A stitch in time: Enhancing university language education with web-based diagnostic testing

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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:

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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.

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A stitch in time: Enhancing university language education with web-based diagnostic testing

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1. Introduction

In this paper, we describe work in progress in the Swedish Learning Lab and at Uppsala University, Sweden, on the development of Didax, the Digital Interactive Diagnostic Administering and Correction System. In the remainder of this section, we describe the background and general motivation for the development of Didax. Section 2 elaborates upon the didactic gains which we foresee from using the system, while section 3 is devoted to the more technical aspects of Didax. In section 4, we report on the current status of the system, and section 5 gives a conclusion and our plans for future work.

1.1 The Swedish Learning Lab

The Swedish Learning Lab (SweLL) is a research effort funded by the Knut & Alice Wallenberg Foundation as part of the larger Wallenberg Global Learning Network endeavour, where a number of centres—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: SweLL, with three participating institutions of higher education, the Royal Institute of Technology and Karolinska Institutet in Stockholm and Uppsala University, the Stanford Learning Lab (SLL), at Stanford University, California, USA, and Learning Lab Lower Saxony (L3S), at the University of Hannover, Germany.

SweLL research is currently organised as 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 *APE* (Archives – Portfolios – Environments) experiment of the SweLL project *New meeting* *places for learning – New learning environments*. For more information, see Gyllensten *et al.* (1999a, 1999b) or <http://www.learninglab.uu.se/>. 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 those teams working with digital archives for humanities teaching (see Gyllensten *et al.* 1999b: 24ff; Borin and Gustafsson to appear), as well as with the Uppsala Learning Lab e-folio project (see Ocklind *et al.* 2000). We also collaborate with computer-assisted language learning (CALL) projects outside WGLN, e.g. the LingoNet project (<http://www.mitt.mh.se/lingonet/>; Borin and Gustavsson 2000) funded by the Swedish Agency for Distance Education (see <http://www.distum.se/>), and the Nordic CALL project *Corpus based language technology for computer-assisted learning of Nordic languages* (Borin *et al.* 2000), funded by the Nordic Council of Ministers (see <http://www.norfa.no>).

1.2 Didax: general background

Diagnostic tests have been used for many years in the language departments at Uppsala University, but not systematically, and not in a compulsory mode. Their purpose is twofold. Firstly, they are used to assess the language proficiency level of individual students and groups of students, in order to adapt particular courses. Secondly, they are used longitudinally, to follow the level of students enrolling in language studies at the university over several years.

Traditional diagnostic tests are of the paper and pen variety. They have turned out to be very useful, but we believe that a computerised test will be even more useful, enabling the testing of other and more language skills. Part of the time that teachers would spend on setting and marking tests can be used for more inspiring pedagogical activities.

If tests can be made more flexible with the help of ICT, they can be used more often, not only for diagnostic purposes, but also formatively. The students will benefit from knowing where they stand with respect to their learning objectives, enabling them to plan their learning accordingly.

Didax was conceived and is being developed primarily for the departments of Romance—for Spanish—and Slavic—for Russian—Languages at Uppsala University, but we can easily imagine a wider use of the concept, a web-based environment for the generation, administering, taking, grading and commenting of diagnostic tests. Its use extends naturally to other languages, of course, but the framework is general enough that non-language subjects could also be considered. In addition to its primary intended use as a system for diagnostic testing, it could also be used for formative and summative assessment (but such a use—especially in summative tests for grading—would raise all kinds of issues which we are not prepared to discuss at this moment). Although not primarily intended for distance education, the system could well be used for this purpose, being web-based and consequently location-independent and asynchronous. The expected didactic gains from using Didax are discussed in section 2 below.

1.3 Why roll our own?

Computerised testing—including language testing—has been around for quite some time (in June 2000, the fourth Annual Computer Assisted Assessment Conference was held in Great Britain; see <http://www.lboro.ac.uk/service/fli/flicaa/conf2000/>), and there is a fair number of commercial and academic projects addressing the issue of computerised testing. Among the commercial systems, we may mention at least Perception by Questionmark Inc. (see <http://www.questionmark.com/perception/>), which is a dedicated computerised testing system, and WebCT and LUVIT, general computer-based learning platforms, which can also be used for administering computerised tests (see <http://about.webct.com/> and http://www.luvit.com>). Hot Potatoes is a dedicated system for creating and administering web-based language exercises and tests (see <http://web.uvic.ca/hrd/halfbaked/>). The DIALANG project, financed by the European Commision under the SOCRATES Programme, has as its goal the development of web-based diagnostic tests for 14 European languages (the official languages of the European Union, plus Irish, Norwegian and Icelandic; see <http://www.sprachlabor.fu-berlin.de/dialang/english/summary.html>). Furthermore, for each of the language skills which we might wish to assess with a diagnostic test—grammar, vocabulary, listening comprehension, etc.—there are also dedicated programs, both commercial and freely available from a number of sources.

