

# **Enhancing pre-service teachers' knowledge building discourse with a hybrid learning environment**

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## **Abstract**

The main objective of this design experiment (Brown, 1992; Collins, 1999) was to evaluate the characteristics of a hybrid learning environment (onsite/online interactions) for knowledge building (Scardamalia & Bereiter, 1994) purpose during a practicum where pre-service teachers needed to tackle a pedagogical and technological innovative context. The concept of affordance (Gaver, 1991; Gibson, 1979) was helpful to understand how participants interacted with the characteristics of the environment. Research results are coming mainly from qualitative analysis and they illustrate how onsite and online interactions can combine to create a collaborative learning environment enhancing pre-service teachers' knowledge and skills.

## **Keywords**

hybrid learning environment; pre-service teachers; knowledge building; network learning; collaboration

# Enhancing pre-service teachers' knowledge building discourse with a hybrid learning environment

## Introduction

The learning sciences (Bransford, Brown & Cocking, 1999; Sawyer, 2005) emphasize both cognitive and social processes in learning thus calling for changes in the way we approach teaching. In the Province of Québec, Canada, an educational reform is underway, one that promotes in particular a socio-constructivist perspective as an epistemological foundation. Professional development and reflective practice are recognized as a key part of any innovation strategy (Guskey, 1995, Fullan, 1993; Lieberman, 1996; Little, 1993).

Information and communication technologies (ICTs) offer promising possibilities to this end (Kollias & Kikis, 2005; Putnam & Borko, 2000; Voogt & Knezek, 2008) because they offer great potential for collaboration purposes (UNESCO, 2008) and can be used to tighten university-school relationship, an important characteristic for bringing coherence into an educational innovation process (Holmes, 1990). Our own research work is anchored in such a partnership that focuses on the use of collaborative technologies in classrooms where each pupil has his/her own laptop connected to the Internet (networked classrooms). These elements contribute to transform the learning environment into a hybrid mode, one characterized by onsite and online interactions. In this context, new practices are likely to emerge and unforeseen challenges to arise, especially for pre-service teachers. At the dawn of the knowledge age, it seems crucial to learn from each other and to reinvest what has been learnt for collective professional gains to be made (Bereiter, 2002).

For preparing students to deal with realities of the knowledge age, teacher communities are called to update their collective repertoire of practices. With such considerations in mind, we designed a hybrid learning environment to support pre-service teachers during their field experiences and student teaching in the networked classrooms of a secondary public school (technology-supported program). Our research development design aimed at fostering collaborative reflective practice (Schön, 1983), considering such an unfamiliar and challenging classroom context for each of them, and knowledge building (Scardamalia and Bereiter, 1994) considering the novelty of such a working context for teachers as a professional community. These are key processes for knowledge improvement, individual and collective.

As researchers, our main concern about the relevance of the design regarded the ways it supported knowledge building. Thus, the following specific research questions were investigated:

- Which possibilities of the hybrid learning environment, among those designed to foster knowledge building, were acknowledged by pre-service teachers?
- How did the knowledge building online discourse unfold?

Design being an intentional activity, our working hypothesis as researchers was that the intended hybrid learning environment would support knowledge building.

## **Theoretical framework**

Sociocultural perspectives on cognition (Vygotsky, 1978; Rogoff, 1994; Wertsch, 1998; Lave & Wenger, 1991; Wells, 1999) stress that learning occurs through interactions among individuals where tools, objects and artifacts operate in various systems in their environment. We designed our hybrid learning environment being inspired by these perspectives.

The concept of affordance (Gibson, 1979; Norman, 1999) was central to understand how participants interacted with specific characteristics of the environment. We adapted Gaver's (1991) distinction of different types of affordances (perceptible affordances, hidden affordances, and emergent affordances). They describe interactions taking place between a designer's intention and a user's perception. A perceptible affordance is a feature of the environment that is perceived in the same way as intended by the designer. A hidden affordance is a designed feature that is not perceived at all by users whereas an emergent affordance is an affordance that is perceived by the user but one that was not purposefully intended by the designers.

