SUCCESSFUL IT PEDAGOGICAL INTEGRATION: HAVING A LOOK AT THE WHOLE PICTURE

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Abstract

The ARC (Association pour la recherche au collegial) carried out a meta-analysis that helped identify factors that must be considered for the successful integration of IT into teaching that is, factors that would have positive impacts on student success. The following learning devices proved effective: 1) devices that rely on specialized adaptive drill and practice tools; 2) devices that promote meta-cognition; or 3) devices that support collaborative learning. The meta-analysis also indicated that all three categories remain sensitive to the influence of conditions linked to the organizational environment, such as the users proficiency level in using IT (teacher and student training), equipment (material, software), appropriateness/availability of support, and changes in practices for professionals and administrators (pedagogical management and institutional policy).

In order to improve this first heuristic model of successful IT integration into teaching, another question had to be considered: how do the professionals' patterns of action compare to those in the ARC meta-analysis model? To answer this question, the second part of the ARC study was conducted. Four college network experts (in pedagogical counselling and research) were interviewed on what they considered as the determining factors for successful IT integration in the classroom. Using a specific, pre-identified series of verbs, conceptual maps were created to reproduce and analyse the data gathered from the interviews with the four experts. All four conceptual maps were validated with their authors. The maps were compared to each other as well as to the meta-synthesis model. The result was an enriched heuristic model designed to explain successful IT integration at the collegial level.

Within the framework of this presentation, our objectives are: 1) to present the methodology that led to our heuristic model; 2) to discuss our model in the light of the factors that were found to be important for successful IT integration into teaching/learning; and 3) to report on the progress of the work in the third part of the study.

Keywords - Technology, research, concept mapping, expert knowledge, reflexive practice.

1 BACKGROUND

Because of the considerable investments required to switch to technology tools, the question "how does the use of information technologies (IT) impact on teaching/learning?" continues to be asked all over the world. And yet, most of the literature on the effects of IT on learning and teaching reaches the same conclusion: there seems to be no direct correlation between the use of any given technology and any given teaching or learning outcome [1], [2], [3]. While it is true that most educational interventions that harness IT to improve academic success have not been shown to have any discernible impact, there is still compelling evidence that a certain number of these interventions do indeed have positive effects.

In Québec, there is no question that the college network[1] has made a significant contribution to research on IT integration. But it was not so long ago that the current state of knowledge in this field

[1] In Québec, general and vocational colleges (CEGEPs) offer either a two-year pre-university program or a three-year technical program. College teaching normally follows the fifth year of the secondary cycle. A

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had yet to be assessed. This was the reason why, in 2003, the Association pour la recherche au collégial (ARC) attempted to answer a very important question raised by the network: "After some 25 years of research, what is known about the effects of using IT on learning and teaching in Québec college network institutions?" To help answer this question, the ARC undertook a meta-research project consisting of three main steps that involve the collection and analysis of three types of data: 1) empirical research data (meta-analysis and metasynthesis); 2) expert knowledge data; and 3) data on critical appropriation by teaching professionals. The following material is concerned more specifically with the comparison and reconciliation of expert knowledge with empirical data. As such, a brief review of the meta-analysis results is provided first. Next, the metasynthesis and expert knowledge data and the resulting analysis grid are discussed more fully. The paper closes with a few details about the progress of the critical appropriation of the results amongst teaching professionals.

2 EMPIRICAL RESEARCH RESULTS

This first step in the metaresearch was to analyse the data from empirical research concerned with the effects of IT integration on the success of college students. This step involved two separate processes: 1) a meta-analysis for processing quantitative data, and 2) a metasynthesis for analysing qualitative data.

Barbeau's meta-analysis [1] was the first project to help form the basis of the ARC metaresearch. This meta-analysis reports and analyses the quantitative results of a dozen educational interventions that use IT to help improve student success at college. Even though the meta-analysis dealt with only 12 research projects and caution is warranted in the interpretation of results obtained, the meta-analysis arrived at the same conclusions as most scientific texts and meta-analyses on the subject: the difference between using IT in college-level educational interventions and not using them is not significant.

