Pedagogies of working with technology

Bernadette Charlier and Pierre-François Coen

Abstract

In this chapter, we first describe an innovative teacher training system that focuses on the uses of educational ICT at the level of a Swiss Canton and provide illustrations of its implementation. In the second part, we synthesize, from ten years of enactment, the main results of the evaluation of the effects of the particular training on students and teachers. A third part of our chapter discusses these results and proposes avenues of interpretation and possible actions. This approach sets out to highlight the positive aspects of this important experience so that it can be renewed and adapted in contexts different than our own.

Keywords

 Teachers training, Uses of ICT, system evaluation, Switzerland

1. Introduction

In Switzerland, as in other European countries, training teachers to use educational technology has been a major concern for over twenty years. In this respect, the French-speaking cantons have tried out a systemic model of interest that articulates initial training and continued training as well as formal training and training in the workplace. This is particularly the case in the Canton of Fribourg. In this chapter, we first describe the framework for this training model and provide illustrations of its implementation. In the second part, we synthesize the main results of the evaluation of the effects of the training on students and teachers. The third part of our chapter discusses these results and proposes avenues of interpretation and possible actions. This approach highlights the positive aspects of this important experience so that it can be renewed and adapted in other contexts internationally.

2. Learning to teach with technology: a global concept

One of the features of the training program that has been in place for nearly ten years in the Swiss canton of Fribourg is its integrated approach to training teachers to use information and communication technology in their teaching practices. This approach can be characterized by its goals, the learning process of which the teachers make use, and its institutional anchoring. The goal is that each teacher, in collaboration with colleagues, is able to develop the uses of ICT required to carry out a given educational

project in accordance with the curriculum. This development of teaching practices consists of designing lesson plans and sharing them on a virtual platform. The skills developed by teachers are not only technological; they are, above all, educational, media-related, social and reflexive. The learning processes that take place include action during classroom practice, interaction with peers during the set up and running of training sessions, reflection involving the review of practices in interacting with peers and resource persons (senior colleagues trained to support teachers in their schools) and the appropriation of knowledge from teachers or scientific theories during the formal training days. These methodological approaches that go beyond mere technology training have borne fruit in the past in many systems enacted in French-speaking Belgium and on a European level (Charlier, Daele, Deschryver, 2002). The environment developed in 2001 by " fri-tic" – abbreviation standing for the "integration of information and communication technology in the Fribourg schools" (Grandjean & Vaucher, 2001) – is a global, systemic and coherent concept for the whole of the Canton ranging from kindergarten to initial and ongoing teacher preparation. This concept was based on three interrelated pillars: 1) the education and preparation of teachers organized into several groups (teacher trainers, resource persons, those responsible for subject areas and teachers), 2) teaching resources whether human or material, including people working in schools and in a cantonal competence center (the fri-tic center responsible for coordination) and finally 3) facilities in schools and the fri-tic Centre. The project originally planned for six years continued until 2008.

3. A concrete and lively environment

Over the years, the proportion of teachers prepared in the educational uses of ICT has increased from roughly 20% to 95% today. The infrastructure has greatly improved and resource people are present in all schools. The fri-tic Centre continues to coordinate tasks, monitoring and training. Its virtual platform (See Figure 1) is now the scene of a considerable drive to develop educational resources produced in collaboration with teachers. In the new curriculum adopted by the French-speaking cantons of Switzerland these resources support the use of media, images and ICTs http://permitic.friportail.ch/.

Figure 1: Screenshot of friportal website (http://www. Friportail.ch)

4. Evaluation and research: an environment under the microscope

Alongside this implementation, Fribourg University and the Fribourg University of Teacher Education, as institutional project partners, carried out research and evaluation of the initiative. The cantonal authorities entrusted Fribourg University (Prof. Bernadette Charlier) with the evaluation and regulation of the inservice teacher-training environment and the environment of resource persons. The Fribourg University of Teacher Education (Prof. Pierre-François Coen) carried out several additional studies (Coen & Schumacher, 2006; Schumacher & Coen, 2008; Rey & Coen, 2013; Coen, Rey, & Monnard Jauquier, 2013). Funded by the Swiss National Fund for Scientific Research, these studies evaluated the effects of the overall environment on teacher practice and student learning. These studies were conducted between 2006 and 2013, and were based on several data sources involving more than 2,000 teachers and 3,000 students. Organized around both quantitative (questionnaires on digital literacy, on practices of ICT integration, on training in this area) and qualitative approaches to educational inquiry (interviews on the integration of ICT, and on strategies of training,

support and assistance), they reached a wide audience representative of the teaching and student population of the Canton of Fribourg.