So why did we decide to build our own diagnostic language testing system? There were several reasons, but all of them are actually aspects of the same thing, namely *openness*. At the time when we started planning the project (late 1999), none of the existing products had the exact combination of features that we were looking for. Most crucially, all products reviewed at the time had proprietary underlying data formats (Questionmark announced recently that their Perception product now supports the IMS QTI format—see section 3 below—but this was well after we started developing Didax, and apparently it does not yet support the full QTI XML DTD; see <http://www. questionmark.com/perception/help/qtixmlviewer.html>. In the case of DIALANG, the project which seems to have most in common with Didax, we do not know what the underlying format is. This is a matter for future investigation; see section 5), whereas we wished preferably to use a standardised, open format for the content, as well as programs for accessing and manipulating this content where we would be able to modify the source code, because:

(1) There is a larger context into which the Didax system has to fit. Other Learning Lab research teams develop and explore the educational potential of digital archives for students and teachers and especially digital student portfolios, (or e-folios; see Ocklind *et al.* 2000), which will use the IMS Content Packaging format (Anderson 2000a, 2000b, 2000c). Educational content should be freely movable between the applications developed by the different teams. The IMS/IEEE standards adopted in the project go quite some way towards fulfilling this goal.

(2) The general testing (or instructional) systems turned out to have poor support for some features which are important in a language testing system, e.g. Unicode and long text input.

(3) The future addition of 'intelligent' language testing features—i.e. incorporating natural language processing (NLP; see e.g. Cole *et al.* 1996) and language learner models based e.g. on learner corpora (see Granger 1998)—would be difficult or impossible without access to the source code.

In consequence of these points, we decided to build our own system, basing it as far as possible on existing and emerging standards for content and open source software for the programs (see section 3, below).

2. Didactic rationale for computerised diagnostic language testing in higher education in Sweden

Swedish universities have been subject to reduced funding for a number of years. Only in the last few years has this taken the form of an actual reduction in the sum of money alloted for each student. More serious, however, is the circumstance that for a long time there has been a factual reduction of the teaching budget, in that inadequate compensation has been given for rising salaries and other costs for a number of years. The humanities (where language education belongs organisationally) have always had to get by on considerably less money per student than the sciences and technical subjects. As a consequence of these circumstances, the number of contact hours for a typical language student has now hit a low of 3–4 hours a week for a full-time course.

2.1. Toward a learner-centered didactics with ICT

At the university, as in other institutions of learning, we encounter language learner groups consisting of individuals with varying cognitive styles, with very different initial proficiency levels and experiences and who also have different goals in their studies. By and large, they meet a kind of teaching at the university where lectures make up the lion's share of the contact hours (see above), and for the remainder of their time they are left to their own devices. Probably those individuals which fail in their learning have a cognitive strategy which is not attuned to this teaching model:

> Those who master a particular skill have certain insights, which in turn determine certain thought patterns. These insights, thought patterns and their mutual relationships constitute the invisible structure of a skill. Analogously, alternative thought patterns constitute the invisible explanatory basis for the lack of a skill. We are talking about individual learners' use of different learning strategies, regardless of whether they are a help or an obstacle to learning
> (Bergström 1995: 28; our translation / LB, KÅS, CB).

Hence, we must take as our point of departure the learner's background: What experiences does she bring to bear on the language learning situation, what previous knowledge and skills does she possess, how will she be able to assimilate new skills and knowledge? Some researchers even go as far as to say that no matter how clearly and explicitly the teacher presents new information; unless the presentation is based on the learner's experiences and knowledge, she will not be able to make use of the new information (Bergström 1995: 17).