Following this meta-analysis and still on the theme of integration of IT into college-level teaching, Barrette [4] [5] [6] [7] [8] conducted a metasynthesis of the qualitative results of 32 empirical studies conducted between 1985 and 2005. The purpose of this metasynthesis was threefold: 1) to identify the characteristics of educational interventions using IT that yielded positive results in order 2) to identify the optimal conditions for effective integration into teaching practices in order 3) to propose a causal model of the effectiveness of IT integration into teaching-learning at the college level. The reports of the research were collected, analysed and synthesized according to the principles of inter-site analysis [9]. The partial results of these 32 studies were compared and validated with those obtained by the *Center for Applied Research in Educational Technologies* [10].

The metasynthesis helped identify characteristics that distinguish interventions with positive impacts from those, which make up the majority, that have no effects or, occasionally, negative effects. An analysis of these characteristics allowed us to glean principles that, when grouped together in a heuristic model, could be used as a guide in carrying out teaching activities that use IT to improve teaching and learning. The following conceptual map (see Figure 1, next page) represents the heuristic model derived from the metasynthesis.

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college is not a CEGEP; the designation CEGEP is reserved for public institutions. The name "college network," of necessity, includes both types of institutions.

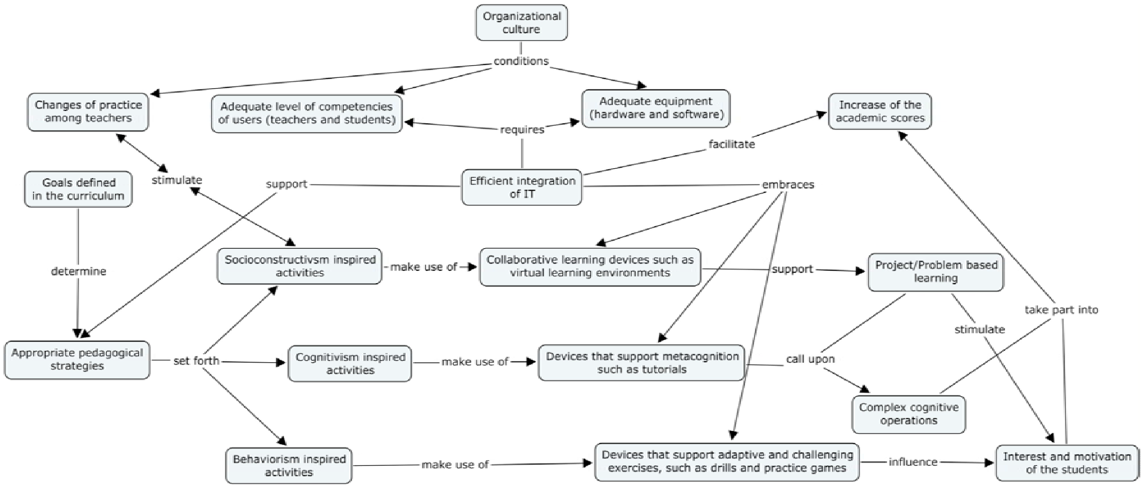

Figure 1: Heuristic model of effective IT integration into teaching

The heuristic model presented here is expressed in a set of 25 propositions (see Table 1 below). These propositions make it possible to build an argument regarding the principles of effective IT integration into teaching practice.

1. Effective integration of IT promotes better academic results. Here's how.
2. First, the objectives of programs of study determine appropriate teaching approaches.
3. IT integration is effective when it supports these appropriate teaching approaches.
4. The appropriate teaching approaches that appear first are those that scaffold behaviourist activities …
5. …making use of differentiated and adaptive drill and practice devices, such as educational games.
6. Effective integration of IT includes the use of such devices…
7. … that influence students' motivation and interest, …
8. … which are important factors in determining their academic results.
9. The appropriate teaching approaches that appear second are those that scaffold cognitive activities …
10. … making use of devices that promote metacognition, such as tutorials.
11. Effective integration of IT includes such devices…
12. … that require complex cognitive operations, …
13. …which are instrumental in improving academic results.
14. The appropriate teaching approaches that appear third are those that scaffold socioconstructivist activities…
15. … making use of collaborative learning devices, such as virtual training environments.
16. Effective integration of IT includes such devices…
17. … that support the project/problem-based approach.
18. This approach impacts on student motivation and interest in positive ways…
19. …and requires complex cognitive operations.
20. Effective integration of IT requires that users have an adequate level of skill (teachers and students),…
21. … that varies from one institution to another according to its organizational culture.
22. Effective integration of IT also requires the proper equipment (hardware and software), …

