of ‘experiments’. Each experiment is further subdivided into ‘tracks’, where each track in turn typically is made up of several research teams cooperating on related research issues. Our work on Didax is thus carried out in the *Digital Resources in the Humanities* (DRHum) track of the *Archives – Portfolios – Environments* (APE) experiment of the SweLL project *New meeting places for learning – New learning environments*.

The Didax research team currently consists of three computational linguists and one SLA researcher, but we also cooperate closely with the other DRHum research teams, drawing on the other kinds of competence found there, especially the teams working with digital archives for humanities teaching, as well as with the Uppsala Learning Lab e-folio project group.

The end result of the Didax project is supposed to be a web-based language testing environment, which will provide both students and teachers with a more flexible format for taking, marking, constructing and setting diagnostic language tests in higher education. In Figure 1, the overall architecture of Didax is shown. The three Didax clients (*teacher – setting test*, *teacher – marking test*, and *student*) run in ordinary web browsers. There is nothing out of the ordinary to be seen in any of the client interfaces. This is quite deliberate. Most of the innovation is hidden under the surface, and the interface is a familiar one from many web applications. Didax is described in more detail by Borin et al. (2001).

4.2. LingoNet

LingoNet is a one-year R&D project funded by the Swedish Agency for Distance Education. The project is a cooperation between the Division of IT Services and the Department of Humanities, Mid Sweden University, and the Department of Linguistics, Uppsala University (see <http://www.mitt.mh.se/lingonet/>).

The aim of the LingoNet project is to build a ‘language lab on the Internet’, i.e. a web site with a collection of language training resources to be used in higher education, both locally and in distance education. Even though the point of departure for the LingoNet project is the traditional language lab, we actually envision a more general language training resource than this, i.e. a ‘computer language lab’, rather than a ‘computerized version of the tape recorder-based language lab’, as the idea is not only to transfer older techniques into this new technology, but also to exploit the additional possibilities offered by the new technology itself, including the incorporation of LT-based language learning resources in the LingoNet lab.

Specifically, in the LingoNet project, we make systematic use of quality control and metadata. It is a well-known fact that the information to be found on the web on any topic is, not only abundant in almost all cases, but also—to put it mildly—of extremely varying quality. At the same time, web search engines are still fairly primitive, so that finding educational resources, appropriate as to their content and level—regardless of their quality—in itself takes some work (Howard Chen, 1999, 24f.). It is only after they have been found that the real work begins, however, when the chaff—resources which are of low quality or of the wrong kind—is to be separated from the wheat—the resources which we can use for our educational purpose, i.e. educational web resources which are quality controlled and classified as to their content and level. In the LingoNet project, the quality control and metadata markup are done by academic language teachers. For more details about the LingoNet project, see Borin and Gustavsson (2000).

4.3. Corpus based language technology for computer-assisted learning of Nordic languages

‘Corpus based language technology for computer-assisted learning of Nordic languages’, or in short, the Squirrel project, is funded by the Nordic Council of Ministers, and represents a collaboration between the University of Helsinki in Finland, the research foundation SINTEF in Norway, and Stockholm University in Sweden (see <http://www.informatics.sintef.no/projects/CbLTCallNordicLang/squirrel.html>).

One of the aims of the Squirrel project has been to build a prototype web browser for students and teachers of Nordic languages as a second language, which will help them to find practice texts on the web according to the three parameters *language*, *topic*, and *text difficulty* (Nilsson and Borin, 2002). For more details about the Squirrel project, see Borin et al. (2002)