In what follows, we present the main results of this research, articulated around the following research questions: 1) From the pupils' perspective: What are their uses of ICT in the classroom? What is their perception of the value of technology in learning? 2) From the teachers' perspective: What are their skills in ICT integration, and how have these evolved? How have the uses of ICT reported by teachers progressed in the classroom? What is their perception of the training offered and of their formal and informal learning practices concerning ICT usage?

It is regrettable that this research was not originally envisaged as a concerted and systematic assessment of the overall project. However, it still offers several possible interpretations that can guide the practice of training and support of ICT use. We will discuss this at the end of the chapter.

4.1. The students' perspective

In this section, we concentrate on three important considerations from the students' point of view. The first deals with the use of ICT in the classroom. The second shows the educational perspective in which the use of ICT fits and the third highlights factors that may influence student motivation.

Students' classroom use of ICT

As part of a study conducted between 2006-2008, Coen and colleagues (2013) sought to identify the classroom uses of ICT as reported by students. The survey, based on the students' perceptions, collected data about teachers. The most used activities are the search for information, the use of presentation software by the teacher and word processing. The use of mail comes in fourth position and is much more present in higher levels of schooling. In comparison, use in primary school is still very marginal. However the opposite is true of the use of software to support the production of a website or audiovisual projects. Note also that the use of tools or software to trace or record student activity is virtually non-existent. In general, the main uses (information retrieval, text processing, presentation software) cited by students corroborate with those tools found in the literature and confirm what teachers say. The study has shown, in contrast, that students perceive no difference in ICT usage between males and females in contrast to what is often reported in the literature.

Pedagogical orientations linked to ICT

This research has not only led to the identification of ICT uses, but also to relating them to two educational paradigms (Tardif, 1998). The first (instructivist) revolves around the teacher. It focuses on student productions and controls the activity, the knowledge transmitted and the feedback mechanisms. The second (constructivist) considers that

the student is at the center of the teaching-learning process. In this paradigm, the teacher is more interested in the learning process and acts as a resource available to students with a view to maximizing their autonomy. Researchers found that electronic correspondence and educational projects (websites, books, pictures) are the most learning-oriented uses. Internet research, simulation or software for exercises lie midway between the two paradigms and may accompany an instructivist or a constructivist approach. The use of an online platform is clearly an instructivist-oriented paradigm. Analysis in terms of academic levels shows that ICT integration in a constructivist perspective is the most prevalent at the end of primary school. This is probably because at that level student autonomy is sufficient and the form of school organization allows for longer, interdisciplinary projects. In comparison, neither disciplines nor the gender of the teacher play a significant role. Note that the more ICT is used in class, the more uses shift to a learning paradigm. This interesting result may indicate that the degree of familiarity of the teacher with technology is a key factor in gradually allowing him or her to try more innovative approaches and even change some teaching practices.

Student motivation

To analyze the impact of the integration of ICT on student motivation, a causal analysis was conducted as part of this study (Coen et al., 2013). It seems that students' willingness to learn is largely determined by the attractiveness of ICT, which in turn is influenced - in a proportion of one to two - by students' sense of their technological competence and by four dimensions of the educational paradigm. In other words, the following factors have a positive effect on student motivation: the creation of learning situations that integrate ICT into a constructivist perspective by sharing the responsibilities of learning between students and teacher; the shifting of the teacher's expertise to students; the importance granted to the integration of knowledge rather than its restitution; and the extensive handling of technologies by students. Used in this way ICT can act as an attractive means of developing student motivation in the classroom context.