Thus, we wanted to link our intentional design activity with the users' actions, to examine different kinds of affordances, digital and social. Digital affordances designate features that support human-machine interactions whereas social affordances surround human-human interactions when onsite/online synchronous and asynchronous activity is occurring in a hybrid learning environment (Kreijns, Kirschner & Jochems, 2002; Bradner, 2001; Bielaczyc, 2001; Little, 2003; Kozma, 2003). By referring to affordances, we were able to unite design and intervention in a concrete way. In design mode, we have not only considered our point of view, but also the user was considered a participant with his/her own point of view. Within such a framework, one understands that what is going on in a learning environment is not the result of the designers and/or teachers only, but of all participants' interactions (and non-interactions). The intervention mode aimed at the design of social and digital affordances that were to support and scaffold, in particular, knowledge building *"defined as the production and continual improvement of ideas of value to a community, through means that increase the likelihood that what the community accomplishes will be greater than the sum of individual contributions and part of broader cultural efforts."* (Scardamalia & Bereiter, 2003, p. 1370). This process thus refers to deliberate idea improvement for one's local professional community's collective knowledge and beyond.

## **Methodology**

The design research methodology (Brown, 1992; Collins, 1999; Kelley, Lesh, & Baek, 2008) is recognized as well suited for educational innovation and was judged proper for the context of this study. We conducted three iterations, in quest to progressively improve our pre-service teachers program for supporting knowledge building discourse.

## **Design of socio-digital affordances**

*Social affordances.* Social affordances were primarily the result of onsite/online interactions in a knowledge building context. They were available before, during and after the field experience or student teaching. In the design of any teacher education program, connection and coherence matter (Darling-Hammond & Hammerness, 2005) as they combine to provide a clearer and stronger picture of what defines the education profession. In our design, connections between university-based and school-based teacher educators and discourse coherence when sending messages to pre-service teachers were manifest in the following social affordances: similar classroom practices (constructivist pedagogies), proximal languages (collaborative project-based learning, problem-based or inquiry-based learning, network-enabled learning community, self and peer-evaluation and, to a lesser degree, knowledge building pedagogy were voiced concepts, notions, and processes), similarity of tool use (ICT integration), common attitudes towards reflective practice and collective idea improvement.

Ideas that pre-service teachers had already contributed and were going to contribute to the electronic forum (Knowledge Forum) were recognized as another form of social affordances, and so were annotations by either peers or teacher educators. In all three iterations of our design, the same university-based teacher educator and the same doctoral student participated in the online discourse. From one pre-service teacher cohort to the next, participants had access to previous cohorts' online discourse and other learning/knowledge building artifacts. The design intention was for them to add their own contributions to their community's understanding of a networked classroom. Thus, the second iteration made available to pre-service teachers' views (a view is a collection of notes on Knowledge Forum) developed by former pre-service teachers, and so on for the third iteration.

Moreover, beginning in the third iteration, a new social affordance was added to the hybrid learning environment: graduating pre-service teachers joined the online discourse. This design decision like the ones mentioned above were made to provide an increasingly coherent environment that would afford more interaction possibilities and uncover new affordances for the renewal of pre-service teacher education.

*Digital affordances.* For the purpose of this paper, we concentrate here on electronic forum's digital affordances. Knowledge Forum was chosen for its diversity of affordances, especially designed to support knowledge building discourse and to encourage a community of people to write and improve ideas by building on one another's contributions and revising their own in order to produce ideas of value to others, and advance their collective knowledge.

A first key digital affordance of Knowledge Forum is its hard scaffolds feature (Bereiter & Scardamalia, 1982; Brush & Sayes, 2002; Vygotsky, 1978). Each time they were to write a contribution to the forum, pre-service teachers would have the possibility to qualify its content by selecting a specific scaffold. One main set of scaffolds, based on the knowledge building principles (Scardamalia & Bereiter, 2003), was available. During all three iterations, pre-service teachers were offered this set.

Other digital affordances of Knowledge Forum were the following ones: participants could visually organize notes in neuron-like shapes (as opposed to the threading shape found in more

conventional forums), a more flexible way to organize the collective discourse. By this means it was possible for them to move notes in the online collaborative space to create regroupings according to specific themes, questions, etc. This allows a more dynamic way to interact with ideas, to make clusters, and to take into consideration emergence and non-linearity.