23.	… which also varies according each institution's organizational culture.
24.	Finally, putting socioconstructivist devices in place requires changes in teaching practices …
25.	… and these changes are also very sensitive to the organizational culture of each institution.

Table 1: Propositions drawn from the heuristic model that explain how IT is effectively integrated into teaching/learning

These principles explain that IT has proven to be effective in pedagogical activities that are deftly centred on methods that serve explicit goals. In other words, experiments on the integration of IT into teaching that combined tools and methods in working toward learning goals proved effective. At this time, the metasynthesis points to the effectiveness of three families of devices:

1. devices that promote performance learning and use differentiated and adaptive drill and practice tools, such as educational games, used mainly in the classroom or lab;
2. devices that require metacognition and use tools, such as tutorials, in individual activities that can extend beyond the classroom or lab;
3. devices that support collaborative learning and use tools, such as virtual learning environments, that create active communities mainly outside the classroom or lab.

The results of the metasynthesis show that IT can be used in approaches based on transmission of content (behaviourism), on conscious mastery of cognitive skills (cognitivism) or on the co-construction of socially significant knowledge (socioconstructivism). The metasynthesis also shows that the three previous associations remain sensitive to the influence of conditions linked to the organizational environment, such as:

1. an adequate level of skill in users (teacher and student training);
2. proper equipment (hardware, software) and adequate support;
3. as applicable, changes in the practices of professionals and administrators (pedagogical management and institutional policy).

Relying on empirical research data and results, the metasynthesis made it possible to map a heuristic model of effective IT integration into teaching/learning. The next step in the ARC metaresearch project was to discover how this heuristic model intersected with the explanatory model of people having expert knowledge in incorporating IT into college-level teaching practices.

3 EXPERT KNOWLEDGE AND HEURISTIC MODEL: CONVERGENCES OR DIVERGENCES

To reinforce the value of the propositions included in the proposed heuristic model, at this point in its metaresearch, the ARC attempted to answer the following question: "How can empirical knowledge, as processed during the metasynthesis, be reconciled with the expert knowledge in the field? Do these two sources of knowledge converge or diverge?" Participating experts are people who have implemented and participated in IT innovations, published in the field and have more than 10 years of experience in research and/or techno-pedagogical consulting. Four individuals who met these criteria agreed to contribute.

The process used was based on the anchored theorization approach proposed by Paillé [11] to process qualitative data. This process was carried out in six steps, the last of which was an anchored theorization in the field's practice setting. (This will be addressed later in "Status of Work in Progress")

1) Initial coding	Set of experts' propositions, drawn from their interviews, and organized in the form of a concept map.
2) Categorization	Reconciliation of experts' ideas (concept-verb-concept propositions) with ideas found in the metasynthesis. The idea (concept-verb-concept proposition) taken from the metasynthesis is the analysis category.
3) Establishing relationships	Development of experts' ideas around an idea found in the metasynthesis (one category) providing a short text that can be used by practitioners of education. This provides themes.

4) Integration	Essay that integrates experts' ideas with a line of argument from the metasynthesis and experts' original material, and takes the form of a long article or a simpler tool helpful in decision-making in project management.
5) Modeling	Validation of the heuristic value of the model (validation of themes and arguments) by practitioners during an extensive consultation process, a colloquium or seminar offered in the form of a credit course.
6) Theorization	Taking ownership of the field as a whole by a community of practice. Feedback effects of reflections on the research (new research projects), changes to theoretical reference frameworks.

