A VOYAGE TO THE REALM OF IT

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Go back in your mind to the late 1990s and picture the hallways, classrooms, and laboratories in your school. Remember all the changes waiting for you at the start of each new school year – all the classrooms transformed into computer labs and traditional labs rearranged to make room for PCs and networked printers? And what about the desks that had been traded in for keyboards and computer screens? What do these memories awaken in you? Were you indifferent? Rattled and worried? Or were you among the hardy first explorers of this New World of digital technologies and cyberspace? If you were a member of that last group, the decade then coming to an end must have been one of the most exciting of your career.

But just like the sixteenth-century navigators summoned to the royal court to deliver nuggets of gold, silk goods, precious woods, and "natives" in traditional costume, at the turn of our millennium, intrepid voyagers to the realm of IT were required to report on the payoff from their explorations, both to each other and to representatives of the ministère de l'Éducation. One simple question cried out for an answer: What effect does this new information technology (IT) have on teaching and learning? Thus began another odyssey, one that would bring forth a somewhat nuanced and complex answer to an initial question that had seemed so simple.

EXPLORING THE TERRITORY: A REVIEW OF PUBLICATIONS ON THE USE OF IT IN COLLEGE TEACHING

To answer the question, the Association pour la recherche au collégial (ARC) undertook to assemble an overview of what had been revealed by research conducted in colleges and CEGEPs as regards the effectiveness of IT in teaching and learning. A preliminary operation consisted in exploring the research done in this field by producing an inventory of relevant publications (Association pour la recherche au collégial 2003). There and then, the initial question starts becoming more complex. What should be included in the inventory? What is meant by "effectiveness of IT"? What effectiveness? For what purpose? For whom? To carry out an expedition, it is important to know your destination. This article and those that follow in this dossier will demonstrate how, in this adventure called research, every answer gives rise to new questions, and how progress is made as much by knowing how to formulate the best question as by using a sound method to answer it.

THE INITIAL QUESTION: "WHAT IS COVERED BY 'IT USE IN COLLEGE TEACHING'?"

Does the intensive computerization that took place in numerous technical programs during the 1990s count as IT use in college teaching? Or, on another level, does producing word-processed course outlines or transmitting students' grades on secure internal networks truly constitute IT use for pedagogical purposes? Do the educational software programs that teachers develop or adopt in order to correct student exams, or to have their students simulate real-life situations (for instance, an archaeological dig or an electoral campaign), count as part of IT use in college teaching?

Georges-Louis Baron and Éric Bruillard (1996) distinguish three ways that digital technologies are present in the world of education:

1. Digital technologies as part of the program content. The case in point is that of… computer science! But just about all the exit profiles of college programs contain statements relating to the mastery of software and programmable devices. This is a given in the fields of graphics communications, civil engineering, and administration, but even the humanities and social sciences have targeted skills that relate to software use for data-gathering and processing as well as for preparing and presenting reports.

2. Digital technologies as working tools. Word processing, spreadsheet and email programs have become indispensable management tools in only a matter of years.

3. Digital technologies as media that improve teaching and learning. This is the world of presentation software, educational software, tutorials and simulators used mainly in the classroom and the lab, and sometimes at home.

The question arises as to whether all three of these ways that digital technologies are manifest must be taken into account when measuring the impact of IT on teaching and learning. Exploration into the territory of research conducted in colleges tells us nothing about the effectiveness of teaching on the subject matter of digital technologies as part of the content of specific programs. If this question has in fact been raised, the answer has not been obtained in the sphere of empirical research. However, program evaluations may hold the answer. Nor has research been done on the impact of digital technologies as work tools, to determine specifically if teachers who go online become more effective… and perhaps happier. What the research conducted in Québec's CEGEPs and colleges has focused on is the presence of IT as media that improve teaching and learning, which constitute the central focus of these institutions' mission. Thus, this is the direction the ARC expedition will follow.

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AN EXPEDITION IN SEARCH OF THE CONDITIONS FOR USING IT TO IMPROVE TEACHING AND LEARNING

The long journey undertaken by ARC to bring to light the conditions for using IT to improve teaching went through three major phases that will be presented in detail in the following pages. The project brings a single question to bear on data from diverse sources and, accordingly, relies on diverse methodologies. The ARC undertaking thus constitutes a metaresearch.

