A Comparison of Three Delivery Systems for Teaching an Information Technology Course

Marie-Michèle Boulet, Faouzi Ben Jebara, Fathi Bemmira, and Serge Boudreault

An important aspect of the global, knowledge-based, technology-enabled economy is that organizations must invest in continuous training [4]. Managers, now exposed to concepts such as knowledge economy, organizational intelligence, learning organization, knowledge era, and organizational learning, [2, 3, 12], need to establish the optimum mix of continuous training activities to leverage organizational knowledge to its fullest potential. Several methods and models aimed at managing organizational knowledge at a macro level are now available [2, 3, 5, 6, 8, 9, 11]. But these methods don't address the micro level problem of planning and selecting continuous training activities while taking into account manager and employee preferences, and constraints such as budget or deliverables. The analysis of empirical data presented in this article incorporated factors, criteria, and weights into a model named Econof. Our findings provide managers with valuable tools to implement a continuous training management process aligned to organizational strategy—a step toward the development of knowledge management strategies.

Using data from 243 undergraduates enrolled in an information technology (IT) course at Université Laval, we investigated the effects of television distance education versus classroom education on learning fundamentals, problem solving, and social skills. The study was a factorial design, with students divided into three groups: fully television distance education course students (FTDEC), partially television distance education course students (PTDEC), and traditional classroom students (TRADC). The three student groups were equivalent in terms of seven variables: age, gender, number of distance education courses, cumulative average, level of interest in IT, enrollment status, and number of credits.

The instructional materials were comparable for all three groups. The TRADC group attended fifteen lectures. The PTDEC group attended seven lectures, receiving

Marie-Michèle Boulet (Marie-Michele.Boulet@mus.ulaval.ca) is a professor in the faculty of music at the Université Laval in Québec City, Canada.
Faouzi Ben Jebara, Fathi Bemmira, and Serge Boudreault are graduate students from Université Laval.

additional instruction from television documentaries and a computer learning environment called Partenaire. The FTDEC students received all instruction from television documentaries and Partenaire. All three groups had the same learning objectives, professor, and textbook, entitled *Technologies de l'information: Applications et Èvolution.* The Information Technology undergraduate course, designed using Gagné and Briggs' principles of instructional design, [7] incorporated the following components:

- Different sets of conditions are required for various types of learning to occur.
- Instructional objectives can be classified according to the type of learning involved.
- In selecting instructional objectives to be learned in the domain of intellectual skills, learning hierarchies indicate which competencies must be acquired.
- Learning hierarchies also provide guidance in sequencing instruction so competencies are taught in a logical order.
- The instructional events provide the external conditions required to support the internal processes of learning.
- Instructional prescriptions are made to ensure each instructional event achieves the desired learning outcomes.
- A variety of instructional media can be used to apply the respective instructional events.

The 13 units of the course are described as follows:

1. *Evolution of the Function.* Explains the roots of current trends regarding the design and uses of information technology.
2. *Evolution of the Investment.* Covers the evolution of IT business investments.
3. *Problems and Challenges.* Addresses limits of the current methods and techniques.
4. *Methods.* Explains the roots of current methods and techniques.
5. *Strategic Aspects.* Prepares a strategic plan pertaining to a particular company.
6. *Process Modeling.* Involves drawing process models using data flow diagrams.
7. *Data Modeling.* Involves drawing data models using entity-relationship diagram notations and symbols.
8. *Levels and Scope.* Modeling at three levels and with three degrees of scope.
9. *Design.* Trains students to transform a logical representation of what a given system is required to do into the physical specifications.
10. *Economic and Financial Aspects.* Costs and benefits resulting from IT.
11. *Implementation.* Managing IT implementation.
12. *Profession.* The nature of tasks performed by IT professionals.
13. *Research.* Keeps students current with the state-of-the-art.