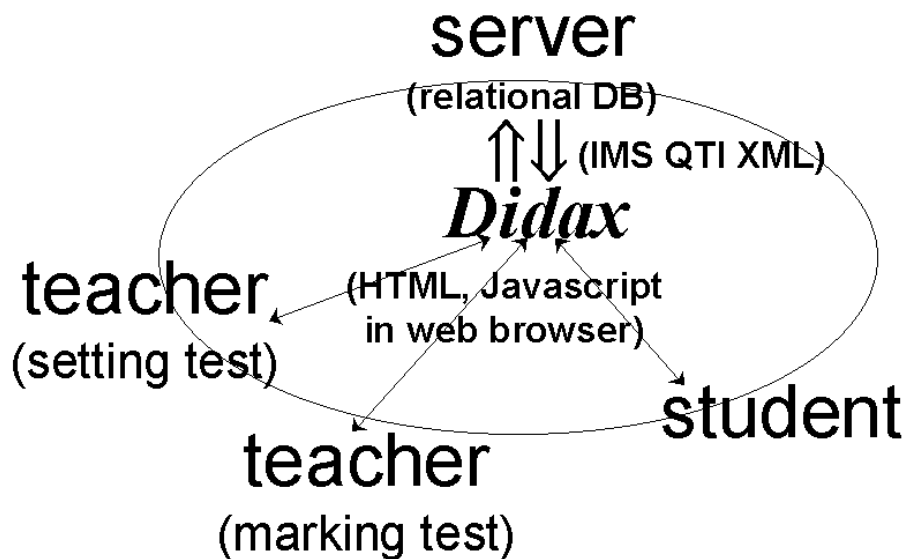


Figure 1: The anatomy of Didax

4.4. SVANTE

SVANTE (SVenska ANdraspråksTexter – Swedish Second Language Texts) is a loose collaboration between linguists, computational linguists, and teachers of Swedish as a second language, with the aim of creating a versatile learner corpus of written Swedish, to complement the learner corpora of spoken Swedish that already exist (see <http://www.ling.uu.se/lars/SVANTE/>). The SVANTE project is partly funded by VINNOVA within the CrossCheck second language Swedish grammar checking project (see <http://www.nada.kth.se/theory/projects/xcheck/>).

4.5. IT-based collaborative learning in Grammar

'IT-based collaborative learning in Grammar' is a collaborative project, funded by the Swedish Agency for Distance Education, with partners in the Linguistics Departments at the universities in Uppsala and Stockholm, and the IT Department and two language departments at Uppsala University. This project revolves around two fundamental assumptions:

1. The use of web-based communication and collaboration technologies will help us make make basic grammar courses better and more effective for students and teachers alike;
2. Language resources originally developed in a research setting, such as tagged and parsed corpora (of Swedish in our case) and grammar writing workbenches, can be (re)used in the context of teaching grammar (Borin and Dahllöf, 1999).

Perhaps I should clarify at this point that this is not primarily an application intended for *language* students, but rather for students of Linguistics and Computational Linguistics, although we believe that it will be useful also as a component in language courses (Saxena and Borin, 2002).

4.6. Relation to e-learning standards and to ICALL

These projects are variously related to ICALL on the one hand and to e-learning standards on the other:

- Didax is not an ICALL project *per se*, but creates an infrastructure which can be used for ICALL applications, and thus must be able to accomodate them. It uses the IMS QTI, and the IEEE, IMS, ARIADNE LOM emerging standards.
- LingoNet is not an ICALL project either, but it goes without saying that among the more exciting possibilities for a web-based language lab are language training applications built on LT methods and resources; hence, we must take this into consideration in designing the underlying language lab format. Like Didax, LingoNet can be considered as an infrastructure project which should be able to accomodate ICALL applications. The standards involved are IMS Content Packaging, and IEEE, IMS, ARIADNE LOM.
- Squirrel is an ICALL project, which does not (yet) utilize any of the proposed e-learning standards, but we see how e.g. the LOM could be used to mark up the located text resources, e.g. for inclusion in something like the LingoNet database.
- SVANTE forms an integral part of an ICALL project, namely the CrossCheck second language grammar checking project, but SVANTE itself is more in the way of a linguistic resource project, where LT standards for basic markup and linguistic annotation of the texts are important.
- 'IT-based collaborative learning in Grammar' is very much an ICALL project. At this initial stage of the project (it started in January 2002), there are still a number of implementational details left to be decided.

However, we would certainly like to make our learning resources as widely useful as possible, meaning, i.a.,

1. that they should be—wholly or in part—easy to integrate into other e-learning environments, but also
2. that it should be easy to use corpus resources for other languages than Swedish in our application.

The first requirement implies the existence and use of general standards for e-learning applications, while the fulfillment of the second requirement certainly would be facilitated by standardization of language resources.