But can we, as university language educators, offer individually tailored language instruction to a group consisting of from twenty students upwards? Given the conditions and constraints under which Swedish academic language teachers are forced to work (see above), this is an next to impossible demand, since it requires that we:

(1) first of all get to know the background knowledge and skills of each student, e.g. by the use of diagnostic tests, and in consequence of this

(2) adapt the teaching methods to the background knowledge and needs of the students.

The hope is that ICT can be of help in both (1) and (2), and we hope to be able to pursue the use of (intelligent) CALL in university language education at a later time. For now, however, we are concentrating on (1), the use of computerised diagnostic language tests.

2.2. Advantages of computerised diagnostic language tests

The didactic gains which we foresee from using Didax are at least the following.

(1) Setting (and marking) tests is a relatively monotonous and unproductive task. Teacher time can be freed for more creative use, if computerised tests are introduced. As test time is moved out of the classroom, communicative language learning can move in instead. This was the original rationale for the Didax project;

(2) It provides the potential for a more unbiased and fair marking of tests, as many items can be automatically marked and others can be marked in the context of previous tests. Also some recurrent comments could be automatised, which saves some time, but also has a pedagogical value. The computer will not tire or lose concentration, neither over the course of one marking session nor over a longer period (e.g., several semesters);

(3) A wider range of test item types will be available. Digital online diagnostics can incorporate audio and video, for testing spoken language and pragmatic understanding, in a way which is not possible with the present diagnostics on paper;

(4) The system has the potential of becoming better over time, as the state of the art of the underlying technology progresses. In particular, 'intelligent' CALL functionality can be built in;

(5) The test is available anywhere and anytime, provided that you have a computer, the proper software and an Internet connection. Thus it is suitable also for distance education;

(6) Short-term and long-term follow-up of test results are facilitated, leading to curricula more adapted to students' abilities and needs.

3. The anatomy of Didax

The system supports the IMS Question & Test Interoperability Final Specification Version 1.01 (Smythe and Shepherd 2000a, 2000b, 2000c) and IMS/IEEE LTSC Learning Objects Metadata (LOM) (Anderson and Wason 2000a, 2000b, 2000c). The QTI standard is being developed by the IMS with the purpose of enabling exchange of simple and complex question and test material between different systems. All the tests in the Didax test database are stored as the XML supported by the IMS QTI DTD.

The Didax system consists of a client side and a server side. Most of the processing takes place on the server. On the server side a relational database holds all user and test information, the latter in QTI XML format. The user and test information is accessed from different servlets via a JDBC (Java Database Connectivity) interface. The interface makes possible the use of almost any relational database on the market. In the present version of the server, the database system used is PostgreSQL, an open source relational database (see <http://www.postgresql.org>). A Java servlet is the server side version of the Java applet frequently encountered on the Internet. However, instead of demanding space on the user's computer system, it does most of the work on the server. Furthermore, a servlet can perform more tasks than an applet since it does not have the security restrictions of the applet and since it has more useful built-in facilities. The possibility of tracking a user's actions is an example of such a facility. The data processed by the servlets is presented to the user clients as plain XHTML-friendly HTML forms, sometimes with multimedia features. The HTML forms are produced by running the XML retrieved from the database through a style sheet that transforms XML to HTML. XSL Transformations are used for this step. The clients, two for teachers and one for students, run in any fairly recent version web browser that has support for multimedia and multiple languages. Using an ordinary web browser has several advantages. Besides being a well-known environment for most people today, the system requirements are manageable. If the browser does not support multimedia and Unicode, downloading plugins for audio and video and a Unicode font is necessary. The teacher clients handle the generation, administering, grading and commenting of diagnostic tests while the student client enables the taking of diagnostic tests.

Teacher client 1 for test generation consists of four (conceptual) parts:

(1) *Test item bank* – this is where the test constructor keeps questions, texts, audio and video clips, pictures, and other test material.

The items which are entered into the test item bank are marked as to their subject, level, difficulty, test type and other metadata. Some of these could be assigned grade points. This part could be of great help for the teacher, although we foresee that the learning curve to start using the system will be fairly steep (this is a well-known fact; see Stephens and Masica 1997). It is not a trivial matter to adapt existing test items to the QTI format, and not all kinds of items are supported by the present version of the proposal.

(2) *Answer bank* – possible correct answers to the test items will be stored here.

