

A sociocultural reading of reform in science teaching in a secondary biology class

Sylvie Barma

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Abstract Adopting activity theory as a theoretical and methodological framework, this case study illustrates how a teaching and learning situation is planned and implemented over a series of nine 75-min biology classes by a high school science teacher in the context of pedagogical reform. The object of this study emerges within a favourable context of science education curricular reform in Quebec, Canada. By examining the interaction between the poles of an activity system sharing the same object, this case study illustrates how one teacher's teaching practice is redefined and how some aspects of her teaching personality orient the ways in which she contextually mobilizes new tools and members of her school community in order to implement an awareness campaign on the risks of tanning salons.

Keywords Activity theory · High school science teaching · Teacher's practice · Sociocultural perspectives · Curricular reform

Dans cet article, nous présentons une étude de cas qui s'est déroulée sur une période de quatre mois dans une classe de biologie du secondaire au Québec, et ce, dans un contexte de réforme des programmes d'études en science et technologie. Ce cas décrit la façon dont une enseignante a cherché à modifier ses pratiques d'enseignement et à faire autrement auprès d'une centaine d'élèves. Préoccupée par le fait qu'un grand nombre de ces élèves fréquentaient les salons de bronzage, elle a décidé de mettre de côté sa planification habituelle et s'est engagée dans l'élaboration d'une séquence de neuf séances ancrée dans cette question. Le but de ces séances a été la mise en place d'une campagne de sensibilisation à l'école. Pour ce faire, elle a remis en question plusieurs aspects de sa formation universitaire ainsi que la façon dont elle était intervenue auprès de ses élèves en classe durant les cinq dernières années. Suite à cette réflexion, et avec l'intention de s'appropriier les nouvelles directives ministérielles (approche d'enseignement plus ouverte,

S. Barma (✉)
Pavillon des sciences de l'éducation, 2320 rue des Bibliothèques,
Local 1134, Québec, QC G1V 0A6, Canada
e-mail: Sylvie.Barma@fse.ulaval.ca

responsabilisation des élèves dans leur apprentissage), elle a choisi de s'éloigner d'un mode d'enseignement magistral et d'une démarche dirigée en laboratoire. Elle a fait appel à des spécialistes du milieu médical pour intervenir auprès des jeunes à l'école et a demandé à plusieurs membres de sa communauté éducative de l'appuyer dans ses démarches. Nous avons été en mesure de cerner plusieurs tensions qu'elle a identifiées et résolues et qui lui ont permis de modifier, du moins pendant neuf séances, certaines règles et la division du travail dans sa classe et dans son école. C'est en adoptant un cadre de lecture socioculturel ancré dans la troisième génération de la théorie de l'activité que nous présentons au lecteur le résultat de nos analyses. Nos données de recherche (verbatim d'entretiens, analyse de documents et notes de recherche) ont été analysées à la lumière de l'activité de l'enseignante que nous avons considérée comme orientée vers un objet, celui de la mise en place de la campagne de sensibilisation. Ainsi, l'activité exercée par un individu est étroitement liée à un but conscient, une motivation liée au contexte effectif dans lequel l'activité a lieu. Dans la première phase d'analyse, il y a eu alternance entre l'analyse et le terrain conformément aux principes de la théorisation ancrée et ceci a permis de décrire l'évolution de la pratique de la participante à l'étude. La seconde phase de l'analyse nous a amené à présenter des systèmes d'activité: caractérisation et mise en relation des pôles : sujet, objet, règles, division du travail, membres de la communauté et outils par lesquels l'activité a été médiatisée. À la lumière de nos analyses, nous concluons que la transformation des pratiques d'enseignement dans un milieu scolaire est susceptible de s'implanter à la fois au niveau individuel et à celui de membre d'une collectivité.

In the field of education, changes can occur in a variety of ways. There are curricular reforms as well as initiatives of a more local nature, undertaken by teachers who are motivated to personally engage in new ways of doing things in the classroom (Sannino and Nocon 2008). Thus, some teachers initiate a new didactic practice in science classes in response to the implementation of a school reform or because personal reasons prompt them to throw into question their academic training or to increase their students' motivation (Barma 2008b). That being said, most would agree that it is difficult to bring about change among school social practices for a variety of reasons, such as the preservation of a school's operating rules, pressure to comply with curriculum requirements, or competition between schools (Edwards 2008). A number of recent studies have adopted activity theory as their research design and have documented how schools' efforts to bring about pedagogical or organizational innovation either managed to be translated into action or failed to be implemented (Engeström 2008). The findings from this research support one of the principles of the 3rd generation of activity theory developed by Engeström (1999), namely that the introduction of new practices is an outcome of the process of resolving the tensions occurring among organizations (Murphy and Rodriguez-Manzanares 2008). Such tensions may stem from the implementation of a new curriculum in the context of school reform (Edwards). Against this backdrop, I focus particularly on the potential impacts that the introduction of a new science and technology curriculum in Quebec may have on the didactic practice of a high school biology teacher.