Moreover, the view creation option was to create a collection of notes into distinct sub-spaces of discussion. This was another way for participants to organize their online collaborative space according to emergent goals and achievements. The problem definition feature offered them the possibility to identify the problem being investigated. The keyword feature called attention to the identification of key terms during note writing. The quotation feature offered the possibility to reference another's contributions. The co-authoring feature offered the possibility for a few authors to co-write a note. Publishing a note was also an affordance, thus allowing specific contributions to be recognized as knowledge advancement. The rise-above feature allowed for synthesis to push ideas forward and, therefore, movement beyond current thinking in a dialectic manner. That is to say the rationale underlying Knowledge Forum reflects a dynamic similar to the one of a research team/community where people try to advance ideas and knowledge of value to others. Knowledge Forum's affordances have been designed along this rationale.

Table 1 synthesizes all affordances (social and digital) of the design research.

| <b>Iteration 1</b>  | <b>Iteration 2<br/>(in addition to those of iteration 1)</b>   | <b>Iteration 3<br/>(in addition to those of iterations 1 and 2)</b>   |
|---|--|---|
| <ul style="list-style-type: none"> <li>- Proximal languages between school and university (social)</li> <li>- Similar classroom practices between school and university (social)</li> <li>- Valorization of reflective practice and idea improvement (social)</li> <li>- On-site (information interactions and reflective seminars) and on-line (Knowledge Forum) discourse between pre-service teachers, university-based teacher educator and doctoral student (social)</li> <li>- Knowledge Forum features to support on-line discourse (digital)</li> </ul> | <ul style="list-style-type: none"> <li>- Access to previous cohort's online discourse and other artifacts (digital)</li> </ul> | <ul style="list-style-type: none"> <li>- Participation of graduating pre-service teachers to online discourse (social)</li> </ul> |

Table 1. Socio-digital *affordances for iterations of the design research*

## Participants

All participants were registered in a four-year integrated baccalaureate program in secondary education. They all did their field experiences in the same secondary school. From the fall session of 2002 to the end of the 2005 winter session, forty-five pre-service teachers (nine cohorts) did their field experiences (10 dispersed days, 5 weeks in a row or four-month duration) in a networked classroom (Table 1).

| <b>Field experiences/<br/>student teaching</b>         | <b>Iteration 1 of the<br/>design research</b> | <b>Iteration 2 of the<br/>design research</b> | <b>Iteration 3 of the<br/>design research</b> |
|--|---|---|---|
| <b>Early field experience<br/>(ten dispersed days)</b> | 4 pre-service teachers                        | 7 pre-service teachers                        | 0 pre-service teacher                         |
| <b>A five-week long field<br/>experience</b>           | 6 pre-service teachers                        | 5 pre-service teachers                        | 6 pre-service teachers                        |
| <b>A four-month duration<br/>student teaching</b>      | 6 pre-service teachers                        | 6 pre-service teachers                        | 5 pre-service teachers                        |

Table 2. *Pre-service teachers' distribution according to iterations*

All field experiences started with an orientation meeting led by the university-based teacher educator and the doctoral student. Goals were discussed and the networked community as a whole (university-based and school-based networked classrooms) was presented. All through their field experience and beyond, they contributed to Knowledge Forum.

Besides the curricular objectives attached to such activities, the advanced pedagogical intention was for these pre-service teachers to join a collective endeavour focusing on understanding highly networked classrooms, such as changes in classroom management, engagement of pupils, teaching and learning dynamics, and so on. They were required to demonstrate reflective practice in their online discourse but engaging in knowledge building was optional. While the former was one element of the official curricular objectives, the later was not, and it was considered very important that students be intentional and self-determined inquirers.

## Procedures

The three iterations of our design unfolded in a similar way. Each started in August and finished late April or early May. Fourth-year students' four-month student teaching started at the end of August and ran until December. In late September, second-year pre-service teachers doing early field experiences joined the same hybrid learning environment for 10 dispersed days, at a rate of one day per week. Beginning in late January, there was a group (third-year students) doing the five-week long field experience. All pre-service teachers were physically in the same school, teaching in the same technology-supported program, i.e. classrooms operating as networked learning communities, and they interacted together onsite, informally and during reflective seminars. The longer the practicum was, the more they assumed teaching in the networked classroom. Moreover, they were all working online in the same Knowledge Forum database for reflective practice and idea improvement purposes. Each group had its own startup view on Knowledge Forum, but as stated earlier, it was possible for participants of iterations 2 and 3 to read all the other views available in the database.