5. So, where will the Standards for ICALL Come from?

Summing up the foregoing, we may say that there are three communities which would benefit from closer interaction, because of a considerable overlap in their goals, but which thus far have pursued these goals separately:

1. The ‘ordinary’ CALL community—including those researchers working with learner corpora—has extremely tenuous links to LT (see e.g. Chapelle (2001, 32ff.)), and, as far as I have been able to ascertain, none at all to the ongoing e-learning standardization work mentioned in section 3.1. above.
2. Nor is the e-learning community working on any standardization for *language learning* (as opposed to *learning* in general). For example, the IMS Question and Test Interoperability (QTI) proposal specifies five test question response types, which can be rendered in up to three different formats (Smythe and Shepherd, 2000, 17). However, for the ‘IT-based collaborative learning in Grammar’ application, as well as for many other of the corpus-based CALL applications found in the literature, a response type “select (portion/s of) a text” would certainly be good to have.²
3. The LT community is not involved in any standardization effort for *language learning* information (as opposed to *language* information in general). The kinds of standards that come to mind first are those involving linguistic annotation schemes, with regard to both their content and their form:

So-called *learner interlanguage* is characterized by a number of linguistic features absent from the native-speaker version of the target language (and sometimes absent from the learner’s native language as well (Richards and Sampson, 1974, 6)). Interlanguage goes through a number of stages, terminating in a final (hopefully close) approximation of the target language. This has some implications for linguistic annotations of learner language production, whether in

²In the QTI specification, there is actually a sixth response type *response-extension*, intended for proprietary response types, but the predefined types will always determine the ‘path of least resistance’, at least for many users.

learner corpora (longer texts) or in analyzers of free learner language production in ICALL language exercises. Thus, part-of-speech (POS) tagging or parsing of learners’ interlanguage may have to deal with categories absent from the canonical target language grammar as reflected in an LT standard, etc., but which can be related either to categories in the learner’s native language, to universally unmarked categories, to a conflation of target categories, to the pedagogy used, to some combination of these, etc. (Cook, 1993, 18f.). The status of a given linguistic element can change from one language learning stage to another, e.g. the unmarked form in a morphological paradigm becoming functionally more and more specified, as the learner acquires the marked forms and their functions.³

Hence, multiple linguistic annotations of the kind proposed for XCES (Ide et al., 2000) and ATLAS (Bird et al., 2000; Cotton and Bird, 2002) are a necessity for language learning applications of e.g. language corpora.⁴ In addition to providing multiple annotations of the same linguistic object (a word, phrase, etc.), the annotations should also be relatable to each other, making it possible to relate an analysis of a form in learner production to the (inferred) intended interpretation of this form, for providing appropriate feedback to the learner. The linguistic categories provided by annotation standards would need to be different from the ones used by native speaker experts (which is arguably most often the kind of annotation aimed for now) if they are to be used for formulating feedback to language learners. They would also have to be different for different kinds of learners, depending on their level, background, native language, etc.

Standardization of (formats for) *error typologies* would also be desirable. Again, this desideratum is not exclusive to language learning applications; work on grammar and style checkers for native speakers would also benefit from standardized formats for error typologies.

In the same way as the learner’s language progresses through successively more advanced stages, the authentic language that the learner is exposed to as part of her learning process should be successively more complex, in a linguistic sense. This is the main motivation for the Squirrel web search application described above (Nilsson and Borin, 2002). Here, there is consequently a need for a classification and concomitant annotation scheme which relates linguistic complexity to language learning stages, for applications where corpora are used for e.g. generating lan-

³Here I have in mind cases such as when e.g. learners of English initially use the infinitive (or sometimes gerund) as their only—and hence extremely polyfunctional—verb form, and then gradually start using other forms (tensed forms in finite clauses, etc.), which then usurp, as it were, some of the functions of the initial forms.

⁴Multiple annotations actually seem necessary for other reasons as well, see e.g. Sampson (2000).

guage learning exercises.

In language learning applications, the need to cater for *bilingual* and *multilingual* text materials is evident, which raises the issues of how to handle multiple writing systems in a standardized way, e.g. left-to-right and right-to-left writing in the same text corpus (the latter issue is raised by Cotton and Bird (2002) as still not having been determined for ATLAS).

Hopefully, the state of affairs depicted here is really due more to lack of interaction than anything else, and if the present paper can be instrumental in bringing about this interaction, it will have served its purpose.

6. Acknowledgements

The work reported herein was carried out partly within the project ‘Corpus based language technology for computer-assisted learning of Nordic languages’, in the framework of the Nordic Language Technology Research Program 2000–2004 (Holmboe, 2002), funded by the Nordic Council of Ministers through Nordisk Forskeruddannelsesakademi (NorFA), partly within the project ‘Digital resources in the humanities’, funded by the Knut & Alice Wallenberg Foundation, as part of the Wallenberg Global Learning Network, and partly within the Cross-Check/SVANTE project, funded by VINNOVA within the Language Technology Program.

