Applying EVA to tailored virtual, distance, on-line education via Internet

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SUMMARY. An on-line system has been developed for on-line education, where each student has unique study needs. In EVA, each student pursues his own syllabus, advances at his own pace, starts anytime, and uses material delivered by EVA. Collaboration with current "classmates" and use of historic information are also important ingredients. Interaction with the adviser is both synchronous and differed.

This article briefly describes how EVA starts its first serious use: delivering a M. Sc. program in Computer Science to 500 remote students, called evanauts. A companion article describes EVA's architecture and theoretical underpinnings.

KEY WORDS:; distance education and telelearning; distributed learning environments; cooperative/collaborative learning; lifelong learning;

1. THE PURPOSES OF EVA

In developing countries like Mexico, there are not enough resources (specially qualified people) to deliver high-quality education in advanced technology fields, such as Computer Science. For instance, the country has perhaps 130 Computer Science specialists with a Ph. D. degree; half are working in Industry. This, for a population of 140,000 undergraduate students and 2,000 graduate students in Computer Science. Low salaries and scanty resources in public university, plus excessive bureaucracy, aggravate this. There is a need to develop and use less expensive education, without sacrificing quality –specially in fast moving fields, like Informatics, where good foundations are required for long lasting productive life and resistance to obsolescence.

1.1 Problem to solve

To deliver high quality education at several levels without sacrificing quality, at low costs. A study group within CIC started in 1997 working in this problem, using the following data:

Method and features.	Advantages and *disadvantages*
In situ education. The student coincides with the teacher in space (moves to the city where the university is located) and in time (synchronous). Similarly for laboratories, libraries and	High quality. Good feedback. Interaction with the teachers and with other students. *Expensive. Cost of resources is shared by a limited number of students. Each student has to move to a city such as the capital of the state or of the country: lodging expenses. Student can not work.*

equipment: these are shared among in situ students.	*Requires 1 professor for 10 students (for Computer Science).* *Requires additional facilities: library, laboratories, equipment, parking spaces, gym, dormitories.*
Self-learning. Students learns on his own, through books, internet,	Inexpensive. Remote. *Varying quality. Limited resources limits knowledge transfer. Lack of hands-on experience. No or little feedback and guidance.*
Correspondence studies. Material arrives by ordinary mail.	Inexpensive. Remote. *Varying quality. Limited resources limits knowledge transfer. Lack of hands-on experience. Limited feedback and guidance.*
TV education. Student listens and reacts to a teacher through video.	Remote. Some student-teacher interaction. *Expensive. Satellite broadcast is expensive.* *Education is synchronous.*
Access to electronic books. Student reads a book in CD Rom or Internet, and sometimes interacts with it.	Inexpensive. Remote. Depending on the book, some interaction. *Few feedback and guidance.*
Use of Computer simulators, training tools. Student interacts with a computer model.	Inexpensive. Remote. Good feedback.
Access to a pool of consultants. The Australian model.	Medium feedback and guidance. Cost is shared.

The constraints were:

C1. Few resources. Both for Government and for the student. Also: in some fields, limited number of available potential faculty.

C2. Many students can not travel. For instance, teachers in many state universities can not travel (and abandon their job) to pursue a graduate degree.

C3. In many towns and cities, there are no good libraries nor laboratories.

C4. In addition, background of students greatly varies; thus, some degree of tailoring was necessary.

1.1.1 Abbreviations and notation

ANIEI is the *Asociación Nacional de Instituciones de Educación en Informática*, or National Association of Institutions that teach Informatics, a Mexican union of Universities.

CONALEP is the *Colegio Nacional de Educación Profesional*, or National College of High Education, a set of 256 Mexican schools that deliver technical training.

EVA stands for *Espacios Virtuales de Aprendizaje*, or Virtual Learning Spaces, a software package for on line education. Evanaut is a student that uses EVA.

ILCE is the *Instituto Latinoamericano de Cooperación Educativa*, or Latin American Institute for Educational Cooperation, a regional organism that engages in help for teaching, notably at the elementary and middle levels.

ITESM is the *Instituto Tecnológico y de Estudios Superiores de Monterrey*, or Institute of Technology and High Studies of Monterrey, a private system of schools based in the North of Mexico, with campuses in main Mexican cities.