## Data gathering and analysis

Two individual interviews and participant observations were conducted to inquire into when and how pre-service teachers perceived affordances of the hybrid learning environment (research question 1). Interviews were done at the beginning and at the end of the field experience. Participant observations occurred in two ways, i.e. animation of onsite reflective seminars, during which field notes were collected by the doctoral student, and contribution to online discourse and its analysis using Knowledge Forum embedded analytic tools.

To document knowledge building discourse (Bereiter & Scardamalia, 1993) (research question 2), we analyzed in an inductive manner specific discourse sequences on Knowledge Forum, i.e. notes linked to one another by participants themselves.

## Results

### **Research question 1: Which possibilities of the hybrid learning environment, among those designed to foster knowledge building, were acknowledged by pre-service teachers?**

The first part of the results is aligned with our adaptation of Gaver's (1991) understanding of affordances.

#### *Perceptible affordances*

As regards the perceptible affordances present in the designed hybrid learning environment, results showed that 75% of all intended socio-digital affordances were perceived, of which 64% were acknowledged from almost the very beginning of the field experience.

*Participants acknowledged social affordances.* Social affordances were acknowledged more quickly than digital ones, i.e. they were perceived at the very beginning of the field experience. Most of the acknowledged social affordances were aligned with the designers' pedagogical intentions. For instance, the designers wanted to provide an environment to raise the level of pre-service reflective discourse, and de-contextualize participants' thinking about their own onsite experience. This participant's statement is illustrative of such recognition: "Participation in the forum helped us take another look at what was going on in the classroom. It's like we were out of the context... but at the same time we were still talking about it."

*Participants acknowledged socio-digital affordances that were visually most salient.* These most visually salient features of the database were first acknowledged. All participants contributed to the database (778 contributions were made; 17 contributions and 14 pages of 500 words per page per participant in average), meaning the electronic forum was successful to support extensive collaborative reflective and knowledge building discourse, from a quantitative perspective. Students were also able to qualify their writing intent using the scaffolds (1303 in total; 1.67 per note in average) and to add one or more keywords to their notes (more than one per note on average).

Participants acknowledged online social affordances to be more useful than onsite social affordances for engaging in collaborative reflective practice and knowledge building. All pre-service teachers stated that explicitly when asked to compare both dimensions of their hybrid learning environment. A striking statement was the following one:

*Social face to face dynamic is more alive because it gives access to the real life of the classroom, but it doesn't allow to step back as much as the social online dynamic. The forum allows it, and it also supports reflection and the development of a thinking culture. The result seems interesting to me because, by reading other people's contributions, we come up with a bunch of questions and we can trace the development of solutions applied in our own practice.*

Pre-service teachers' experience in the hybrid environment was a factor in the perception and use of Knowledge Forum's features (affordance recognition level) by other pre-service teachers who were part of the same experience during the same semester. Figure 1 shows three groups of pre-service teachers with at least one participant with previous experience in the hybrid learning environment. In Time One, no participant had previous experience; in Time Two, at least one participant had one previous experience; and in Time Three, some participants had two previous experiences.