Each television program is a documentary detailing how information presented in the textbook is used in the workplace. Twenty professionals from various organization were interviewed to make the documentaries, which focus on concepts difficult to explain in written form. Program 7, for example, illustrate how analysts must be aware of issues not mentioned by clients. In this program, analyst and client are seen strolling the Centre Jardin Hamel in deep discussion. Several signs appear before them, naming particular trees and tree categories, and advising on the care of these trees, but the client does not appear aware of these signs. Yet the information conveyed on each sign is important for the analyst—it is part of the data model.

Partenaire was designed according to the cooperative learning paradigm found in Lotus Notes-Domino, a distributed, document-based database application system. Its features, which include broadcasting, discussion capabilities, referencing, and tracking, were thought to increase student-student and student-faculty interaction, within a context of distance education, as well as prepare students for the new millennium, where teamwork and interdependence prevail. Partenaire allows students to practice positive interdependence, creative controversy, group problem solving, and others activities that characterize the cooperative learning–teaching strategies [10].

A main navigator facilitates student access to the sections of Partenaire. First, a graphical section presents an exercise. The second section allows students to request assistance. The third allows students to select relevant learning materials, such as extracts from the textbook, television programs, and study guide. The fourth section presents the content of the database sorted by type of documents. Here, team members can view what other team members have accomplished, as well as any requests for assistance and their responses. The fifth section of the navigator presents the same content sorted by creation date. The last section allows the user to quit the navigator.

Figure 1 illustrates the presentation of a context diagram (diagramme de contexte) exercise. To solve this problem, students can access relevant parts of the unit learning material: extracts from the television program (visionner des extraits vidéo), the book (voir l'explication du livre) and the study guide (voir l'exemple du guide d'étude). Students ready to produce an answer select the Créer une réponse button on the top left of the screen.

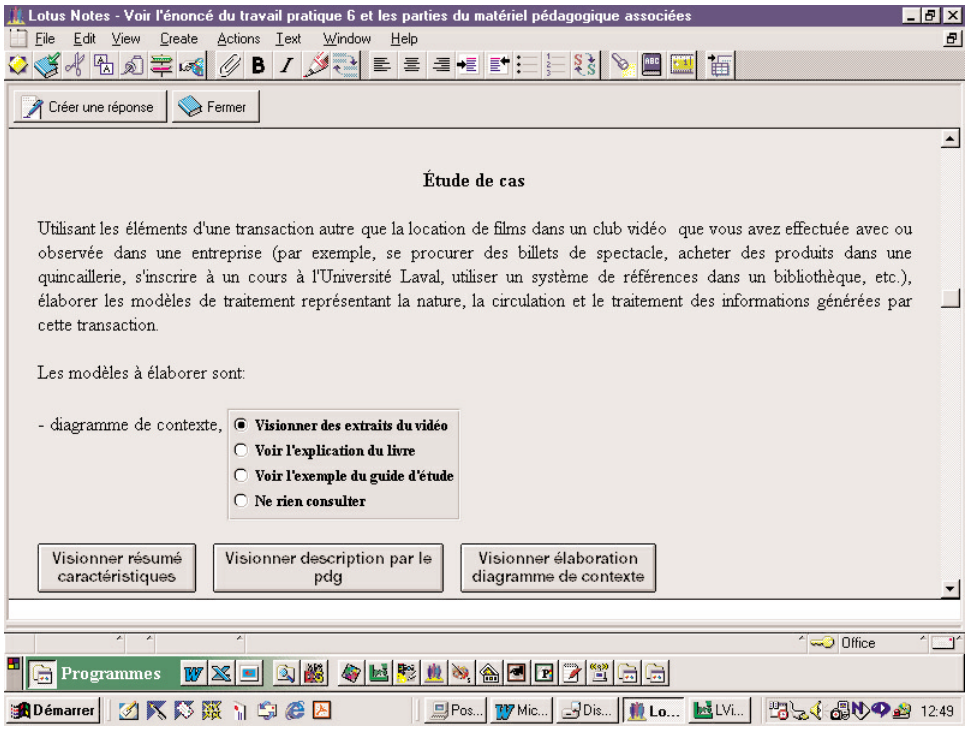

Figure 1. Statement of an exercise with links.