Table 2: Anchored theorization process according to Paillé

Steps 1 to 4 involves collecting, processing, validating and comparing expert knowledge. First, the experts' comments are collected during a free interview that lasts about two hours. This interview deals with the same question as the one the metasynthesis is attempting to answer: "What are the main determinants (causes and conditions) that should be taken into account to ensure that the use of IT in teaching has a positive impact on student success"? The second and third steps involve processing and validating the expert knowledge according to the technical cognitive maps [12], a variation of the conceptual maps created specifically to express expert knowledge. Concepts maps have shown their potential in expert knowledge processing ([13]. The principal researcher transcribes the interview data and processes them using *Cmap Tools* [14] [15], and then meets with each expert again. Together, they do a first validation of the conceptual map that is drawn up. Once they come to a mutually satisfactory understanding of this first sketch, the principal researcher corrects the conceptual map. This second sketch is returned to the expert so that he or she can provide feedback or, if applicable, make further changes. The map resulting from these validation steps is the final conceptual map retained for metaresearch. In the fourth and final step, the researcher compares the expert knowledge with the heuristic model previously presented (see Figure 1); this corresponds to Step 4 in Paillé's anchored theorization process : integration (see Table 2).

In terms of results, the four experts' maps provided a total of 397 propositions, while the heuristic model that emerged from the metasynthesis provided 25 (see Table 1). The experts' propositions can be reconciled with those of the heuristic model (see Figure 2, next page, for an example of reconciliation based on the concept of "socioconstructivism").

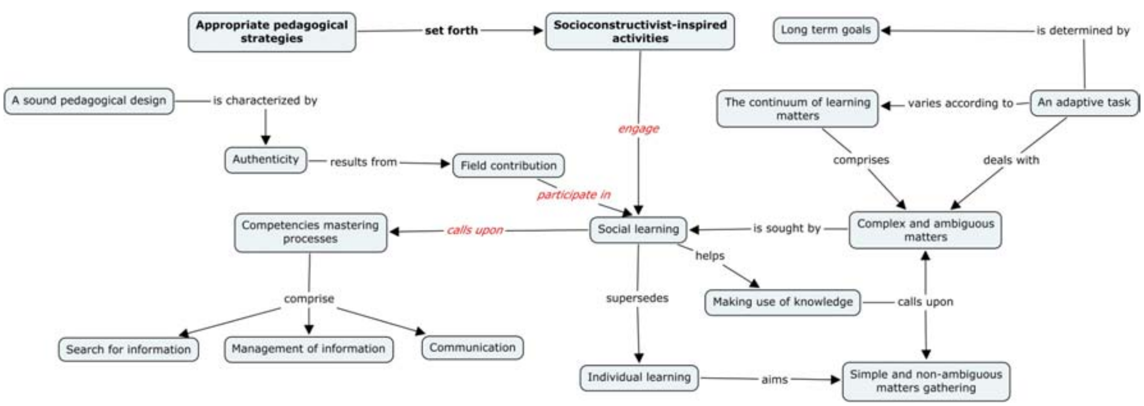

Figure 2: Conceptual map of a theme that reconciles the ideas expressed by experts in interviews with ideas from the metasynthesis (in bold characters)

A comparison of the experts' conceptual maps with the conceptual map of the heuristic model that emerged from the metasynthesis underscores the following points:

1. A high percentage of the ideas expressed by each of the four experts interviewed (63%, 72%, 81% and 86%) can be reconciled with the ideas in the metasynthesis model.
2. None of the 397 experts' propositions contradicts any of the 25 metasynthesis propositions.
3. Experts raise points that do not appear in empirical research issues.

The high percentage of the experts' propositions that can be reconciled with the heuristic model's propositions shows that, for the most part, experts deal with the same themes and the same field as the empirical research. As a result, the propositions provided by experts increase the level of complexity and the scope of the metasynthesis results while reinforcing the value of the heuristic model developed. However, the experts' propositions go beyond the results of the metasynthesis, as will be seen in the next section.