In the current science education context, overlapping concerns among European and North American actors—the growing focus on developing competencies, implementation of an interdisciplinary practice grounded in current problems having relevance for students—point to a widely shared core of issues (European Commission 2006). In particular,

the curricula of several Western nations have made a priority of improving the contextualization of science learnings through the study of problems having relevance to the lives of students (and not just through the study of subject-specific problems).

In Quebec, this trend has led to a ministerial guideline respecting a new disciplinary competency that draws on an interdisciplinary teaching/learning approach. Formulated in terms of “making the most of [the students’] knowledge of science and technology,” (Government of Quebec 2006, p. 236), this competency is to be developed around problems grounded in “broad areas of learning” that deal with issues that are important to both individuals, namely: health and well-being, career planning and entrepreneurship, environmental awareness and consumer rights and responsibilities, media literacy, and citizenship and community life. These new directions have led science teachers to renew their classroom practices and have sparked my interest in describing the ways in which teachers make the proposed changes and throw into question their classroom practices and how they bring innovations into their classrooms. Likewise, such reflections have fuelled my interest to investigate the way in which classroom practices were shaped by the goals pursued by teachers. Furthermore, I developed an interest in how the members of an educational community (or the teachers in particular) managed to work and facilitate renewed science teaching practices in a school that subscribed to the principles underlying a reform of science education curricula.

The results of a case study that I present in this paper fit with a general trend in research relating to new practices in science education (Méheut 2006). Situated in a Quebec context (Government of Quebec 2006), these findings illustrate how, over a 4-month period, a 9th grade biology teacher re-examined her teaching practice and called on several members of her educational community to plan and implement nine activities she considered to be innovative into her science classes. The overarching theme of the nine activities involved approximately 100 female students aged 14–15 years and focused on developing awareness among these teenagers as to the risks of tanning salons on their health.

Research problem

Aside from the existing North American and European political and ministerial considerations on the matter, a number of propositions have been put forward by researchers from the standpoint of renewing classroom teaching practices with approaches grounded in citizenship-related educational goals (Barma 2007). In these approaches, the emphasis is on developing interdisciplinary competencies and teaching practices that are grounded in community problems (See Table 1). In order to foster citizenship skills among students, these approaches must incorporate different points of view and different frameworks. They thus combine the learning of scientific notions with the explication of cultural, political, social and ethical considerations—all as part of documenting the questions and issues laid before students by science teachers. Table 1 illustrates the propositions of these researchers as how teachers could better socioculturally anchor their teaching practices.

It is worth scrutinizing the proposals of a number of other researchers. For Roth and Calabrese Barton (2004) and Roth and Désautels (2002), empowered citizenship in the community should be developed through science education. As with other fields of knowledge, science and technology would benefit from becoming the objects of reflection on the part of all citizens. Accordingly, science education should be oriented toward developing citizens’ capacity to take social action.

Table 1 Socioculturally anchored teaching practices

Beane (1997)	Fourez et al. (2002)	Lemke (2001)	Roth and Lee (2004)
Problems and issues organized around real-life social and personal concerns.	Construction of knowledge in response to a meaningful problem.	Consideration of the sociocultural dimension of learning.	Curriculum is genuinely experienced by students.
Integration of <i>relevant</i> knowledge within the context of organizing themes.	Grounding of the situation in the experience, daily life, cultural universe and concerns of students for whom the project is intended.	Learning activity is viewed from a historical and evolving perspective as unfolding on several scales (ranging from the microsocial to the broader, society-wide context).	Problem situations emerge from the daily life of the community of which students are a part.
Knowledge is developed and used to investigate themes for study rather than to cover the contents of a particular program.	Construction of a representation of a situation within the framework of a project.	Importance of including several dimensions in teaching practice or in research (social interactions, organizational aspect, sociological aspect, historical, biographical, linguistic, semiotic, cultural) as well as the political, legal and economic dimensions.	Integration of knowledge into a situated, distributed context.
Emphasis is on actual activities and projects.	Construction of “rationality islands” (i.e., simple interdisciplinary models) around tangible problems or notions relating to daily life.	School is part of a wider community: students must be taken outside of the framework of school.	Actualization of the student’s process through a real action in the surrounding community, thus providing an opportunity to negotiate various types of knowledge.
Participation of students in the choice of themes (and not the concepts) to be studied.	Knowledge is mobilized solely with a view to immediate use.		Students take part in decision-making within the community. Participation of students in the choice of problems and controversies to be studied.