7. References

- Jens Allwood and Lars Borin. 2001. Datorer och språkteknologi som hjälpmedel i bevarandet av romani • Computers and language technology as an aid in the preservation of Romani. Plenary presentation at the symposium *Romani as a language of education: possibilities and restrictions today*. Göteborg University.
- Thor Anderson and Tom Wason. 2000. IMS learning resource meta-data information model. final specification version 1.1. Retrieved from the WWW in August 2000: <http://www.imsproject.org/metadata/mdinfov1p1.html>.
- Thor Anderson. 2000. IMS content packaging information model. final specification version 1.0. Retrieved from the WWW in October 2000: <http://www.imsproject.org/content/packaging/cpinfo10.html>.
- Steven Bird, David Day, John Garofolo, John Henderson, Christophe Laprun, and Mark Liberman. 2000. ATLAS: a flexible and extensible architecture for linguistic annotation. In *Proceedings of LREC 2000*, pages 1699–1706, Athens. ELRA.
- Lars Borin and Mats Dahllöf. 1999. A corpus-based grammar tutor for Education in Language and Speech Technology. In *EACL’99. Computer and Internet Supported Education in Language and Speech Technology. Proceedings of a Workshop Sponsored by ELSNET and The Association for Computational Linguistics*, pages 36–43, Bergen. University of Bergen.
- Lars Borin and Sara Gustavsson. 2000. Separating the chaff from the wheat: Creating evaluation standards for web-based language training resources. In Khaldoun Zreik, editor, *Learning’s W.W.W. Web Based Learning, Wireless Based Learning, Web Mining. Proceedings of CAPS’3*, pages 127–138, Paris. Eurovia.
- Lars Borin and Klas Prütz. 2001. Through a glass darkly: Part of speech distribution in original and translated text. In Walter Daelemans, Khalil Sima’an, Jorn Veenstra, and Jakub Zavrel, editors, *Computational Linguistics in the Netherlands 2000*, pages 30–44. Rodopi, Amsterdam.
- Lars Borin and Klas Prütz. 2002. New wine in old skins? A corpus investigation of L1 syntactic transfer in learner language. To be presented at the *International Conference on Teaching and Language Corpora (TaLC) 2002*, Bertinoro, Italy.
- Lars Borin, Karine Åkerman Sarkisian, and Camilla Bengtsson. 2001. A stitch in time: Enhancing university language education with web-based diagnostic testing. In *20th World Conference on Open Learning and Distance Education The Future of Learning – Learning for the Future: Shaping the Transition. Düsseldorf, Germany, 01–05 April 2001. Proceedings*, Oslo. ICDE. (CD-ROM: ISBN 3-934093-01-9).
- Lars Borin, Lauri Carlson, and Diana Santos. 2002. Corpus based language technology for computer-assisted learning of Nordic languages: Squirrel. Progress report September 2001. In Henrik Holmboe, editor, *Nordisk sprøgteknologi. Nordic Language Technology*. Museum Tusulanums Forlag, Københavns Universitet, Copenhagen.
- Lars Borin. 1999. Alignment and tagging. In *Working papers in Computational Linguistics & Language Engineering 20*, pages 1–10. Department of Linguistics, Uppsala University.
- Lars Borin. 2000a. A corpus of written Finnish Romani texts. In Donncha Ó Cróinín, editor, *LREC 2000. Second International Conference on Language Resources and Evaluation. Workshop Proceedings. Developing Language Resources for Minority Languages: Reusability and Strategic Priorities*, pages 75–82, Athens. ELRA.
- Lars Borin. 2000b. You’ll take the high road and I’ll take the low road: Using a third language to improve bilingual word alignment. In *Proceedings of the 18th International Conference on Computational Linguistics*, pages 97–103, Saarbrücken. Universität des Saarlandes.
- Elena Borissova. 1988. Two-component teaching system that understands and corrects mistakes. In *COLING Budapest. Proceedings of the 12th International Conference on Computational Linguistics. Vol I*, pages 68–70, Budapest. John von Neumann Society for Computing Sciences.
- Carol Chapelle. 1997. CALL in the year 2000: Still in search of research paradigms? *Language Learning & Technology*, 1(1):19–43. <http://llt.msu.edu/>.
- Carol Chapelle. 1999. Research questions for a CALL research agenda: a reply to Rafael Salaberry. *Language Learning & Technology*, 3(1):108–113. <http://llt.msu.edu/>.
- Carol Chapelle. 2001. *Computer Applications in Second Language Acquisition*. Cambridge University Press,