3.1 Original themes addressed by the experts

The experts' original propositions are grouped into two main themes: a) the teachers' role in initiating teaching activities that make effective use of IT, and b) the role of the social and ethical dimension of using IT. Both are discussed below.

A. Teacher involvement

According to the experts' discourse, teacher motivation seems to be a determining factor in their commitment to initiating teaching activities that make effective use of IT (Figure 3). In fact, the teachers' motivation for using IT seems to depend largely on whether they can expect savings and/or benefits related to their professional pedagogical management tasks. Thus, the choice of whether to use IT in planning teaching-learning activities, for example, seems to depend on how much time they estimate they can save in educational follow-up and support tasks, administrative duties and/or class management tasks, at least in the medium term (two to three years). Therefore, before they even embark on a program to develop their skills in using or creating IT devices for their teaching, teachers will have to be able to expect to save time on work-related tasks.

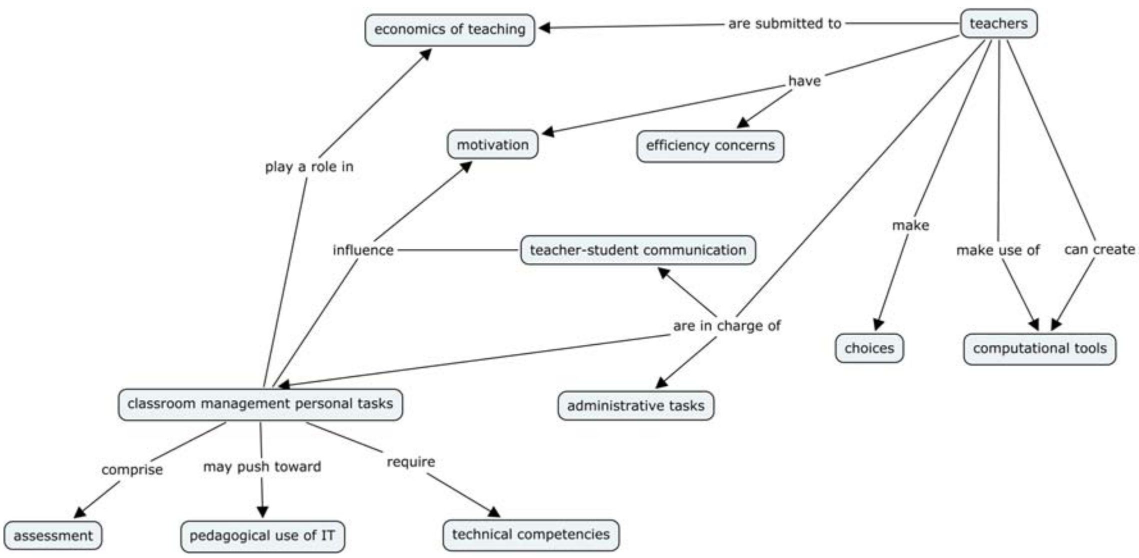

Figure 3: Partial conceptual map of the theme related to teacher motivation to promote teaching strategies that make use of IT

B. The social and ethical dimensions of using IT

Another theme developed solely by the experts interviewed concerns the social and ethical dimensions of using IT in teaching-learning (Figure 4). In the experts' discourse, it was proposed that IT be considered as a cultural phenomenon, influenced by economic, social and political issues capable, under certain conditions (accessibility, safety), of bridging the digital divide and alleviating certain social inequalities.

According to the experts, IT is approached like any other cultural phenomenon: primarily as a focus of beliefs and representations. These beliefs and representations mainly concern the use of IT in a teaching/learning context. Accordingly, the beliefs and representations held will influence the teacher-student relationship and affect the teacher's pedagogical choices.