Multibook (*polilibro*, in Spanish) is an electronic book with chapters (called ULMs) written in one of several media: text, video, audio, power point slides, virtual reality. EVA uses multibooks as the source to build individualized multibooks to be sent to evanauts.

SEP is the *Secretaría de Educación Pública*, or Ministry of Public Education, a federal secretary of the Mexican federal government.

SIT. The *Sistema de Institutos Tecnológicos*, or System of Technology Institutes, is a set of 80 Technical Universities, scattered through Mexico, that deliver undergraduate and graduate education. It belongs to SEP.

ULM. Unit of learning material. An atomic set of material delivering or describing a set of concepts; indivisible part of a polybook. Think of a chapter of a normal book. EVA assembles individualized polybooks out of ULMs.

1.2 Related previous work

A. Learning Space. This commercial tool is being used in Mexico, notably in effort 1.2.1.D.

B. WebCT. This commercial tool is quite widespread; it recently had 15 million students.

C. The Australian Model. A centralized pool of advisers answers questions (posed by email) from many students across the country. Students are charged a reasonable fee.

1.2.1 Our previous work

D. *Telesecundarias* (Middle schools through TV classes, by SEP). Since many years ago, middle school levels (years 7, 8 and 9) are taught in remote areas of Mexico by TV channels. Next to the television set, the students have a teacher that complements education.

D. The *Universidad Virtual* (Virtual University, by ITESM) teaches undergraduate and some graduate programs by TV. Feedback is through TV (in some campuses), or by email and telephone. Advisors are also available.

E. *Red Escolar* (School Net, by ILCE) is an effort to buy PCs and introduce them at the elementary school level in selected Mexican schools.

F. Mobile shops and laboratories (by CONALEP) is a cost-reducing effort where the shop or laboratory visits nearby CONALEP schools in different days or weeks. A shared laboratory. "The laboratory moves to the schools".

F. *SADI* (Open undergraduate studies in Administration, by IPN) has been working for about 20 years; it is like an open university, where students go to a few *in situ* lecturers, and complete most of their work through homework and group projects.

G. *Centros de Educación Continua* (Continuous Education Centers, by IPN) do teleteaching by dedicated Satellite TV channels; have 11 reception rooms scattered through the country. In these, feedback is by video (full duplex). Signal can also reach reception only places, where feedback is none, or through telephone or email.

2. DESCRIPTION OF EVA

EVA delivers on-line, asynchronous education, as well as the teaching material. Education is tailored to each individual [5, 8, 9-11].

EVA first administers an exam (from a large pool of questions) to the student, measuring his knowledge in each of several areas, and thus locating his initial state in the knowledge space (in Computer Science, the curriculum model of ANIEI contains eight areas, and the space has eight axes [5]). Then, EVA asks the student (or it is already known) what is his desired final state, for instance, "to obtain a M. Sc. degree in Computer Science, majoring in Information Systems." From these two states, EVA designs for that student his particular study plan. EVA then selects corresponding teaching material (ULMs) from the many multibooks available (§3.1), and assembles a particular multibook suited to the student. No material is assembled if he already knows it. This unique multibook is delivered to the student, through the EVA server (§2.2). In addition, the student can buy paper version of the multibooks, which contains a CD ROM with (a) the paper material, in electronic form; (b) exercises, homework; (c) the multibooks, in electronic form –this permits faster access to EVA servers, since many pages are now delivered from the CD, and not through Internet, and optionally (d) simulators, and other aids.

As the student reaches the end of a ULM (think of a chapter), EVA administers a quiz. Other exams and homework can be administered by EVA or by human beings. Grading is either by EVA or by people. Also, the school may require some exams to be *in situ*. Currently, EVA can grade only multiple-choice and closed questions (those having an answer like 350 meters). Questions can be parameterized, by inserting parameters instead of the underlined constants in a question such as "A car traveling at 50 km/h and weighting 2 tons ...". In multiple choice answers, the positions of the choices are randomized each time the question is posed. A large pool of questions at the end of each ULM assure little repeatability. Other features of EVA follow.

2.1 Features

A. Remote, on line. The student learns at home, or at work, at his own pace.

B. Asynchronous. No need to study a given subject or chapter at a particular time. But: some precedence of knowledge is needed; often, you can not study ULM 3 of your multibook without studying first ULM 1 (Will EVA let you read ULM 3 without approving the exam of ULM 1 of your multibook? Yes, except that the university may override this and say NO). This means: no groups, no semesters, no maximum time to finish this course. But: some universities using EVA may still prefer to form groups or sessions, to finish studying "Operating Systems" by December, etc. See K.2 below.