THE COUNTRY DISCOVERED

Once completed, the metaresearch will have made it possible to formulate a set of principles that must be taken into account in implementing a successful integration of IT into pedagogy. They are as follows:

1. **THE POSITIVE EFFECTS OF AN EFFECTIVE INTEGRATION OF IT INTO PEDAGOGY SHOW UP IN THREE INTERRELATED WAYS:**
   a. improved academic results;
   b. increased manifestation of complex cognitive operations, such as metacognition, transfer, and generalization;
   c. signs of increased motivation and interest by students.

2. **THE MAXIMUM POSITIVE IMPACT IS ATTAINED WHEN CERTAIN TYPES OF DEVICES ARE COUPLED WITH CERTAIN PEDAGOGICAL STRATEGIES. THESE ARE:**
   a. collaborative learning devices, such as virtual training environments, as part of teaching/learning activities based on a socioconstructivist perspective;
   b. devices that promote metacognition, such as tutorials, as part of teaching/learning activities based on a cognitivist perspective;
   c. adaptive and differentiated devices for drill and practice, such as educational games, as part of teaching/learning activities based on a behaviourist perspective.

3. **CERTAIN CONDITIONS EXTERNAL TO THE TEACHING/LEARNING ACTIVITY AS SUCH, INFLUENCE THE DESIRED EFFECTS:**
   a. suitable equipment (materials and software);
   b. an adequate level of user competency (users include teachers and students);
   c. the capacity to elicit and support changes in teachers' practice;
   d. teachers' motivation to embark on innovative projects focused on IT;
   e. consideration given to projects' social and ethical aspects.

METASYNTHESIS OF EMPIRICAL STUDIES RESULTS: OVERVIEW OF A FAMILIAR TERRITORY

The first phase of ARC's metaresearch aims to explore and describe, and then to place in order and explain, the results of empirical studies on the integration of IT into pedagogy. Three approaches for doing this presented themselves.

The **first approach** consisted of an enumeration of, on one hand, studies that have found that the integration of IT yields beneficial effects and, on the other hand, studies that have shown an absence of any significant effects or, worse, adverse effects. This approach has IT appeal when applied to a very large corpus, as demonstrated by Russell (1999, 2010), but it is of no real significance as applied to the thirty or so Québec studies reviewed on the subject. In any case, this approach fails to consider the number of students or the intensity and duration of experiments done, not to say the quality of data collected. Could we place the evaluation of several years' trial of DECVIR with hundreds of students (Ducharme, Lizotte, and Chomienne 2002) on the same level as a hypothetical evaluation based solely on the teacher's self-report, of a three-week trial by one teacher and a group of students?

The second approach was more arduous although more reliable. It related to studies of a more experimental kind that compare the results for one group of students who have used a technological device in completing a task (experimental group) to results for another, similar group (control group) that has not had recourse to the device to complete that same task. Is the difference between their results significant, that is, attributable to causes other than chance? If several studies of this type are available, it is possible to reprocess their respective data as if all the studies together formed a single, very large experiment. This statistical reprocessing is called a meta-analysis. Is there a significant difference between the results obtained overall by students who used the technological devices and those for students who did not use them? In the meta-analysis led by Barbeau (2007) on a variety of interventions targeting success by CEGEP students, it was possible to reprocess data from roughly a dozen experiments centred on IT. Barbeau is cautious in answering the question: despite a slight tendency to observe that students using devices with technological components performed less well than those using traditional means, it is not possible to detect a significant difference between the experimental and control groups.

But even if it is true that, when taken as a whole, the cases where IT is used to improve teaching and learning show no notable impact, can we conclude that no experiments in this area will have any effect? Think of the impact of such a conclusion: so much money, so much time, so many material resources invested for… nothing? Would it have been better to take a different turn during the nineties than that of technological consumerism? But wait – that's not right. The tales of pioneers and explorers are not without foundation; there have been true success stories in the integration of IT into pedagogy.

This observation opens up the third approach, that of a process for conducting qualitative analysis called metasynthesis, which makes it possible to organize and explain the results of experiments (Miles and Huberman 2003) in such a way as to identify the conditions that were present in successful cases, and were absent or insufficient in the more numerous cases where there was no beneficial effect. This is the approach ARC has taken since 2004 (Barrette 2004a, 2004b). It took several months for the researcher to read and analyze the 32 relevant reports on experiments and extract what can be termed the winning conditions for integrating IT into pedagogy with a view to improving the effectiveness of teaching and learning. For each case, an entry is made in a qualitative database. The entry records the features of those variables deemed relevant in the light of other, similar studies.