A posture of this kind presupposes long-term participation and learning in relation to the resolution of actually existing problems in a community. Roth and Lee (2004) argue that if teachers enable students to participate in the life of their local community—beyond the spatial and temporal setting of the classroom—students will develop awareness of the importance of such participation. These two authors refer here to the development of scientific and technological literacy in terms of a perpetual construction process.¹ They also argue that teachers should avoid creating learning environments that funnel students into performance-based tracks; they should instead not only offer students a broad variety of situations conducive to participation but also emphasize a democratic approach enabling students to make decisions in keeping with their own interests. “Rather than privileging disciplinary science we ought to foster situations that allow the negotiation of different forms of knowledge geared to particular (controversial) problems as these arise in the daily life of a community” (p. 287). In such environments, students have the feeling that they are involved in their learning process and are thus able to perceive the usefulness of what they learn. Doing so, the traditional boundary between school and community becomes less marked.

¹ Scientific and technological literacy should be understood in terms of the definition provided by Fourez (2002, p. 198), for whom it is a “person’s capacity, in a sociotechnical society, to build for him or herself a field of autonomy, communication and negotiation with his or her environment.”

In the section of the Quebec Education Program dedicated to the Science and Technology subject area emphasis is laid upon the development of what is qualified as a democratic and humanistic perspective (Barma and Guilbert 2006). With respect to the context surrounding the teaching of this subject area, the program document states, that various cultural resources can also be exploited. “Museums, research centres, engineering firms, medical facilities, local industries and businesses or any other organization in the community can be mobilized to develop the students’ scientific and technological literacy” (Government of Quebec 2007, p. 2). Although it cannot be claimed that such intentions laid down in the Quebec document are consistent with the researchers’ proposals that are taking into account the sociocultural context in which students evolve, I see them as constituting an invitation to teachers to ground their classroom interventions in the real problems of the community and to encourage various actors of the school and out-of-school community to take part in the curriculum-building process.

Thus, the research under study stems from a gap occurring between a number of more traditional teaching practices and a renewal of practices of the kind that have been proposed by Quebec government for science to be taught by centering on the solving of complex problems (Government of Quebec 2006). It is from this perspective that I inquire into the motivations of a grade 9 biology teacher who takes steps to renew her classroom practice with a view to adhering to some of the new ministerial guidelines. Some of these guidelines in particular recommend studying science as a means of analyzing the world around students, thus allowing them to put scientific and technological achievements into perspective and to appreciate the impact of such achievements on their health. For example, focusing on the controversial issue of tanning salons permits that teacher to examine more closely how a technological system (tanning booth) for the production and introduction of ultraviolet radiation into a biological system (human skin) meets a specific need and produces various effects. Such a focus permits a pragmatic and complex approach to the study of a technological system.

The following research question is the focus of this study: In the context of the implementation of a new Science and Technology curriculum, how does a science teacher make an effort to change her practice as she plans and implements an awareness campaign on the risks of tanning salons?

Theoretical framework

From previous research with seven high school science teachers in Quebec, I used the third generation of activity theory (Engeström 2001) as the theoretical framework to be used for interpreting the renewal of classroom practices in science classes. This framework emphasizes the contextual and systemic aspect of practices that are meant to be innovative. So equipped, I was able to identify the concerns of teachers involved in planning Teaching and Learning Situations (TLSs) in terms of the resources effectively available versus the resources desired; the goals pursued by these teachers in a school context; and the constraints of the school community as experienced by these teachers when planning new TLSs. My analyses showed that the resources mobilized or desired by these teachers are context-specific, interrelated and dependent on the conditions (facilitating or non-facilitating) of the community in which the renewal of their teaching practice is located (Barma 2008b).