C. Tailored, individualized education. Study plan is unique, and automatically assembled.

D. Interaction with the adviser. Guidance and feedback are achieved through emails, chats and discussion forums (bulletin boards).

E. Interaction with current students (classmates). Collaboration. EVA compares similar trajectories in the knowledge space, and tells those evanauts: "you are studying approximately the same material now; perhaps you should be in touch –specially if you live nearby– and work or collaborate together".

F. Interaction with previous students. EVA analyzes a student trajectory and compares it with similar trajectories of *people living nearby* but more advanced (further down the stream). EVA tells them: "this person already knows what you are studying; perhaps, if she consents, she can give you help and advise. Contact her on this."

G. Learning from tracks of past evanauts. Each question posed by a student and its answer is a small journey in the knowledge space, towards less ignorance (more knowledge). EVA (with some human help) indexes each pair {question, answer} at the appropriate point in the knowledge space. Evanauts having nearby trajectories can use these pairs (1) to read them, before asking a question to the adviser (like a file of frequently asked questions): "before you ask, read these 118 questions and see if there is an answer to your doubt"); (2) to learn more; (3) to dissipate unknown doubts; (4) as tests: "let me see if I know the answers to these historic questions." In traditional education, a student learns from the questions of his classmates; in EVA, an evanaut learns from the questions of his *former* classmates, too (and some of them had very good questions).

H. Interaction with computer. Use of other computer tools. Simulation, virtual reality, pointers to Web sites containing simulators, tools, files of programs, files of data, etc., can be used in the multibook, up to the ingenuity and resources of the author.

I. Homework, Quizzes, Exams. As explained above, these can be administered by EVA (at the appropriate point in the learning trajectory; usually at the end of each ULM) or by the adviser or class supervisor (in case EVA is being used in the fashion "all students are learning the same material at approximately the same time). Grading can be done by EVA or by people.

J. Thesis work. Evanauts requiring thesis (for example, in Mexico, all M. Sc. and Ph. D. degrees require thesis work) must do this work independent of EVA. For instance, in §3.1 an evanaut spends up to six months together with his thesis advisor.

K. Blending with other education models. EVA works well with other models. **(1) Traditional model**: Evanauts can acquire additional or complementary knowledge from normal paper books and *in situ* teachers, can undergo *in situ* exams and thesis work, can go to a real library, etc.; **(2) synchronous model:** EVA can be used to teach a group of students that *must complete the course* at a given date, so that all of them advance at approximately the same pace; this model is followed in §3; **(3) education based in competencies,** where the final point in the knowledge space to be reached by the student is defined by a set of abilities, experiences and knowledge derived from job descriptions; **(4) life long learning,** where the evanaut becomes addict to EVA and keeps learning, by defining new "final" points in his learning trajectory.

L. Grade accounting. EVA keeps track of each student grades obtained through EVA; in addition, the teacher or teacher assistant can enter additional grades (obtained from quizzes and homework graded manually), as well as weights for each exam. A typical graduate course in Computer Science of §3 contains 10 quizzes (administered and graded by EVA), two or three partial exams (one administered and graded by EVA, two by teaching assistants), and a final exam, graded by the teacher.

M. Payment accounting. EVA keeps track of who is allowed to use what courses, and for how long (some schools require additional payment each semester, say).

2.2 Architecture

EVA has an EVA server (a PC) that keeps the multibooks, the accounts, the grades, and related information. The server uses ACCESS as the database, and runs on Windows NT. Most pages are formed at execution time. The architecture is described in an accompanying paper in this issue [11]. See also [5, 8, 9-10].

The evanaut receives multibook pages from the EVA server, or from a CD ROM reader in his client computer. Interaction is through Internet.

2.2.1 Status of EVA

Version 1.0 is available by the time you read this. Most of the features of §2.1 are in place, with the exception of E, F, G, which will appear in next version.

Currently, several faculty groups are writing multibooks, or converting ordinary books (in files) to the multibook format.