However, another study (Rey & Coen, 2011) sets these results in perspective. This research, carried out with a hundred upper secondary school students, indicates that learners have mixed views on the benefits of ICT in learning. Students recognize the playfulness and the novelty of such devices and agree on their effectiveness in quickly finding information or translating a word, but they think that their contribution to learning is not direct and immediate. Nearly a quarter of them believe that the distractive nature of technology might even reduce their school performance as measured in terms of the success of school tasks requested by their teachers.

4.2. The evolution of teachers' competences

In this section, we present the results of research based on the teachers' perspective. Initially, we distinguish between private and professional use of ICT. We then discuss the evolution of technology integration in schools and the increase of perceived competence in ICTs. We conclude this section by presenting results focused on training methods and their assessment by teachers.

Private and professional use of ICT by teachers

In a longitudinal study involving more than 1,000 teachers of Fribourg between 2006 and 2012, Pineiro, Rey and Coen (2012) show that the time spent on the Internet by teachers is increasing significantly. In 2006, no teacher estimated spending more than 10 hours a week on the Internet. In 2012, nearly 40% did. In addition, one in ten teachers (9.4%) estimated spending more than 20 hours a week on the web.

Professional use of ICT by teachers has also evolved during this period. In 1999, 10 to 20% of teachers replied that they used ICT with their students. In 2006, 71% said they used ICT mainly in class time. In 2012 this figure rose to 87%. Uses focused mainly around professional email (89% consult their email once to several times a day) and information research (25%) for course preparation. 38% consult YouTube once or more a week. In comparison, three quarters will never or rarely visit blogs, 80% do not use a podcast and less than one percent play games online. In addition, it would seem that, from a professional perspective, social networks are rarely used by our respondents.

The integration of ICTs by teachers

The research conducted by Coen in the canton of Fribourg was also designed to measure the degree of penetration of technological innovation in the classroom in relation to the implementation of the comprehensive teacher-training program led by the fri-tic Centre. Based on the work of Depover and Strebelle (1997), the scale of penetration has 5 levels from 1 (level of implementation) to 5 (level of routinization). In six years, the increase was statistically significant, increasing from 2.19 in 2006 to 3.29 in 2012. In addition, the difference between males and females, which was significant in 2006, was considerably reduced. There also has been a significant increase in the penetration of ICTs with teachers over 56 between 2006 and 2012 Note that the differences between the various levels of education decrease over time. A statistically significant difference found between primary teachers (grades 6 to 12) and secondary teachers (students aged 13 to 16 years) in 2006 had disappeared by 2012. Thus, in general, we can say that techno-pedagogical innovation is progressing in the canton of Fribourg.

This positive development is consistent with the level of technical expertise of teachers. In 2012, the study shows good knowledge of widely-used office tools (word processing, spreadsheets and presentation software). Learning platforms are in second position; a

pleasant surprise compared to the 2006 results. In contrast, more specific tools for montages and film editing are less well understood. In terms of self-assessment of technical skills, the gap between men and women between 2006 and 2012 widened. While gender explained 10% of the variance of perceived competence in terms of technical mastery in 2006, this factor rose to 12% in 2012. However, the age factor became insignificant. In 2006, age significantly influenced the impression of technical mastery, whereas in 2012, this factor was no longer significant.

Attitudes and impressions of competence with ICT

This progress of technical mastery is accompanied by positive changes in teachers' general attitudes toward ICT between 2006 and 2012. There is a statistically significant increase in responses evoking the interest of ICTs for teaching (+ 0.61), the pleasure of using them (+ 0.58), their inescapable presence in our time (+0.50) or their pertinence for learning (+0.37). At the same time, there has been a substantial and statistically significant decrease in responses related to a lack of understanding of their use (-0.44) or about their lack relevance (-0.24). In 2012, teachers feel more able to help their students in activities integrating ICT and to manage the class or solve technical problems, despite relatively large deviations indicating some heterogeneity of these skills. Note also that teachers who were consulted in 2012 think they are better able to measure the educational potential of ICT. On a scale of 1 to 5, the evolution of this skill increased from 2.9 in 2006 to 3.6 in 2012 and the gap between men and women shrank from 0.6 to 0.4. Teachers reckon they are better able to perceive the advantages and disadvantages of technologies (+0.68); they believe they have a better overview of their educational potential (+0.72); and finally, they think they are better able to effectively help their students to use ICT to learn (0.80).