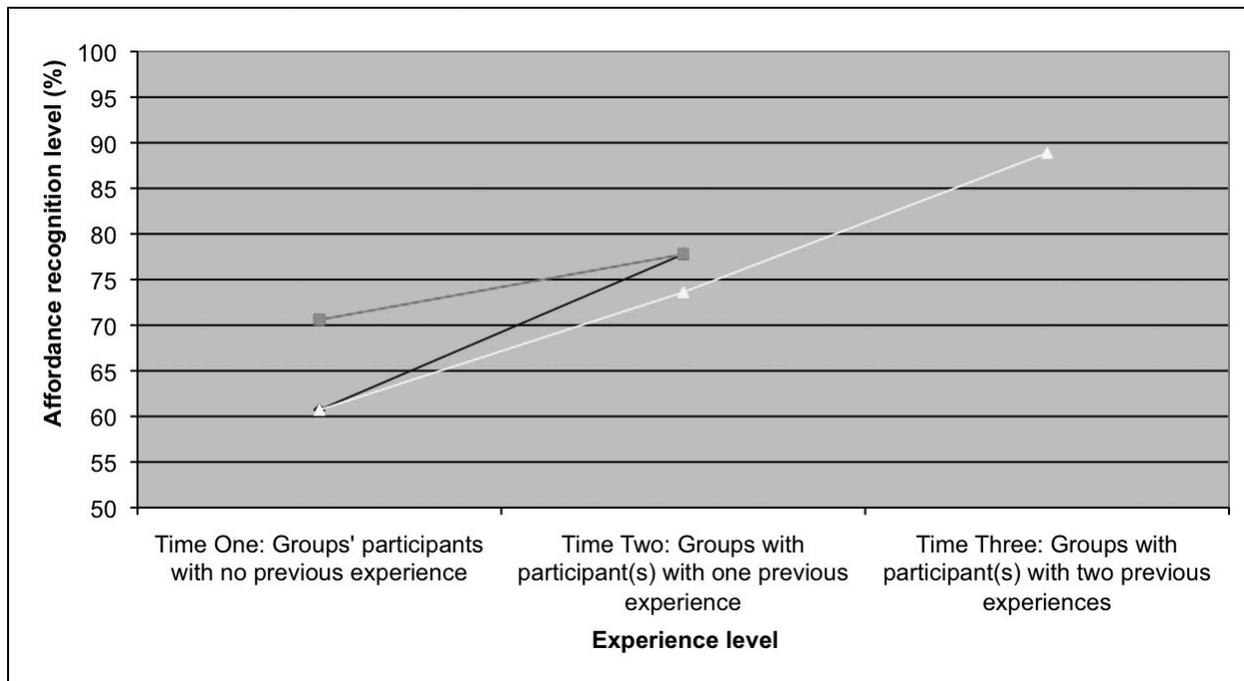


Figure 1. Groups' affordance recognition level according to the experience level of participants already acquainted with the environment.

The dark line shows the progress of a group including participant(s) with one previous experience (Time Two) in the hybrid learning environment: the group acknowledged 60% of the affordances in Time One and 77% in Time Two. The gray line shows the progress of another group that included participant(s) with experience (Time Two) in the hybrid learning

environment: the group acknowledged nearly 70% of the affordances in Time One and 77% in Time Two. The white line shows the progress of a third group that included participant(s) with two previous experiences in the hybrid learning environment: The group acknowledged 60% (Time One), 73% (Time Two), and 88% (Time Three) of the affordances. This illustrates a collective growing capacity when the knowledge of pre-service teachers with experience is reinvested from one practicum to another. We must clarify each "time" (X axis) doesn't necessarily correspond to one iteration as each iteration corresponds to one school year whereas practicums are distributed all along the baccalaureate program.

### *Emergent affordances*

*Participants transformed some of the designers' intentions.* A first case of an emergent affordance occurred during iteration one. It was one of a digital nature and one that pertained to the views of former pre-service teacher cohorts in the same database. Designers had envisioned those views to be inert but pre-service found them useful for the progression of their own online discourse. In iteration two, designers presented those views as learning/knowledge building artifacts and, therefore, as part of the hybrid learning environment. But design issues remained throughout iterations two and three: some pre-service teachers had difficulty following the thinking thread of a previous cohort. As reported by one of them:

*We don't really understand the views at first sight... We need to be involved [in the forum exchanges] to understand it properly. This is my opinion.... [...] visual cues could help understand the views of former pre-service teachers better.*

A second case of an emergent affordance occurred during iteration three, one of a social nature that regarded the participation of graduating pre-service teachers to online discourse. Although their participation opened up a number of opportunities for newcomers, some pre-service teachers felt they were being observed if not assessed by outsiders. There was indication such as verbal expression of dissatisfaction on the part of one cohort that some pre-service teachers began to dislike the presence of graduating teachers. The design problem, one that remained a challenging one throughout iteration three, was how to minimize the possibility that graduating pre-service teachers' comments would overshadow those of newcomers, leaving them with a sense of having a too limited space in their community. One student suggested that the roles of the graduating pre-service teachers be better clarified at the very beginning of their participation.

A third case of an emergent affordance was that readers as well as writers found scaffolds useful. Even when writers did not seem to need them anymore, readers kept finding them helpful. Although a scaffold is meant to disappear once a writer outgrows it, the use of scaffolds endured for reading purposes. Readers said during interviews that they could understand more explicitly the writers' intentions who wrote contributions to the database. Whether the use of digital scaffolds over time should be encouraged or not is an arising question, and a specific study is needed.

## Hidden affordances

Affordances constantly hidden to most participants were the following ones: the problem definition window (although a feature as salient as the keyword window); the note publication feature; and the co-authoring note feature. The two last ones were less visible than the problem definition one. A few more experienced pre-service teachers, those who had already done a field experience combined with online reflection, acknowledged the note publication affordance and the co-authoring note affordance during their second and third participation in the environment, those corresponding respectively to iterations two and three of our design.