These initial findings have brought out the importance of the contextual dimension of teachers’ TLS-building activity and accord with the spirit of research conducted by Brown

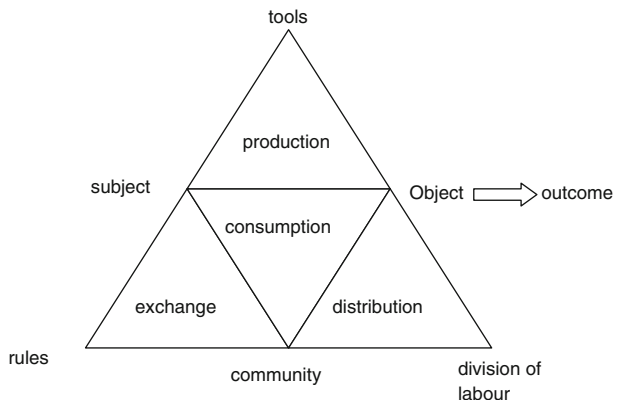
et al. (1989) and Wenger (2005) in which the activities undertaken by an individual are closely related to a conscious objective or with motives specific to the context in which a given activity unfolds. The individual is not studied per se, yet is studied in terms of interaction with others. From this perspective, the unit of analysis consists in interaction. In other words, the unit of observation is not the individual alone but instead the individual in his or her context. According to Bracewell et al. (2007), theoretical frameworks anchored in a sociocultural theory of learning can enrich how one considers a unit of analysis and thus allows him to interpret data in a systemic and contextual way. When adopting these premises, action and context in which the activity takes place are not considered separate from one another (Brown et al. 1989). Therefore, the activities undertaken by an individual are closely related to a conscious goal, a motivation linked to the actual context where the activity is occurring.

Activity theory examines human activity in terms of being socially situated—for example, in relation to the world of labour or the world of learning (Parks 2000). The origins of this theory are to be found in the work of Vygotsky (1985), who considered the development of human behaviour as being above all mediated by the creation and use of cultural artifacts of a material or symbolic nature (e.g., instruments, signs, symbols). According to Vygotsky, who developed the first generation of that theory, the human being is defined with respect to his or her activity with objects (not solely material) and actors in his/her environment.

Building on Vygotsky's work, Leont'ev (1978) developed the second generation of this theory. This author emphasized the distinction between individual/collective action, and took into consideration the complex interactions occurring between an individual and his or her community. In his view, labour is essentially cooperative. In human societies, the meaning ascribed to a given activity is thus shared by a community of actors who pursue the same goal. For this reason, mediation is characterized by the division of labour and the rules that frame the interactions between individuals belonging to the same activity system and pursuing the same object. For Leont'ev, it was essential to distinguish between the concept of activity and that of the actions related to the carrying out of this activity. Activities are themselves concretely realised in and through *goal-directed actions*. Moreover, the relationship between actions and activities is a mutually constituting and presupposing one: a series of actions realise an activity, but the activity gives rise to, orients, legitimises and gives sense to the actions. "An activity is associated with a purpose, an action with a goal, and an operation with the conditions necessary to its execution" (Class 2001, p. 2).

In the 1970s, a recontextualization of activity theory by researchers in the West was observed. Thus, in line with the works of Latour (1993) and their human and non-human actor network, the concept of activity networks was developed. Engeström (1999), who developed the third generation, then proposed a systemic model based on the first two generations of activity theory, integrating the socioinstitutional infrastructure of the activity—that is, rules, the division of labour, and elements of the community. As presented in Fig. 1, "the uppermost subtriangle may be seen as the tip of the iceberg representing individual and group actions embedded in a collective activity system" (Engeström 2001, p. 134). For Engeström, it had become increasingly crucial to recognize that individual's interactions with the world were mediated by objects, methods, rules and values and as well as all other aspects of human culture. Hence, the author positioned the individual at the centre of an activity system consisting of six interrelated poles (subject, tools, rules, division of labor, community, and object of study), with each different pole representing key nodes of that system (Fig. 1). Although these poles can presumably be

Fig. 1 The poles of an activity system triangle (Engeström 1999)



considered separately, they must be interpreted as interconnected. On a methodological point of view, Engeström points out that his model offers a dynamic reading grid for the analysis of the transformation of social practices. Thus, activity is a goal-oriented and tool-mediated action; the activity pursued by the subject is analyzed in its dynamics, transformations and in its evolution and historical change. Activity theory “regards innovation as a process of shared construction of an object, a mobilization of essential and complementary cultural resources as well as a process of mutual learning” (Miettinen 2006, p. 176).