The importance of learning environments

The positive evolution of these various elements is due to several factors (omnipresence of technology in everyday life, simplification of devices, etc.), but in particular to the training developed by the fri-tic center in Fribourg since 2003.

A portion of the research carried out with 31 primary and secondary teachers by Rey and Coen (2013) sets out to analyze the characteristics of this training and its impact on teachers. The results show that they have developed their techno-pedagogical skills through the complementarity of formal (courses in the training institution) and informal (in school or at home) training. Respondents argue that formal training provides the basics, but is not enough and is not always adapted to different contexts. They recognize the quality of the training, but stress that it doesn't always fit practices in the working environment. These interviews point to a need to: 1) take the needs of the field even more into consideration, 2) emphasize the creation of timely resource networks in the field, 3) incorporate training in self-study in formal training, and 4) offer training activities similar to those to be carried out in class with students (increased

isomorphism). These results show the relevance of a systemic model of education providing, among other things, resource persons in the field who are able to respond to these demands.

Teachers' view of the training provided

For most teachers, the willingness to learn is anchored in personal interest (4.27 out of 5). However, 35% of teachers underline the importance of hierarchical directives among the reasons that led them to learn about ICT integration in education. 20% believe that their personal motivation was not central in their decision to train in the integration of ICTs. When asked where they were trained, informal contexts (self, environment, colleagues) come out well ahead. These results corroborate those obtained in the qualitative part of the research. Note, however, that 36% of teachers feel they developed skills in initial training and 45% in ongoing training. Comparing the level of technical skills in the different training environments, researchers noticed that the higher the skills the more they were developed in informal settings. This is particularly true for word processing, for the use of PDAs and tablets for the treatment of images, working with online applications (google-doc), and, to a lesser extent, for presentation software and spreadsheets. There is, however, no correlation for tools used to create Web pages, for the use of podcasts, and for the processing of sound or motion pictures. When it comes to handling learning platforms that are particularly developed in formal situation, the correlation is negative.

In the quantitative part of the research, Coen and Melfi (2013) captured teachers' perceptions of training courses attended between 2003 and 2012. More than 2000 teachers responses to a questionnaire and, in general, their assessment of training is positive. On a scale of 1 to 5, teachers consider the training as: useful in practice (3.61), meeting their expectations (3.44), well designed pedagogically (3.37), adapted to their skill levels (3.33) and to the infrastructure available in the field (3.21). According to the teachers, the most important criteria for effective ICT preparation is the portability to the field of content learned in training and the fact that training provides practical answers to their needs. However, satisfaction decreases gradually as one moves to higher levels of education.

The nature of aid and strategies used to solve problems are interesting indicators of teacher perspectives on training. Among other things, Coen and Melfi (2013) studied how teachers dealt with technical or educational problems. Results show that respondents begin by trial and error, which is more or less successful. Such a strategy dominates and is mostly used by females. In terms of order of importance, it is followed by the use of online help and forums, which are mainly used by males, as are the consultation of online video or reference books. When teachers are overwhelmed by a technical problem and seek help, they first turn to a person close to them (3.57 out of 5). This is especially true for infant and primary school teachers. They next consult

resource persons and colleagues (3.26) who tend to be sought out most by teachers at lower secondary level. In comparison, heads of training centers, computer scientists and students are rarely solicited. The person with expertise provides help, above all, in the form of demonstrations (3.65 out of 5) accompanied by a practical explanation. Situations where the teacher who has unresolved questions remains in control have a score of 2.95 (out of 5). Cases where the expert provides different resources (online help, books, internet links) received a score of 1.94. This is relatively low even though this strategy ought to develop learner autonomy. Finally, solving the problem in lieu of the person with the difficulty scores only 1.41. Note that significant differences exist between the genders. Female teacher more often relinquish their place to whoever is helping them, thus losing control, and make significantly less use of documents than male teachers.