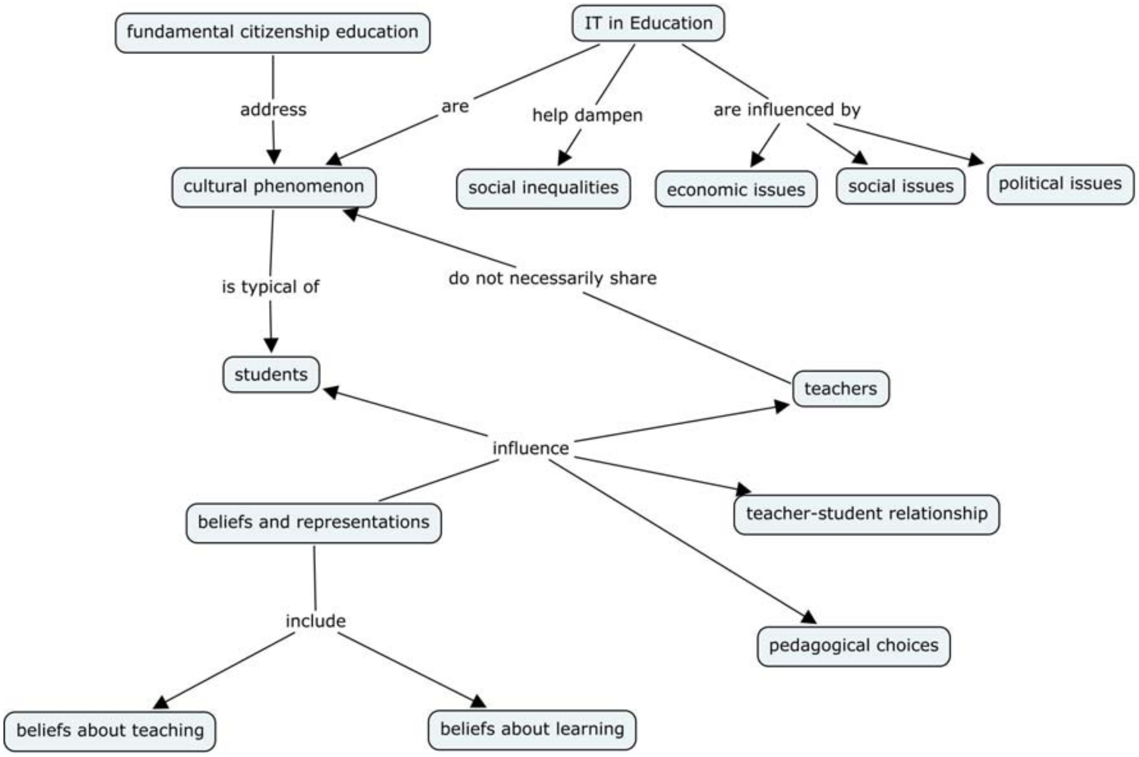

Figure 4: Partial conceptual map on the theme of IT as a social phenomenon that concerns the education and responsibilities of citizens

However, IT as a cultural phenomenon is not seen in the same way by teachers and by students; students are often more familiar with IT and build better IT devices. Approaching IT from a social and ethical perspective points to the importance of including mastery and responsibility in a citizenship education program.

4 ENRICHED HEURISTIC MODEL AND ANALYSIS GRID

A comparison of the empirical data and the expert knowledge data resulted in an enriched heuristic model. A first spin-off for the Québec college network was the building of an analysis grid that applies to teaching activities that make use of IT (see Table 3, below). This analysis grid helps reveal the interplay of the determining factors involved in experiments, as reported in teachers' accounts of practices or in projects.

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1. Are teachers motivated by the activity?
   a. Do they see or expect beneficial effects for their students?
      - Do they expect an improvement in academic results?
      - Do they expect an increase in academic motivation?
      - Do they expect greater in-depth learning?
   b. Do they see or expect that the activity will have a positive impact on their duties?
   c. Do they see or expect that they will be able to learn to use the techno-pedagogical devices effectively?
2. Is the scenario of the activity characterized by fine-tuned links between the teaching methods used and the objectives pursued?
   a. Are the objectives of the scripted activity consistent with those of the course?
   b. Are the objectives of the scripted activity consistent with those of the program?

c. Are the teaching methods used suitable for the objectives of the activity?

d. Do the evaluation methods and goals make it possible to verify whether the objectives of the activity have been attained?