Engeström (2001) has set out the characteristics of the third generation of activity theory and framed the analytical and methodological approaches appropriate to research. According to Engeström, any learning theory must answer at least four central questions:

1. Who are the subjects of learning? How are they defined and located?
2. Why do they learn? What makes them make the effort?
3. What do they learn? What are the contents and outcomes of learning?
4. How do they learn, what are the key actions or processes of learning?

He stresses that in order to understand human life and its development and thus make it possible to bring about the conditions required to improve it, it is necessary to understand that the interactions of human beings are mediated by objects, methods, rules, the division of labour and the members of the community in which the activity of learning subjects unfolds.

Furthermore, one of the particularities of Engeström’s research (2001) is to focus on the transformation of a group rather than on that of an individual. In my findings, I will focus on that aspect and explain how the participants (individually/collective) allow the biology teacher to transform her practice as she plans and implements an awareness campaign. Each stage in the development of a new activity by the teacher constitutes a resource for the production of innovations in the activity system and of transformations in a particular organizational context.

The third generation of activity theory can be summed up according to five principles:

1. The activity system constitutes the prime unit of analysis. Being artifact-mediated and object-oriented, an activity system is enmeshed in network relations to at least one other system. The goal of activity is constantly evolving and cannot be reduced to short-term objectives. New representations must make sense for all.

2. An activity system is “multi-voiced”—that is, reflects a “community of multiple points of view, traditions and interests,” (p. 136) which itself stems from the division of labour in an activity whereby different positions are created for each system participant. This multi-voicedness demands a considerable effort of translation and negotiation on the part of all participants.
3. The historicity of activity systems is reflected in the way they take shape and are transformed over long periods of time.
4. Contradictions, defined as the “historically accumulating structural tensions within and between activity systems” (p. 137) (as opposed to mere problems or conflicts) play a central role as sources of system change and development.
5. In an activity system, an innovation (or “expansive transformation”) is accomplished whenever “the object and motive of the activity are reconceptualized to embrace a radically wider horizon of possibilities than in the previous mode of activity.” (p. 136)

The third generation of activity theory constitutes a fruitful approach for picturing learning activity. Traditionally, theories of learning have centred on processes in which the subject (as isolated individual) acquires stable and relatively well-defined knowledge and skills. Likewise, it is assumed that:

There is a competent ‘teacher’ who knows what is to be learned. The problem is that much of the most intriguing kinds of learning in work organizations violate this presupposition. People and organizations are all the time learning something that is not stable, not even defined or understood ahead of time. (p. 137)

The capacity of subjects to mobilize other actors of the system and bring them together around the same object is a precondition of the generation of an innovation in an organization or local community. Miettinen (2006) stated that, “These [learning-centred] relationships are not based on written contracts but rather on the norm of reciprocity, based on the complementarity of the knowledge, resources and interests of the actors” (p. 176).

The range of points of view results primarily from the great variety of actors involved in the educational community and to the division of labour characterizing it (Barma 2008a). Through this division of labour, different roles are defined for each actor interested in participating in the subject’s (i.e., teacher’s) activity. These actors may be situated at more or less greater removed from the school itself—in this case, the biology teacher or the students, who are situated at the classroom level. Other actors, such as parents or experts are located outside of the school. Activity theory considers a subject not only as an individual but also as a member of a wider community (Engeström 1999).

As was mentioned above, the introduction of new tools—such as a curriculum—is accompanied by calling into question the rules and the division of labour in schools (Edwards 2008). Carrying forward with these reflections, Bracewell et al. (2007) brings out how the capacity of teachers to mobilize other members of the educational community and to rally them around the same goal (for example, planning and implementing new activities in the classroom) is a precondition of the generation of innovation in the local environment. Innovation necessarily entails a shared mobilization of resources in the spirit of a mutual learning process (individually collective transformation).