- Cambridge.
- Ron Cole, Joseph Mariani, Hans Uszkoreit, Annie Zaenen, and Victor Zue, editors. 1996. *Survey of the State of the Art in Human Language Technology*. Cambridge University Press, Cambridge. Also as <http://cslu.cse.ogi.edu/HLTsurvey/>.
- Vivian Cook. 1993. *Linguistics and Second Language Acquisition*. Macmillan, London.
- Scott Cotton and Steven Bird. 2002. An integrated framework for treebanks and multilayer annotations. In *Proceedings of LREC 2002*, Las Palmas. ELRA. To appear.
- Hamish Cunningham. 2001. *Software architecture for language engineering*. Ph.D. thesis, University of Sheffield.
- Philip Dodds. 2001. ADL SCORM – Advanced Distributed Learning Sharable Content Object Reference Model. Retrieved from the WWW in February 2001: <http://www.adlnet.org/>.
- D.A. Dokter and J. Nerbonne. 1997. A session with Glosser-RuG. Alfa-Informatica, University of Groningen. Retrieved from the WWW in November 1998: <http://odur.let.rug.nl/~glosser/welcome.html>.
- D.A. Dokter, J. Nerbonne, L. Schurcks-Grozeva, and P. Smit. 1997. Glosser-RuG; a user study. Alfa-Informatica, University of Groningen. Retrieved from the WWW in November 1998: <http://odur.let.rug.nl/~glosser/welcome.html>.
- D.A. Dokter. 1997. Glosser-RuG; Prototype December 1996. Alfa-Informatica, University of Groningen. Retrieved from the WWW in November 1998: <http://odur.let.rug.nl/~glosser/welcome.html>.
- D.A. Dokter. 1998. From Glosser-RuG to Glosser-WeB. Alfa-Informatica, University of Groningen. Retrieved from the WWW in November 1998: <http://odur.let.rug.nl/~glosser/welcome.html>.
- Eleni Efthimiou, editor. 2000. *LREC 2000. Second International Conference on Language Resources and Evaluation. Workshop Proceedings: Language Resources and Tools for Educational Applications*, Athens. ILSP.
- European Commission. 2000. e-Learning – designing tomorrow's education. Commission of the European Communities, Communication from the Commission. COM(2000) 318 final. Brussels, 24.5.2000.
- Frank Farance and Joshua Tonkel. 1999. LTSA specification. Learning Technology Systems Architecture, draft 5. Retrieved from the WWW in March 2000: <http://edutool.com/architecture/>.
- Claude Frasson, Gilles Gautier, and Alan Lesgold, editors. 1996. *Intelligent Tutoring Systems. Third International Conference, ITS '96. Montréal, Canada, June 12–14, 1996. Proceedings*. Number 1086 in Lecture notes in computer science. Springer, Berlin.
- Barry P. Goettl, Henry M. Halff, Carol L. Redfield, and Valerie J. Shute, editors. 1998. *Intelligent Tutoring Systems. 4th International Conference, ITS '98. San Antonio, Texas, USA, August 16–19, 1998. Proceedings*. Number 1452 in Lecture notes in computer science. Springer, Berlin.
- Sylviane Granger, editor. 1998. *Learner English on Computer*. Longman, London.
- Ralph Grishman, Ted Dunning, Jamie Callan, Bill Caid, Jim Cowie, Louise Guthrie, Jerry Hobbs, Paul Jacobs, Matt Mettler, Bill Ogden, Bev Schwartz, Ira Sider, and Ralph Weischedel. 1997. TIPSTER text phase II architecture design. Version 2.3.
- V. Melissa Holland, Jonathan D. Kaplan, and Michelle R. Sams, editors. 1995. *Intelligent Language Tutors: Theory Shaping Technology*. Erlbaum, Mahwah, New Jersey.
- Henrik Holmboe, editor. 2002. *Nordisk sprogteknologi. Nordic Language Technology*. Museum Tusulanums Forlag, Københavns Universitet, Copenhagen.
- Hao-Jan Howard Chen. 1999. Creating a virtual language lab: an EFL experience at National Taiwan Ocean University. *ReCALL*, 11(2):20–30.
- Nancy Ide, Patrice Bonhomme, and Laurent Romary. 2000. XCES: an XML-based encoding standard for linguistic corpora. In *Proceedings of the 2nd International Conference on Language Resources and Evaluation (LREC2000)*, pages 825–830, Athens. ELRA.
- Sake Jager, John A. Nerbonne, and A.J. van Essen, editors. 1998. *Language Teaching and Language Technology*. Swets & Zeitlinger, Lisse.
- Michael Levy, editor. 1997. *Computer-Assisted Language Learning. Context and Conceptualization*. Clarendon Press, Oxford.
- Monica Monachini and Nicoletta Calzolari. 1996. Synopsis and comparison of morphosyntactic phenomena encoded in lexicons and corpora. a common proposal and applications to European languages. EAGLES Document EAG-CLWG-MORPHOSYN/R.
- John Nerbonne and Petra Smit. 1996. GLOSSER-RuG: In support of reading. In *COLING-96. The 16th international conference on computational linguistics. Proceedings, vol. 2*, pages 830–835, Copenhagen. Center for Sprogteknologi.
- Kristina Nilsson and Lars Borin. 2002. Living off the land: The Web as a source of practice texts for learners of less prevalent languages. In *Proceedings of LREC 2002*, Las Palmas, Canary Islands, Spain. ELRA. To appear.
- Mari Broman Olsen, editor. 1999. *Computer Mediated Language Assessment and Evaluation in Natural Language Processing. A joint ACL-IALL symposium*. Retrieved from the WWW in July 1999: <http://umiacs.umd.edu/~molsen/acl-iall/accepted.html>.
- Fredrik Olsson. 2002. *Requirements and Design Considerations for an Open and General Architecture for Information Refinement*. Number 35 in Reports from Uppsala University, Department of Linguistics, RUUL. Uppsala University, Department of Linguistics.
- Martha C. Pennington, editor. 1996. *The Power of CALL*. Athelstan, Houston, Texas.
- Jack C. Richards and Gloria P. Sampson. 1974. The study of learner English. In Jack C. Richards, editor, *Error Analysis. Perspectives on Second Language Acquisition*. Longman, London.