5. Discussion: what should we retain for the future and other contexts?

5.1. What should we retain from this project?

Over 95% of teachers are trained in classroom use of ICT and nearly 85% say they use them in class. The differences between levels of education and between women and men teachers have diminished. Uses have gone up both in quantity and in quality: more diversification, increased emphasis put on student learning. These can be associated with increased student motivation. However, many questions remain open. These should guide the implementation of similar projects.

First, if these positive results can undoubtedly be credited to the global concept developed by "fri-tic" in 2001, the positive feedback observed cannot be interpreted as a direct consequence of this concept. Indeed, as we noted earlier, this concept did not initially include scientific research to evaluate it in its entirety. This is an important point and, of course, a recommendation for other similar projects or those of a similar magnitude. We will return to this point later.

In addition, the needs of ICT use have changed since 2001. The initial project contained training objectives in media. At the lower secondary level, for example, there was the following objective: "The student understands ICT as a social and economic phenomenon and is aware of the possibilities and risks" (Grandjean & Vaucher, 2001, p.13). Such needs have grown and developed with the emergence of phenomena like plagiarism, social networks and cyber-harassment. How will the environment change? How should it change?

5.2 What surprises?

If the above picture is more than positive, we can then ask ourselves questions about a number of effects that have not been sufficiently highlighted.

Training should bring about more collaboration between teachers

Although this implication was not a specific question raised, teacher collaboration on joint projects and exchange of best practices among peers could have increased due to the presence of resource persons, but also because of the push to produce, share and reuse learning scenarios. What about this collaboration? Shouldn't the initial concept be expanded to systematically provide more opportunities for exchange between teachers as well as more means to do so and a greater appreciation of their production of scenarios and their reuse of those produced by others? Shouldn't these courses lead to teachers developing ways and means of developing each other?

Training should lead to more innovative practices

The training provided by the fri-tic Centre insisted on making learning scenarios, but in practice, it seems that some teachers did not formally script the sequences they give students (Bouverat & Theytaz, 2014). They often implicitly follow the instructions given by the manuals, books and official guidelines. In this sense, the integration of ICT is often presented as a veneer added to traditional practices, rather than a vector for innovative educational approaches. That is why the Fribourg school authorities offer teachers educational resources (teaching aids) imbedded in the disciplines (didactics) with technology (see: http://permitic.friportail.ch/)

Support needs should evolve

In the 2001 project, schools were required to explicitly request support. In 2014, this form of support is still present although it is organized differently in primary and secondary schools. In the former case, a group of resource people share a set of institutions, while, in the latter instance, resource persons are present in each school building. Often teachers envisage these people intervening at a later stage (after searching for solutions themselves or with relatives) but primarily to resolve technical issues. If these practices are both rich and varied, they also deserve further reflection. This reflection is currently underway but from the perspective of transferring this experience to other contexts. It seems important that the assistance provided to teachers should evolve and vary according to needs. Thus, resource people could be given the role of research practitioner accompanying groups of teachers while documenting and analyzing the innovative practices implemented. These steps would stimulate the sharing between teachers we mentioned earlier and provide useful data to assess the environment.

Representation of the resource person

Resource persons should focus more on long-term support with fewer teachers. The image of "troubleshooter" they have with teachers could evolve and change into that of a "companion", a partner in the success of innovative projects. Teachers could then rely on colleagues who would design and carry out teaching scenarios with them (co-education) and who would contribute to the development of their techno-pedagogical skills.

5.3 Which ways forward?

A global concept integrating ICT in education across a region, a canton or a country is undoubtedly essential for an efficient education policy. The fri-tic project is a good example. Thus any proposed integration of ICT, like in the canton of Fribourg, should rely on three pillars: training, technical and human resources and infrastructure. However, we would add a fourth, which provides a more stable foundation and, above all, facilitates the development of the project over time and as required. This fourth pillar is research. Indeed, with such a project involving considerable investment in both people and equipment, only a coherent research program designed from outset of the project would enable its evaluation and steering. Finally, this research program should allow international comparisons through the concerted use of methods and instruments for joint research.