Exploring cases by cross-tabulating variables made it possible to extract recurring configurations of conditions associated with specific effects. For example, one can ask what kinds of devices serve to implement the experiment reported on: presentation software, drill-and-practice software, educational software, collaborative environments? What type of task is looked for: rote learning or creation? Are these tasks completed individually or in teams; in the classroom, in the lab, anywhere the students choose? Is the technology used accessible, well mastered by its users? And, in terms of impact, the crucial question arises: What exactly are we talking about when the time comes to report on the impact of IT on student achievement? Academic results are not alone in attesting to this impact, because students' interest and motivation, their ability to make connections and to retain what they have learned for a longer time, are not always reflected in better marks, especially when the assessment tools remain traditional and do not take into account all the effects of the innovative pedagogical strategies put in place thanks to the use of IT-based devices.

Thus, it was by cross-tabulating the features of the variables that describe instructional-technology-based teaching/learning activities and effects on learning that the researcher was able to gradually extract the optimal conditions so eagerly sought, which characterized instances of glowing success in integrating IT into pedagogy. There is no simple recipe, because the ingredients are numerous and the effects sought-for diverse, but the cross-tabulating of observations made in experiments of an empirical nature made it possible to highlight associations of conditions specific to successful experiments in integrating IT into pedagogy. These results can serve as guides to professional action, once associations of conditions are translated into guiding principles for experiments in integrating IT into pedagogy.

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However, the number of experiments covered by our metasynthesis was small (32 source documents) and some principles might be supported by only two or three cases. A detailed examination of other more substantial metasyntheses, such as that by the Center for Applied Research in Educational Technology (2005), allowed for the comparison, validation and support of the initial conclusions from our metasynthesis. In this way, the soundest principles were retained for use in drawing up a guide for planning teaching/learning activities



focused on using IT to improve student success. A summary can be found in an article published in *Clic* (Barrette 2007).

Although very useful, knowing about these identified principles did not solve everything. Other questions remain unanswered. For example, it could be asked whether the lessons learned in an experimental context are always appropriate to daily practice, which is more exposed to random events than the more controlled environment of an empirical study. It could also be asked which aspects of the optimal conditions may have escaped observation in the context of the small number of cases taken into account in ARC's metasynthesis. In short, questions were raised about the validity and exhaustiveness of the results.

Then the idea arose to consult expert practitioners in the field to check whether, on one hand, the conclusions of the metasynthesis corresponded closely to their representations and, on the other hand, to see whether their experience was instructive about new conditions to be taken into account for a successful experiment in integrating IT into pedagogy. Thus, the second phase of ARC's metaresearch got underway; during this phase, the researcher set up meetings with experts in the field in order to validate and supplement the account formulated at the end of the first phase. This new phase was that of the formalization of expert knowledge.

THE FORMALIZATION OF EXPERT KNOWLEDGE: MAPPING OUT NEW TERRITORIES

Four people were then identified as experts, and they agreed to participate in the proposed undertaking. In an interview, they were led to theorize on their personal research practice and on their advice about instructional technology to teachers trying out IT-based pedagogical strategies in the classroom. In this way, each participant reviewed a period of ten years or more of professional life by answering the following question, "What are the main determining factors and principal conditions that must be taken into account to ensure that the impact of the pedagogical use of IT is positive?"

Concept mapping (Cossette 2003), a technique from the field of cognitive science, was used to gather the expert knowledge and accelerate the process of formalizing the rules put forward by the experts. For each interview, a concept map provided a visual representation of the significant statements pinpointed. A second meeting with each expert was conducted to review their concept map in detail and validate it. In this dossier, the article by Gazaille (see "Four Views, One Portrait"), one of the experts consulted, reports on the reflective process that ensued.

The maps obtained for the four experts each contain between 68 and 136 statements. According to the individuals, between 60% and 86% of their ideas can be linked to principles taken from the metasynthesis, which means that the expert knowledge and the knowledge resulting from empirical research deal with essentially the same area of knowledge. One reassuring fact is that none of the statements made by the experts contradict the observations that emerged from the metasynthesis, thus attesting to its reliability.