### Research question 2: How did the knowledge building online discourse unfold?

The second part of the results section presents discourse progression on Knowledge Forum.

On some occasions, when pre-service teachers went beyond their own individual reflection and moved to communal advancement, collaborative reflective discourse transformed into knowledge building discourse. Pre-service teachers tackled rather complex pedagogical challenges such as:

- Ways to support metacognition in a networked classroom context;
- Place of individual work within collaborative inquiry;
- Ways to help teenagers find meaning in their learning;
- Strategies to get into learners' zone of proximal development.

At an inductive fine-grained level of analysis, we noticed that although each discourse thread had its own organizational logic (autopoiesis), common patterns could be identified. Figure 2 is an example. It illustrates the presence of socio-cognitive processes in each of the notes of a twenty-note discourse thread built during the second iteration.

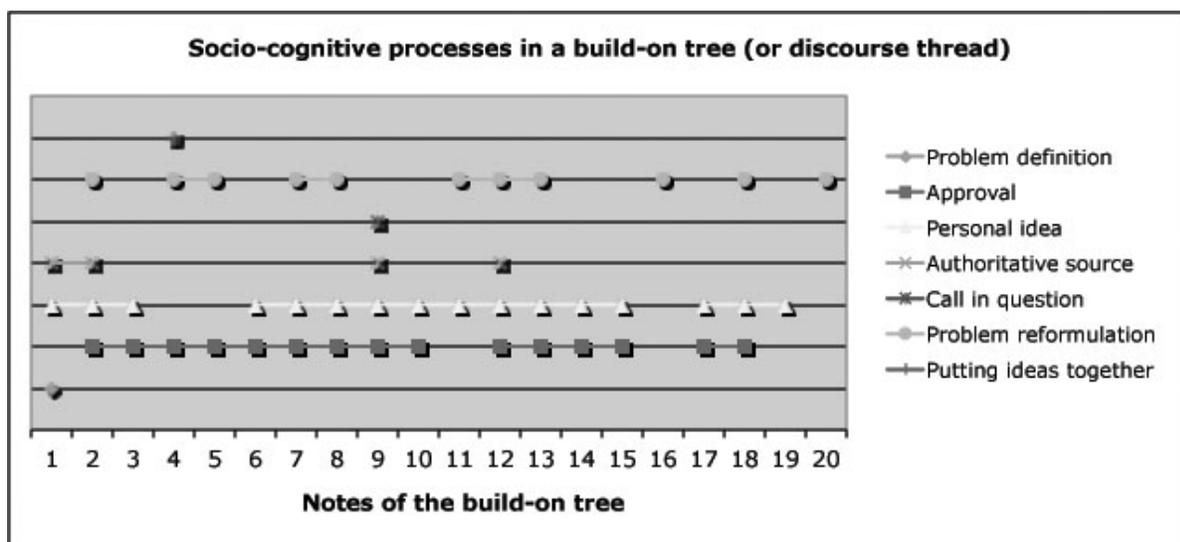


Figure 2. Socio-cognitive processes identified in an exemplary build-on tree with 20 notes.

Discourse threads began with an authentic question growing out of the field experience.

« ... It would be pertinent to reflect on what we can learn while we collaborate. How is it possible to achieve collaboration? With who, where and when? Do you think such a discussion could benefit our collaborative spirit? ... ». Through the exchange, the initial shared object (question or problem submitted) was reformulated as new details offered more precision and as practice-based evidence was added. « ... As she wrote, I think there is a specific difficulty with particular needs (student differentiation) during collaborative activity. Is this construction mode really appropriate to everyone? ». Approval-type discourse not only supported but helped link participants' ideas. « ... I think your reflection is very interesting and stimulating and I'd like to share a particular case with you in this regard ... ». Authoritative sources were used in a limited manner; but in each, they added depth to idea formulation.