5.4. Implications for Teacher Education

What we have learned from our ICT practices and research with in-service teachers in the Canton of Fribourg, leads us to recommend the following suggestions for the ICT preparation of preservice teachers. The first is to ensure multimodal ICT literacy among preservice teachers. Today students have good technological skills, but often in very narrow areas. They have difficulty to treat and evaluate complex ICT uses relevant to education. On the other hand, most of them do not integrate digital technologies to support their own learning. The second track is to intensify the integration of ICT in preservice training. The professors of future teachers offer too rarely learning situations in which technologies play an important role. As a result, students are not immersed in meaningful situations where they can live "from inside" the contributions of ICTs. Finally, it would be necessary to spare, during preservice programs, self-study learning time to be prepared to develop less dependency on resource persons, but also to spark educational creativity. We believe that it is crucial that teachers learn to find themselves the levers of their own learning and development. This seems particularly essential at the level of ICT as technical innovations evolve very quickly. Therefore, students should

learn to develop their capacity to integrate ICT in in their teaching practices and to contribute to researches in this domain.

6. References

Bouverat, M. & Theytaz, C. (2014). *Introduction d'un mode de BYOD : quand les individus choisissent le métissage des instruments comme ajustement pragmatique*. Mémoire de master non publié. Genève: Faculté de psychologie et des sciences de l'éducation, Université de Genève.

Charlier, B., Daele, A. et Deschryver, N. (2002). Introduire les TICE dans une pratique d'enseignement, une question de formation *? Revue des Sciences de l'Education*, Sherbrooke, Canada.

Coen, P.-F., Rey, J., Monnard, I. & Jauquier, L. (2013). Usages d'Internet à l'école selon le regard des élèves. Pratiques d'intégration, paradigmes pédagogiques et motivation scolaire. *Sciences et technologies de l'information et de la communication pour l'éducation, 21*.

Coen, P.-F. & Melfi, G. (2013, 21-23 août). *Profils d'apprentissage des enseignants en matière de TICE à partir de l'analyse des procédures de résolution de problèmes techniques et pédagogiques.* Papier présenté au Colloque de la Société suisse de recherche en éducation, Lugano.

Coen, P.-F., & Schumacher, J. (2006). Construction d'un outil pour évaluer le degré d'intégration des TIC dans l'enseignement. *Revue internationale des technologies en pédagogie universitaire, 3*(3), 7-17.

Grandjean, CL., Vaucher, G. (2001). MESSAGE N° 305 accompagnant le projet de décret relatif à une conception générale de l'intégration des technologies de l'information et de la communication dans l'enseignement, à tous les degrés de la scolarité. http://www.fri-tic.ch/dyn/bin/31275-31337-1-message-fri-tic_final.pdf (consulté le 1 Septembre 2014).

Depover, C. et Strebelle, A. (1997). Un modèle et une stratégie d'intervention en matière d'intégration des TIC dans le processus éducatif. Dans L.-O. Pochon et A. Blanchet (dir.), *L'ordinateur à l'école : de l'introduction à l'intégration* (p. 73-98). Neuchâtel, Suisse : Institut de recherche et de documentation pédagogique (IRDP)

Pineiro, C., Rey, J., & Coen, P.-F. (2012, 3-5 mai). *Eléments-clés des formations des enseignants à l'usage des technologies*. Papier présenté au Colloque scientifique international sur l'intégration des TIC en éducation: bilans, enjeux et perspectives futures, Montréal.

Rey, J., & Coen, P.-F. (2013, 2-3 mai). *Approche systémique des formations continues à l'intégration des TIC : entre formel et informel.* Papier présenté au Colloque du GRIFPE, Montréal.

Rey, J. & Coen, P.-F. (2011). Regards croisés entre professeurs et élèves sur l'intégration de l'iPod Touch comme outil d'apprentissage. Premières expériences et perspectives futures. *Frantice, 3*, 6-18.

Rey, J. et Coen, P.-F. (2013). Evolution des attitudes motivationnelles des enseignants pour l'intégration des technologies de l'information et de la communication. *Formation et profession*, 26-44.

Schumacher, J., & Coen, P.-F. (2008). Les enseignants fribourgeois face aux TIC: quelle alphabétisation, quelle(s) intégration(s). *Formation et pratiques d'enseignement en questions, 7*, 51-71.