In order to gauge the extent to which new practices generated in a school environment can be qualified as innovative, it is important to recall the emphasis that Bracewell et al. (2007) articulated on tensions within a given activity system. On an initial level, will the resulting of new Teaching and Learning Situations (TLSs) be of interest to the other teachers in the school? Do new ways of constructing TLSs interfere with other practices

that are grounded in the community? Will they have an impact on the rules of operation and the division of labour? Do the motives underlying the production of TLSs conflict with the school's dominant culture in respect of science education teaching practices? Can tensions be perceived between the cultural-historical dimension of participants and that of their school? Finally, I raise the question of whether the production of innovations will create tensions between the activity system and any neighbouring systems with which it shares a common interest. For example, does a new way of constructing and implementing TLSs in the science classroom interfere with practices grounded in a local environment, any associated rules, and the division of labour within the school? Another level of tension may also emerge whenever the motives underlying the production of the TLS comes into conflict with the dominant culture of the activity—i.e., with this culture as it existed prior to the introduction of an innovation. If, on the other hand, the motives of the participant and that of her community are in accord, then it will be possible to present the conditions that facilitate the grounding of an innovative classroom intervention in the context of science education (Barma 2010). It is important to recall that tensions can emerge within the subject (cultural-historical dimension) or at the level of the community's culture. Again, the question under investigation in this study is to discuss how one science teacher changes her practice as she plans and implements an awareness campaign on the risks of tanning salons in her biology classroom.

Presenting the context of my investigation

As pointed out previously, activity theory was selected for this study wherein context and mediation had to be considered while the production of a new TLS anchored in the theme *Awareness of the Risks of Tanning Salons* was examined. Hence, this allowed for the investigation of a teacher's practice through a systemic approach that takes into account the role of tools in the mediation of the production of a new TLS along with the role of human actors who share common goals within their educational community (Engeström 2001). An ethnomethodologically inspired approach (Denzin and Lincoln 2005) coherent with activity theory was used in this research. Specifically, "Ethnomethodology is not a research method, but rather an orientation that focuses on the ordinary actions of people as they proceed through everyday life" and "it studies the methods of people use in various contexts to get through the mundane activities in their given situations" (Kelly 2008, p. 449). Accordingly, it also justifies the basis underlying the format of investigation selected for this research—that is, the case study, which lends itself well to scrutinizing and grasping objects of study (Stake 1995). According to Murphy and Rodriguez-Manzanares (2008), case studies are usually chosen for studying activity systems.

Introducing Catherine and the study

The case described in this study refers to a high school biology teacher, Catherine (a pseudonym). Catherine is young in age and in experience and responsible for four groups of 9th graders and one group of 11th grade students, all girls. Having worked in the same school for 5 years, she holds a bachelor of education, with a concentration in biology and mathematics. When preparing her educational interventions, Catherine claimed spending over 2 h per week on designing activities other than the ones suggested in school manuals. Although she took many courses in pedagogy (renewal of pedagogical approaches, integration of Information and Communication Technologies in the classroom) at the

beginning of her career, she considered her level of expertise in the new curriculum to be rather low. Catherine indicated willingness to participate in a research project, but also revealed a high level of anxiety towards getting involved in the planning and implementation of novel teaching/learning activities. Furthermore, Catherine mentioned that she had failed to grasp the principle guidelines behind the school reform in science and technology, but had always taught one subject at a time (biology or mathematics) and was therefore unaware of how they could be combined around a common theme or a problematic arising from the students themselves. Additionally, although she questioned certain aspects of her university training, she wondered how her lecture-based classroom style could be adapted to comply with the new reform. The issue of evaluating concepts was also a concern to her and made her question its feasibility in teaching. In laboratories, the experimental protocols were always given to the students, thus leaving them with little flexibility in terms of manipulation.

As a matter of fact, right from the beginning of our collaboration (January 2007), Catherine was able to identify several causes of tension that should be dealt with would she participate in the study: (1) insufficient training provided to teachers to allow them to master the current reform; (2) time constraints; (3) not enough information given as to how time spent on lecture-based courses can be reduced; (4) how to deal with colleagues who feel either humiliated or unenthusiastic towards the reform; (5) the inflexibility of the student's weekly schedule. Despite these constraints, after realizing that many of her students were proud of attending tanning salons on a regular basis, she developed the ultimate goal of launching an awareness campaign, and decided to design what she qualified as innovative course plans to redirect her teaching towards the theme of the risks of tanning salons and the implementation of reform.