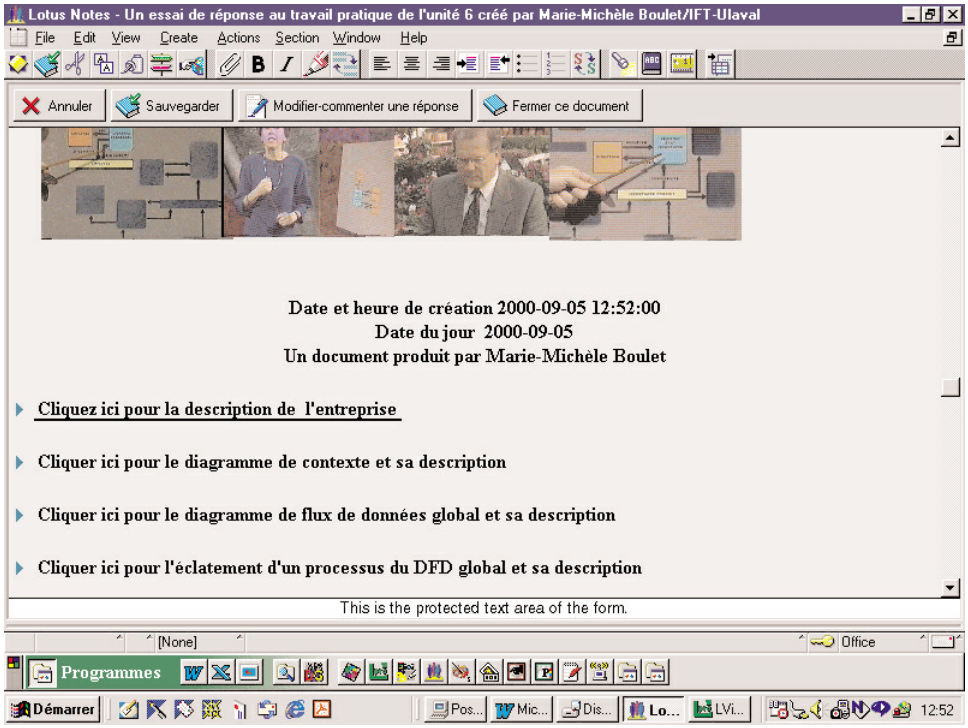

Figure 2. The response form.

Selecting the Créer une réponse button brings students to the response form. The response form illustrated in Figure 2 has four components: students must provide a business description (description de l'entreprise), a context diagram and its description (diagramme de contexte et sa description), a global data flow diagram and its description (diagramme de flux de données global et sa description), and a breakdown of a process appearing in the global data flow diagram (…clatement d'un processus et sa description).

The buttons at the top of the form illustrated in Figure 2 allow students to cancel (annuler) the work in progress, to record the content of the current document within the team's file (sauvegarder), and to modify or comment on a teammate's answer (modifier-commenter une réponse), or to close the document (fermer ce document).

Students use Lotus Notes-Domino for its powerful sharing, discussing, referencing, and tracking features, but they also have the option of using software products such as Office 2000 and Corel suite. Students can share the content of their works, discuss tentative solutions, and keep track of each solution release, and professor can give the whole class access to questions asked by others and their answers.