- Rafael Salaberry. 1999. Call in the year 2000: Still developing the research agenda. *Language Learning & Technology*, 3(1):104–107. <http://llt.msu.edu/>.
- Geoffrey Sampson. 2000. Where should annotation stop? In Anne Abeille, Torsten Brants, and Hans Uszkoreit, editors, *Proceedings of the Workshop on Linguistically Interpreted Corpora. LINC-2000*, pages 29–34. Held at the Centre Universitaire, Luxembourg, August 6, 2000.
- Anju Saxena and Lars Borin. 2002. Locating and reusing sundry NLP flotsam in an e-learning application. In *Proceedings of LREC 2002 workshop on Customizing Knowledge in NLP Applications: Strategies, Issues, and Evaluation*. To appear.
- David Schneider and Kathleen F. McCoy. 1998. Recognizing syntactic errors in the writing of second language learners. In *COLING-ACL '98. Proceedings of the Conference, Vol. II*, pages 1198–1204, Montréal. Université de Montréal.
- Mathias Schulze, Marie-Josée Hamel, and June Thompson, editors. 1999. *Language Processing in CALL*. EURO-CALL/CTI Centre for Modern Languages, Hull.
- Colin Smythe and Eric Shepherd. 2000. IMS question & test interoperability information model specification. version 1.01 – final specification. Retrieved from the WWW in December 2000: <http://www.imsproject.org/question/qtinfo101.html>.
- Merryanna L. Swartz and Masoud Yazdani, editors. 1992. *Intelligent Tutoring Systems for Foreign Language Learning*. Springer, Berlin.
- P. Wittenburg, D. Broeder, and B. Sloman. 2000. Meta-description for language resources. EAGLES/ISLE. a proposal for a meta description standard for language resources. Retrieved from the WWW in May 2001: <http://www.mpi.nl/world/ISLE/>.
- Michael Zock. 1996. Computational linguistics and its use in real world: the case of computer assisted-language [sic] learning. In *COLING-96. The 16th International Conference on Computational Linguistics. Proceedings, vol. 2*, pages 1002–1004, Copenhagen. Center for Sprogteknologi.

Reports from Uppsala Learning Lab

- 1.2002 *A stitch in time: Enhancing university language education with web-based diagnostic testing*
Lars Borin • Karine Åkerman Sarkisian • Camilla Bengtsson
- 2.2002 *DRHum in History — a status report*
Esbjörn Larsson • György Nováky • John Rogers
- 3.2002 *Digital learning portfolios: inventory and proposal for Swedish teacher education*
Jan Sjunnesson
- 4.2002 *Didax – a system for online testing: technical documentation*
Sanja Babić • Camilla Bengtsson • Mattias Lingdell
- 5.2002 *Where will the standards for Intelligent Computer-Assisted Language Learning come from?*
Lars Borin
-