Obviously, the experts also touched upon some determining factors in integrating IT into pedagogy that had not been taken into consideration in the body of research drawn on by the metasynthesis. Specifically, the experts revealed two new dimensions. The first relates to teachers' motivation, role and job. The second has to do with questions of a social, cultural, ethical or political nature linked to the integration of IT into pedagogy. In this dossier, the article by Gazaille explores the first of these dimensions.

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A COMMUNITY OF PRACTITIONERS TAKES OWNERSHIP: A MEETING OF TWO CONTINENTS

The initial publication (Barrette 2005, 2007) of the results of the first phases of ARC's metaresearch generated interest among the professional staff responsible for instructional technology in colleges. This gave rise to, among other things, presentations taking the form of addresses to members of the Réseau des répondantes et répondants TIC (Réseau REPTIC). But this traditional approach, that of transfer of scientific knowledge to a community of professional practitioners, quickly became the object of criticism, which Bachand reports on in his article (see "Taking Ownership of Knowledge: Going beyond transfer!"). These critiques led to favouring another approach, one based on Paillé's presentation (1994) of grounded theory to analyze qualitative data.

The process proposed by Paillé unfolds over six stages. The work accomplished with the four experts, including comparing their ideas with those that emerged from the metasynthesis, covered the first four stages. But the final two stages give us a whole new perspective requiring, once again, that the researcher weigh anchor and set off on a new journey:

- **The modelling stage,** during which an effort is made to validate the explanatory model (validate the rules it contains) with practitioners, through an extensive consultation process.
- **The theorization stage,** which targets ownership of the rules contained in the model by an ever-growing section of the community of practitioners engaged in reflection on their practice.

In his article, Bachand explains how the modelling and theorization stages unfolded within REPTIC, of which he was a member. These stages had three significant repercussions. One was the translation of the model into a useful and practical form. REPTIC members soon announced the need to convert the study results into a professional tool. The tool devised is in the form of an analysis grid of plans for teaching/learning activities and projects based on IT. An article in this issue presents that grid (see Barrette, Bachand, de Ladurantaye and Gazaille, "Analysis Grid for an IT-based Learning Activity").

Another significant repercussion of the modelling and theorization work undertaken with REPTIC concerns the typical area of intervention for advisors on instructional technologies, namely, organizational conditions. These constitute the third set of conditions identified in the metasynthesis. In each of the institutions where they work, educational advisors who are members of REPTIC are engaged daily in managing the organizational aspects of IT integration: equipment, venues, training sessions, pedagogical issues, and support and motivation are their day-to-day concerns. Thus, these key players have in-depth experience of these realities; and they are keenly stimulated, as demonstrated by the Bachand article, by the idea of theorizing about their interactions.

In another article in this dossier, de Ladurantaye, who is also a REPTIC member, attests to another revealing example of the ownership process specific to the theorization stage (see "What Is Covered by 'IT Use in College Teaching'?"). He specifies how the model inherent in the REPTIC grid can be integrated into a broader process, that of the development of a pedagogical frame of reference favourable to the integration of IT. This frame of reference constitutes a true pedagogical stance that sanctions the use of digital technologies as media capable of improving teaching and learning.

The stage of theorizing about one's own practice within a community takes time. It is in fact a process of support and maturing leading to the emergence of a shared awareness regarding the issues and determining factors underlying one's professional acts. In grounded theory, the explanatory model, that is, the representation of conditions and effects, cannot be imposed, and above all not from outside the community. The process is undoubtedly never-ending; it could even be said that its longevity constitutes a sign of its successful implementation. As of this date, it is still going on within REPTIC.

The phases of ARC's metaresearch: a retrospective look at a long journey

The research trajectory presented in this article features three major phases: first, modelling based on data from empirical studies, obtained by reprocessing the quantitative data (meta-analysis) and the qualitative data (metasynthesis); then, the validation and enrichment of the model based on the knowledge of people recognized as experts in their milieu; finally, the theorization of practice by professionals directly concerned by the issues the model deals with.

After such a journey, one realizes that the path taken is likely to inspire exploration of other territories besides that of effectively integrating IT into pedagogy. This is the case, in particular, of peer help as a strategy for promoting success. While there is no shortage of imagination nor of a spirit of initiative in the CEGEP system, its key players would certainly benefit from in-depth reflection on their practice, which could guide innovative action based on empirical research data and on the rules that direct their more experienced colleagues. An invitation to a voyage… the voyage of research and informed practice.

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