Comparing New with Old

Our study aimed to determine the effect of television distance education on overall learning, as well as how effectively such distance programs teach fundamentals, problem solving, and social skills. Measures consisted of scores on a paper-and-pencil test

(post-test; split-half reliability = 0.7) on fundamentals, problem solving, and social skills of computer professionals. First the means, standard deviations, and scores were calculated. Then a Manova was performed. When the results indicated a significant difference ($p < 0.05$), an Anova was performed. If these results indicated a significant difference, the Tukey multiple comparisons test was performed to find the group(s) causing the difference. Results are summarized in Table 1. Significant findings include:

- Regarding overall learning, the FTDEC students outperformed the other groups for units 3 and 12, and the FTDEC and PTDEC students outperformed the TRADC group for unit 10.
- Regarding fundamentals, the FTDEC students surpassed PTDEC and TRADC students in units 3 and 10.
- Regarding problem solving, the FTDEC students outperformed the other groups for unit 12, and the FTDEC and PTDEC students outperformed the TRADC group for unit 10.
- Regarding social skills, there was an added value for the FTDEC students in units 3, 5, 6, 8, 9, 10, 12, and 13, and for PTDEC students in units 6, 9, 10, and 13.

Table 1. Results for the 13 units ($p > 0.05$).

	Fundamentals	Attitudes	Problem solving	Total
Unit 1	No	No	No	No
Unit 2	No	No	No	No
Unit 3	Yes FTDEC	Yes FTDEC	No	Yes FTDEC
Unit 4	No	No	No	No
Unit 5	No	Yes FTDEC	No	No
Unit 6	No	Yes FTDEC Yes PTDEC	No	No
Unit 7	No	No	No	No
Unit 8	No	Yes FTDEC	No	No
Unit 9	No	Yes FTDEC Yes PTDEC	No	No
Unit 10	Yes FTDEC	Yes FTDEC Yes PTDEC	Yes FTDEC Yes PTDEC	Yes FTDEC Yes PTDEC
Unit 11	No	No	No	No
Unit 12	No	Yes FTDEC	Yes FTDEC	Yes FTDEC
Unit 13	N/A	Yes FTDEC Yes PTDEC	N/A	N/A

This first release of Econof addressed the problem of choosing a computerized training program [1]. The current release, described in this article, was developed to help decision-makers determine the cost-effectiveness of investing in a continuous training program. It is based on a multi-criterion model. To produce and enhance the model, criteria must be found. In its current state, the model comprises four themes: training transfer, program evaluation, cost/benefit analysis, and training technologies needs (see Figure 3).

Results presented here will allow improvements to be made. For example, the program evaluation comprises 11 criteria (see Figure 4). In its current state, Econof considers two subcriteria regarding the training outcomes (see Figure 5), but it does

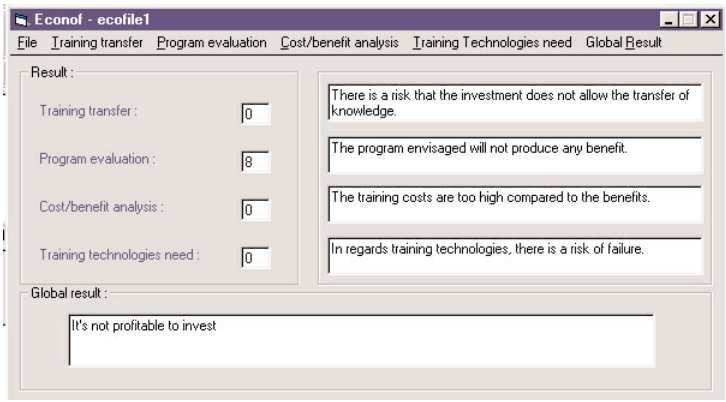

Figure 3. Main menu of Econof.