(3) *Test construction template(s)* – allows the teacher to construct a test by providing the test parameters, in terms of types and number of items. Thus, you could specify a test consisting of: ten general linguistics problems at an elementary level, a text with accompanying vocabulary test for learners having three years of high school Russian, five grammar items dealing with verb conjugation, etc. On the basis of the specification, the system generates a test from the test item bank. The teacher can then edit the test and also see the version which later will be delivered to the students. Further, the conditions for the test can be stated, e.g. time limits for the availability of the test, how it should be taken—with or without supervision, whether aids are allowed, such as dictionaries, etc.

(4) *Statistics module* – statistics on tests, test items, students, student groups, etc. are accumulated, stored and displayed on demand.

Teacher client 2 is for test marking and commenting. The client presents the preliminarily (automatically) marked tests to the teacher through an interface which facilitates the looking-up of other students' tests or tests from earlier occasions for comparison with the current test. This makes it easier to be consistent both within a large student group and over time, in marking and in comments. Generally, however, we foresee that the teacher will need to go over mainly those items which the computer has marked as wrong (or not been able to mark at all). Sometimes these answers will turn out to have been erroneously marked as wrong, due to a missing item in the answer bank, which the teacher may then choose to add.

The student client administers the test to the student, and also delivers marked and commented tests together with references (preferably in the form of hyperlinks) to concrete exercises, textbook sections, etc.

4. Current status of Didax

The Didax system is being developed for prototype testing in early 2001, and more extensive tests and evaluation in the spring and fall terms of 2001. Theory-anchored evaluation will be used summatively, in relation to the expected short and medium term gains mentioned above, and also formatively, in pursuit of the outlined longer term goals. At the time of writing of this text (December 2000), the core functionality of the server component is completed, and the student client and teacher client 2 are in the finishing stages. Teacher client 1 is still only at the planning stage, but will be fairly easy to complete, once the other two clients are ready, as it will be able to reuse a large part of their program code (in fact, teacher client 2 can be seen as a more advanced version of the student client, and teacher client 1, in turn, can be seen as the result of adding bells and whistles to teacher client 2). Security features, such as passwords and encryption (probably using SSL) are planned for the production version, but have not been implemented in the test version.

Evaluation of the effects of introducing new ICT support in higher education is a high-priority (and mandatory) component in all WGLN projects. The evalution framework is being developed simultaneously with the individual projects, by special so-called *assessment teams*. The evaluation framework adopted by the Swedish Learning Lab assessment team, in cooperation with that of the Stanford Learning Lab (another WGLN partner) is *theory-anchored evaluation*, a further development and combination of American and Swedish perspectives in theory-based evaluation. Theory-anchored evaluation is an approach where evaluation is seen as an ongoing process of negotiation between the 'stakeholders' of the ICT support application being developed on the one hand—in our case students, language department faculty, and the developers of the Didax system—and the evaluation researchers on the other, resulting in a successively refined (and detailed) evaluand model against which the *evaluand* (the process or entity being evaluated) can be systematically compared. Thus, the chosen evaluand model will be a tool for guiding the evaluative investigation and, by force of its theoretical content, an instrument for analyzing the data gathered in the evaluation process. See Borin *et al.* (to appear).

5. Summing up and looking ahead

Today's world puts great demands on learners. There is much talk about lifelong learning as a necessary prerequisite for being successful in the modern world, or even just coping in it. Learners are supposed to take charge of their own learning: to search for information, to analyse and structure this information, and finally to turn it into knowledge. In addition to this information processing, an integral part of most learning is honing skills by practicing them, very much so in the case of language learning.

Learners may possibly be able to handle that aspect of learning which consists in the retrieval and refinement of information on their own. Thus, they could conceivably be entrusted to deal with those components of their language studies which boil down to (linguistic) analysis and structuring (These are also skills which need practicing, of course, although they may be expected to carry over from the study of one language—or linguistics, or perhaps most any subject—to another). However, it would be extremely unrealistic to assume that they could practice active language skills, such as speaking and writing, on their own, without proper feedback. Practicing these skills is strenuous work, in which our students need qualified guidance. Didax may become a tool which helps us to provide such guidance.

As for future plans, one item which is high up on our agenda is to investigate to which extent Didax can be made compatible with the work done in the DIALANG project (see section 1.3, above).

Like we implied above, we see Didax as an open-ended system, a kind of language-assessment infrastructure on which we plan to build further 'intelligent' computer-assisted language learning and language learner modelling applications, for even more flexible ICT-supported language testing. We hope to be able to return to this issue in the not too distant future.

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