*... In his classroom management model, Glasser states that during the process of quality work, students become aware that the knowledge they build is relevant. If the teacher is a collaborator, i.e. someone contributing to the common goal, how will he present himself to students? Obviously, we all know the teacher is a guide, a motivator and a resource of knowledge and strategies. But is he also a knowledge builder? I think that if we define the work of the classroom from a collaborative perspective, we'll reach a socio constructivist view of philosophy of science. Fourez talks of science as a way to structure our interpretation of the world. This way, we can consider the teacher as a group leader, alike the research director of a research group.*

When comparing each cohort's longest discourse thread over the four-month long student teaching experience, we noticed a higher level of problem reformulation over time (0%, 36%, 58% presence), proportionally to the number of notes in the sequence. This was not the case however for the early field and the five-week long experiences, although problem reformulations were present. We stress that a vertical approach was taken by more experienced pre-service teachers as they not only set the problem but progressively updated its formulation as their discourse lead, not only to new solutions, but to a more complex understanding of the problem that was raised.

## **Discussion**

The results of this study point to the possibilities of combining onsite and online activity for teacher educators who want to engage pre-service teachers in rich discourse about innovative teaching practices. Rich discourse goes vertical, and leads to deep understanding rather than to shallow horizontal discussions on multiple concurrent topics. Socio-digital affordances that combine online and onsite supports to create a rich learning environment of interactions are a work of design through several iterations. This is the first outcome of this study, one that brings further evidence to support the relevance of design research in real settings of use in pre-service teaching. In our specific design experiment, results were incremental: online discourse improved as the affordance effect got stronger.

From a teacher professional development perspective, the results highlight the potential of collaborative technologies to support university-school partnerships with a strong practice

teaching component, and improvement in the preparation of pre-service teachers. One implication we would like to highlight is the anchoring of collaborative reflective practice into real ideas and authentic problems (first knowledge building principle, Scardamalia & Bereiter, 2003). It brought meaning to pre-service teachers' online participation, thus making the electronic forum a means to support their professional thinking instead of a simple requirement task subject to evaluation.

The combination of converging social and digital affordances for the design of a rich environment for teacher education and professional development is the second outcome of the present research. At a first level of convergence, designed possibilities of interaction took into account a communal shared object of inquiry by the school and the university, that is, the merging of the imperatives of a reform context, the contribution of the social perspective of the learning sciences to educational practice, and the integration of ICTs in teaching and learning. A second level of convergence was achieved by the complementarity of the university and the school's discourse and practice. Instead of saying something at one place and doing something else at the other, a multiple-view approach was cultivated in a context of "enough" similarity and continuity. Although some digital affordances remained hidden or were acknowledged only during iterations 2 and 3, the affordances of the electronic forum provided a means to introduce some continuity into what would have been otherwise a student teacher's isolated field experience in an innovative classroom.

As an upcoming step in a further iteration, participation of graduating teachers in the online discourse would need to be revisited. As some graduating pre-service teachers are sometimes hired to work in a networked classroom once they have their bachelor degree, we are in a position of asking a few of them to continue their participation in the online discourse as a beginning teacher on the professional development continuum, and as a way of bridging undergraduate studies and induction years in the teaching profession. This would allow for inquiry into the innovation challenges faced by beginning teachers as they reach the workplace while providing legitimacy to participate in the online discourse of the pre-service teacher community. Such a social affordance is now possible with the new online tools available, and teacher education and professional development have much to gain from learning scientists who would bring their knowledge and skill to the understanding of the socio-technical affordances available in these early years of the 21<sup>st</sup> century.

## References

- Bereiter, C. (2002). *Education and mind in the knowledge age*. Mahwah, NJ : Lawrence Erlbaum Associates.
- Bereiter, C., & Scardamalia, M. (1982). From conversation to composition: The role of instruction in a developmental process. In R. Glaser (Ed.), *Advances in instructional psychology* (vol. 2, pp. 1-64). Hillsdale: Erlbaum.
- Bereiter, C., & Scardamalia, M. (1993). *Surpassing ourselves: An inquiry into the nature and implications of expertise*. La Salle, IL: Open Court.
- Bielaczyc, K. (2001). Designing social infrastructure: The challenge of building computer-supported learning communities. In Dillenbourg, P., Eurelings, A., & Hakkarainen, K. (Eds.). (2001). *European perspectives on computer-supported collaborative learning: The first european conference on CSCL* (pp. 106-114). Maastricht, The Netherlands.