3. If the teaching methods used in the scripted activity focus mainly on transmission of content by assigning a reactive role to the student and the transmissive role of content matter expert to the teacher,

   a. Do the techno-pedagogical devices induce performance learning or facilitate training, as educational games or drills can do?

   b. Do the techno-pedagogical devices have characteristics that stimulate student motivation?

   c. Are the techno-pedagogical devices differentiated and adaptive in such a way that they allow individual students to progress at their own pace, all the while experiencing their own challenges and successes?

   d. For the most part, are the techno-pedagogical devices used individually in the classroom or in the lab?

4. If the teaching methods used in the scripted activity focus mainly on conscious mastery of cognitive skills by assigning a proactive role to the student and the role of facilitator to the teacher,

   a. Do the techno-pedagogical devices require students to develop metacognition and to reflect on their work methods and learning, as tutorials or intelligent simulators can do?

   b. Are the techno-pedagogical devices primarily used individually in the classroom or in the lab, but also outside of these settings?

5. If the teaching methods used in the scripted activity focus mainly on the co-construction of socially meaningful knowledge by assigning an interactive role to the students and the role of moderator to the teacher,

   a. Do the techno-pedagogical devices support collaborative learning, as virtual training environments can do?

      - Are the teaching methods used in keeping with a project-based approach or a problem-based approach?

   b. Do the techno-pedagogical devices give access to external human (specialists, mentors) and digital resources?

   c. Are the techno-pedagogical devices useful in organizing group activities outside the classroom or lab?

6. Are the organizational conditions favourable to the activity?

   a. Does the institution where the activity is taking place have a plan for integrating IT into teaching/learning activities?

   b. Does the institution assign someone to act as a techno-pedagogical consultant for a significant portion of his or her duties?

   c. Are the computer hardware and software adequate for the techno-pedagogical devices used in the activity?

   d. Do users (teachers and students) have a high enough level of competence or skill to benefit from the techno-pedagogical devices used in the activity?

      - Is training on how to use the devices provided, where necessary?

   e. Is technical support available for the users (teachers and students)?

   f. If the teachers are not very familiar with the teaching methods involved in the scenario, is teaching support available to them?

7. Do the techno-pedagogical devices used in the activity tend to reduce sociocultural disparities (gender, social class, ethnocultural background) between their users?

   a. Does the activity promote a civically responsible use of the technologies?

b. Does the activity help bridge the gap between the students' and teachers' ability to use the technologies?

Table 3: Analysis grid showing teaching scenarios or activities that integrate IT into the classroom

Before it was used and validated by professionals in the college network, the analysis grid was already a valuable integrative tool. While this grid has definitively helped smooth the transition from scientific research and expert knowledge data to college teaching practice, as of this writing, the modeling and validation steps in the anchored theorization process (Paillé's steps 5 and 6) are still under way. In lieu of a conclusion, the following section presents the status of work in progress.

5 CONCLUSION: STATUS OF WORK IN PROGRESS

In steps 5 (modeling) and 6 (theorization) of the anchored theorization process, the principal researcher teamed up with members of the IT consultant community, whose main function is to support teachers and administrations of institutions in the network involved in IT integration into teaching. Now, the goal is to validate the key ideas that emerge from the heuristic model of the expert knowledge-enriched metasynthesis. In addition to agreeing to use and validate the grid presented above, these consultants also had the opportunity to carry out a shared cognition exercise on their professional practices that involves answering the following question: "In your opinion, what organizational conditions are likely to determine the effectiveness of the use of IT in your college classrooms?" The preliminary analysis of data collected to date from IT consultants reveals a certain number of concepts that are considered important, including the IT integration plan, financial resources, material resources, human resources and IT professional development for staff.

Data resulting from the various modeling activities carried out within the IT consultant community should reveal the divergences and convergences in the viewpoints of the stakeholders who experience IT integration into teaching/learning on a daily basis. The purpose here is to raise the level of theorization of these stakeholders and to bring about research projects aimed at advancing theoretical and practical knowledge in the field of IT integration into teaching at the college level.

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