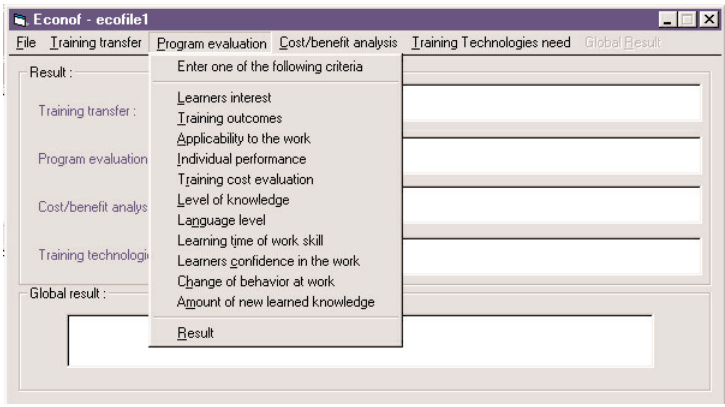

Figure 4. The Program Evaluation list of criteria.

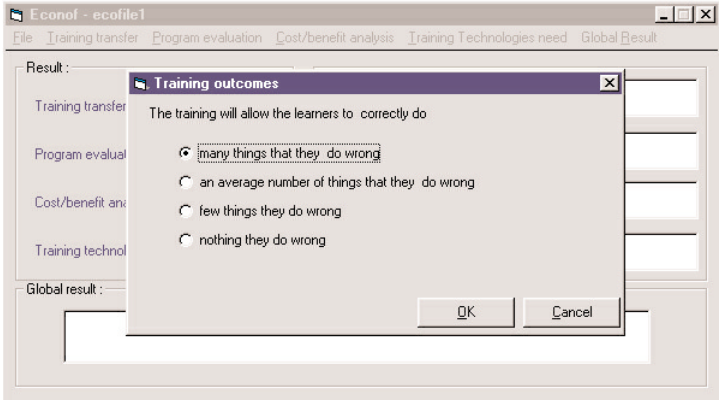

Figure 5. One of the Training Outcomes subcriteria.

not take social skills, fundamentals, or problem solving abilities into account. Using the empirical results from our research program, which includes data from several undergraduate courses, we will propose adjustments to criteria and subcriteria. For example, if several social skills have to be learned, then the availability of a distance education course with a television component will have a higher weight than a lecture when the cost/benefit analysis is performed. Once the new release of Econof is complete, the validation process will begin. When the validity and reliability of the model and software are established, we will use it to produce a mathematical model that is solved using linear programming techniques.

References

1. Boulet, M.M., Sene, L., and Ben Lamine, S. (1998). ECONOF: A tool to take into account economic aspects of computerized training. *Journal of Computing in Higher Education 9*, 2 (1998), 31–43.

2. Choo, C.W. *The Knowing Organization: How Organizations Use Information to Construct Meaning, Create Knowledge, and Make Decisions.* Oxford University Press, New York, 1998.

3. Davenport, T.H. (1997). *Information Ecology.* Oxford University Press, New York, 1997.

4. Drucker, P.F. *Post-Capitalist Society.* HarperCollins, New York, 1993.

5. Fayyad, U., Piatetsky-Shapiro, G., and Smyth, P. The KDD Process for extracting useful knowledge from volumes of data. *Commun. ACM 39*, 11 (1996), 27–34.

6. Fiol, M.C. Consensus, diversity, and learning in organizations. *Organization Science 5*,3 (1994), 403–420.

7. Gagné, R.M., and Briggs, L. *Principles of Instructional Design.* New York: Holt, Rinehart and Winston, New York, 1979.

8. Haskin, D. Leverage your knowledge base. *Internet World* (Feb. 1998), 12–16.

9. Huber, G.P. Organizational learning: The contributing processes and the literature. *Organization Science 2*,1 (1991), 88–115.

10. Johnson, D.W., Johnson, R.T., and Holubec, E.J. *The Nuts and Bolts of Cooperative Learning.* Edina: Interaction Books, 1994.

11. Leonard-Barton, D. *Wellspring of Knowledge.* Harvard Business Press, Boston, 1995.

12. Willinsky, J. *Technologies of Knowing.* New York: Beacon Press, New York, 1999.

This research was granted by the Natural Sciences and Engineering Research Council of Canada and the Office of Learning Technologies (Human Resources Development Canada).