- Bradner, E. (2001). Social Affordances of Computer-Mediated Communication Technology: Understanding Adoption. *Proceedings of the CHI EA '01*, Seattle.
- Bransford, J. D., Brown, A. L., & Cocking, R. R. (1999). *How people learn: Brain, mind, experience, and school*. Washington, DC: National Academy Press.
- Brown, A. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of the Learning Sciences*, 2(2), 141-178. [On-line]. Available: <http://depts.washington.edu/edtech/brown.pdf>
- Brush, T., & Saye, J. (2002). A summary of research exploring hard and soft scaffolding for teachers and students using a multimedia supported learning environment. *The Journal of Interactive Online Learning*, 1(2), 1-12.
- Collins, A. (1999). The changing infrastructure of education research. In E. Condliffe Lagemann, & L. S. Shulman (Eds.), *Issues in education research* (pp. 289-198). San Francisco, CA: Jossey-Bass.
- Darling-Hammond, L., & Hammerness, K. (2005). The design of teacher education programs. In L. Darling-Hammond & J. Bransford (Eds.), *Preparing teachers for a changing world* (pp. 391-441). San Francisco, CA: Jossey-Bass.
- Fullan, M. (1993). *Change forces: Probing the depths of educational reform*. London: Falmer.
- Gaver, W. (1991). Technology affordances. *Proceedings of the CHI*, New Orleans.
- Gibson, J. J. (1979). The theory of affordances. In R. Shaw & J. Bransford (Eds.). *Perceiving, acting and knowing* (pp. 67-82). Hillsdale, NJ: Erlbaum.
- Guskey, T. (1995). Results-oriented professional development: In search of an optimal mix of effective practices. [On-line] Available: [http://www.ncrel.org/sdrs/areas/rpl\\_esys/pdlitrev.htm](http://www.ncrel.org/sdrs/areas/rpl_esys/pdlitrev.htm)
- Kelly, A. E., Lesh, R. A., Baek, J. Y. (2008), *Handbook of design research methods in education*. New York: Taylor & Francis Inc.
- Kollias, A., & Kikis, K. (2005). *Pedagogic innovations with the use of ICTS. From wider visions and policy reforms to school culture*. Barcelona: Edicions Universitat.
- Kozma, R. (2003). Material and Social Affordances of Multiple Representations for Science Understanding. *Learning and Instruction*, 13 (2), 205-226.
- Kreijns, K., Kirschner, P. A., & Jochems, W. (2002). The sociability of computer-supported collaborative learning environments. *Educational Technology and Society*, 5(1), 8-22.
- Lave, J., & Wenger, E. (1991). *Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.
- Lieberman, A. (1996). Practices that support teacher development: Transforming conceptions of professional learning. In M. W. McLaughlin & I. Oberman (Eds.), *Teacher learning: New policies, new practices* (pp. 185-201). New York : Teachers College Press.
- Little, J. (1993). Teachers' professional development in a climate of educational reform. *Educational Evaluation and Policy Analysis*, 15 (2), 129-151.
- Little, J. (2003). Inside teacher community: Representations of classroom practice. *Teachers College Record*, 105(6), 913-945.
- Norman, D. (1999). Affordances, conventions, and design. *Interactions*, 6(3), 38-41.
- Putnam, R. T., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher*, 29(1), 4-15.
- Rogoff, B. (1994). Developing understanding of the idea of communities of learners. *Mind, culture, and activity*, 1(4), 209-229.
- Sawyer, K. (Ed.) (2005). *The Cambridge handbook of learning sciences*. New York, NJ: Cambridge University Press.

- Scardamalia, M., & Bereiter, C. (1994). Computer support for knowledge-building communities. *The Journal of the Learning Sciences*, 3(3), 265-283.
- Scardamalia, M., & Bereiter, C. (2003). Knowledge building. In J. W. Guthrie (Ed.), *Encyclopedia of education, second edition* (pp. 1370-1373). New York: Macmillan Reference.
- Schön, D. (1983). *The reflective practitioner*. New York: Basic Books.
- Van Manen, M. (1977). Linking ways of thinking with ways of being practical. *Curriculum Inquiry*, 6(3), 205-229.
- Voogt, J., & Knezek, G. (Eds.) (2008). *International handbook of information technology in elementary and secondary education*. New York: Springer.
- Vygotsky, L. S. (1978). *Mind in society. The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Wells, G. (1999). *Dialogic inquiry. Toward a sociocultural practice and theory of education*. Cambridge, UK: Cambridge University Press.
- Wertsch, J. V. (1998). *Mind as action*. Cambridge, UK: Cambridge University Press.