2.3 Other tools linking to EVA

As said in §2.1.H and K, many tools can be used "together" with EVA, requiring little interaction. For instance, the student can have a C++ compiler in his (client) PC, and download (by cut and paste, perhaps) exercises from the multibook, or from a Web site specified in the multibook. In fact, many multibooks contain a list of interesting Web URLs where students can obtain software, examples, homework, additional reading material, etc.

CIC's digital library in Computer Science is available to evanauts. As more schools open EVA programs, more subjects will be added. Other digital libraries residing in the Web are available to evanauts (and to anybody).

CIC is building the *Index of Knowledge*, a taxonomic catalog of written material in the Web, in Spanish, mostly from digital libraries and collections. We are now interested in Computer Science. The catalog looks like a tree of concepts [7], and uses Clasitex [1-4] and agent techniques [6] for its construction. It does *not* keep full books or articles, just the URL to them, plus a small sample or description (2000 bytes, say) of each one. The *Index* will be updated periodically by agents or spiders that search the Web for new or changed material. The *Index* will be available to evanauts. In fact, the *Index of Knowledge* may perpetually guide the student (see Life Long Learning in §2.1.K.4) by pointing to him new material of which he was unaware, on areas in his interest profile.

3. THE TEACHING OF A M. Sc. IN COMPUTER SCIENCE

This section describes the first serious use of EVA, to teach 500 graduate students.

3.1 Setting

The Sistema de Institutos Tecnológicos (SIT) has 80 Technology Institutes, and all together about half a million students. Many of their teachers want to reach higher levels of education. From these, 500 will be accepted (through CIC entrance examination, similar to

the entrance examination of EVA) to CIC's Master's Degree Program in Computer Science (http://www.cic.ipn.mx). Three areas will be taught: Information Systems, Software Technology, and Distributed and Parallel Computation. For these, 24 multibooks are being written (by authors from CIC and SIT, typically two authors per multibook). One will be available in August 2000; four in January 2001. Authors will have royalties: a polybook which is completely read will get US$2 per student (remember, the individualized polybook of a student may contain only some ULMs of a given author, as dictated by his learning trajectory).

Six Technology Institutes were selected through Mexico as regional sites; evanauts may visit them in Fridays and Saturdays to receive advice and help. Registration is done in these sites. Students are CIC students, and CIC will grant the degree.

The synchronous mode of §2.1.K.2 is followed. One EVA course, Formal Languages and Automata Theory, will begin in August 2000; four more in January 2001. These correspond to the first semester. Some final exams will be *in situ.*

Thesis work will be *in situ;* the student will spend up to six months together with his thesis director. A list of more than 700 approved thesis topics (and the corresponding directors) will be available within six months, for student selection. Up to 50 thesis directors will be current CIC faculty; the rest, faculty from SIT with advanced degrees.

The M. Sc. Computer Science Program at CIC is composed of 13 courses plus thesis; thus, we plan four full-time semesters to obtain the degree. IPN is updating its legislature so as to register these evanauts as full IPN students.

3.1.1 Other efforts using EVA

SIT plans to use EVA for undergraduate teaching, for instance, in Industrial Engineering. At present, other universities are interested, including IPN, and are considering the first step: to write the necessary multibooks.

A multibook on Agents exists, as well as pieces of others.

3.2 Methodology

EVA is being installed in several PC servers in SIT. SIT will provide the necessary client computers for student use (the sites are Technology Institutes with good computer facilities), and the networking. There will be 6 main sites. System support people will be on duty at them.

Entrance examinations and formal registration will be in these six sites. Later, documents will be sent to CIC. CIC will open EVA to the selected 500 students, and wait a reasonable time for documents to reach.

The synchronous mode of §2.1.K.2 is followed. Thus, students will move through the teaching material at a predetermined pace. Exams will be scheduled on selected weeks. Advisors will be available in each of these six sites. In addition, advice will be available online, as per §2.1.C.

A backup plan exists in case some major failure should happen: CIC will use IPN's teleteaching facilities (§1.2.1.G) to deliver synchronous remote education, if needed.

3.3 Conclusions and comments

- EVA is ready for use [5, 10-11] and will be seriously tested soon.
- Current efforts are in two lines: (a) completing the software functionality, and (b) writing the multibooks. It seems that to write a multibook is 20% more difficult than to write a normal book. If this is available, effort for translation is about 20%.
- EVA seems to follow a reasonable model; expectations are high; students and authorities are enthusiastic.

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