Data gathering: my ambitions versus some limitations

At first, six participants from four different high schools signed on to take part in my research project. I met twice at their respective schools with five of them (Barma 2008a). Of the six, only Catherine effectively planned and implemented nine biology classes that she described as innovative. The other five teachers did not follow through on their initial intent, owing to work overload, incomprehension respecting the new ministerial guidelines, a lack of support on the part of their administration, or a lack of flexibility in their schedule in relation to evaluation (Barma 2008a). My observations are in accord with findings by Nocon (2008), who inquired into the reasons why desired changes failed to take place in a school, namely, pressure to conform to curriculum objectives, the inability of teachers to personalize their didactic practice, an overload of tasks, etc.

Data were gathered in a girls-only Quebec high school over a 4-month period. While it would have been useful to pursue interviews and visits at the school over a longer period, the single semester study poses some limitations in data collection. For example, Catherine's semester schedule, coupled with pressures related to the summative evaluation, meant that she wanted to limit our meetings to a single semester. While respecting Catherine's semester-long planning process, I did not investigate the impact that the new TLS had on students' appropriation of concepts although Catherine showed me the summary evaluation she gave her students and all the other documents she had prepared to keep track of the students' work. Over the 4 months, I regularly went to the school where a new TLS was planned and implemented by Catherine. There I conducted both semi-structured and informal interviews with the participant. Catherine had a hard time scheduling meetings with me. Our meetings took place between January and May 2007. In

addition to assuming her teaching duties (9th and 11th grade biology classes), she became involved in appropriating the principles of Quebec's new science curriculum. Furthermore, she was responsible for monitoring the academic progress of 30 students in all their school subjects. Thus, I investigated the way Catherine planned and implemented her biology courses with the aim of changing her teaching practice in the context of curricular reform in Quebec. I learned how her thoughts and actions evolved over the 4 months as she decided to launch the awareness campaign on the risks of tanning salons in her school with the hope to have an impact on her students.

Catherine planned and reflected on a TLS in nine classes of 75 min each. I was interested in observing and learning about the process she went through to renew her practice in the context of curriculum reform teaching practice in that particular school. At this point, I want to take the opportunity and the liberty to elaborate more on some characteristics of that context in order to better understand the activity systems I will later describe. This case study will have allowed me to better grasp some of Catherine's teaching personality, but at the same time, as I will specify later on, my interaction with Catherine during the interviews and my informal visits to the school will have also been oriented by my own trajectory and teaching experience. I actually taught high school science for over 15 years before engaging in postgraduate studies. Over the years, I witnessed a change in my own teaching practice and I became more and more interested in teacher training. It led me to contribute to the writing of the new Quebec curriculum. So it was with a triple posture that I engaged interviews with Catherine : as science teacher, curriculum writer and researcher.

What led me to investigate Catherine's school was that it was a school small enough to permit student-staff contact on a personal scale. In 2008, the school had a teaching staff of about 40 and roughly 650 girl pupils aged 12–17 years. I also knew that this school had a long established tradition (150 years) of intellectual freedom and responsible education for young girls. For example in 1925, this was the first school in Quebec to qualify young girls for university entrance.

So, I conducted five semi-structured interviews in accordance with an approach centered on the co-construction of meanings (Savoie-Zajc 2003). The interviews were recorded on digital audio tape. Savoie-Zajc proposes to “view an interview as a verbal interaction between individuals who voluntarily engage in such an action with the goal of sharing knowledge and expertise, and together, create a new understanding of a shared interest” (p. 295 free translation). My personal experience when I am conducting an interview is that the interaction taking place is situational and contextual: therefore, always singular and not reproducible.

As I wished to respect her work pace, Catherine notified me by phone or email to discuss the various phases of the process in which she had become involved. All the interviews recorded in digital audio took place at her high school. Catherine came to each of our meetings with all her planning documents or the documents she had planned to hand out to her students. No recording was made of a first, informal meeting that nevertheless provided material for my research notes. The exact time of interviews was determined by her, who preferred to meet often in order to recount the phases of planning and implementing the TLS developed over the 4-month period. Verbatim transcripts constitute the primary research data and have been supplemented by my research notes and the documents gathered by the participant during work planning TLSs.

An interview framework was developed as a means of laying the groundwork for the meetings. Some of the questions that oriented two of the five interviews are mentioned in the Appendix. The first formal semi-structured interview was focused primarily on some

aspects of Catherine's teaching personality, her understanding of various components of the Science and Technology program (e.g., competencies, the context surrounding the reform being implemented, etc.) as well as her conception of pedagogical innovation—prior to starting in on constructing a TLS in relation to the second subject-specific competency. The second, third and fourth interviews were dedicated to describing the planning and/or implementation of her teaching/learning situation. For these interviews, I did not really have any pre-established framework but I did have a supply of questions for clarification purposes whenever the need might arise. An interval of 9 and 13 days separated these interviews, respectively. The second interview took place 6 weeks after the first. The fifth or final interview took place 3 weeks later. It is important to note that in the interim, Catherine had the time to launch the awareness campaign that she had planned within the framework of her pedagogical interventions. For the final interview, Catherine told me about how the activities had gone and reflected on her process. I took advantage of this opportunity to ask her to what extent she felt that planning this campaign was different from what she was accustomed to doing and what conditions had facilitated or impeded her efforts. In addition, I opened the discussion to talk of her conception of innovation and whether she felt that a new way of doing things in the classroom could at some point become grounded in her teaching environment.

Finally, I discussed the implementation of the TLS with the school principal on two occasions and with the laboratory technician on three. For the purpose of assessing the impact of the implementation of this practice on the other teachers, on four occasions I went to the teachers' classrooms and had discussions with the Catherine's teaching colleagues in the Science, French and Technology departments. Triangulation was performed in relation to the observations noted down during the meetings with the principal, the technician and the teaching colleagues.

Data analysis

During the data-gathering period, analysis of data alternated with field work in accordance with the principles of socioconstructivist grounded theory (Charmaz 2005). For example, the observations and informal conversations figured in my research notes and provided me with insights when interpreting her comments and interview data. Assessing both the tensions identified by Catherine and the ways she had managed to resolve some of them was one way to describe the way she evolved over the 4-month period. Specifically, I used an inductive thematic analysis (Paillé and Mucchielli 2003) to code every interview and to link and group the emergent codes into larger categories: Catherine's academic education; her evolving practice; goals and motivations; and her concept of innovation. Analyzing these aspects allowed me to better describe the cultural-historical aspects of the corresponding effects of the way Catherine transformed her practice and made herself unique but also a part of her school community (individually/community). Throughout this phase, refinements made to my comprehension of Catherine's evolving practice were validated by means of an ongoing comparison of the observations and the emerging analysis.

Next, after getting a better understanding of Catherine's teaching personality, my analysis was performed in compliance with the poles of the triangle of activity theory (Sawchuk et al. 2006). For example, I emphasize Catherine (the pole subject) and discuss how she evolved during the 4-month period as she questioned her training, her practice and then decided to engage in planning her biology classes differently. I used an open-ended (L'Écuyer 1990) content analysis to characterize each pole; these poles being respectively: subject (Catherine), object (the awareness campaign), tools (artifacts that mediate the

activity of producing the campaign), community (actors sharing the activity of producing the awareness campaign), division of labour between the different community actors involved in the planning of the nine classes, rules (implicit and explicit rules set within the school community) (Engeström 2001).

Below is the adaptation of the activity triangle poles in relation to the object of study—namely, a science teacher's production and implementation of a TLS concerning awareness about the risks of tanning salons for human health. This adaptation continued forward with prior research that investigated the importance of the accessibility of information and material resources for constructing new teaching/learning situations (Barma 2008b).

Subject (agent): a teacher or any other member of his/her educational community involved in producing TLSs; in this case, Catherine.

Object: transformation of the environment targeted by the activity: an innovative TLS according to Catherine; the planning and launching of the awareness campaign on the risks of tanning salons.

Tools: material or symbolic tools (artifacts) that mediate the activity; information resources: information resources: magazines, newspapers, media, Internet, textbooks, Ministry programs, TLS models, new teaching practices (problem-based learning, controversy, etc.), software, training sessions offered in the sector; material resources: laboratory equipment, layout of classrooms, computers.

Community: all of the subjects (or sub-groups) who are focused on producing TLSs and who thus stand out from other communities; human and institutional resources; possible human and institutional resources related to Catherine's school community: human resources: individuals, colleagues, laboratory technicians, experts, training staff, principals, parents, and students; community of individuals, such as members of the science department, association of teachers from various schools, parents association; and institutional resources: communities of communities, and collectivities, such as public or private schools, school boards, Quebec Federation of Private Schools, Quebec Ministry of Education, Sports and Recreation, museums, and industries.

Division of labour: horizontal redistribution of actions among the school community members and, simultaneously, the vertical hierarchy of power and status. This pole refers to the organization or set-up within the school: department policy, teachers' task description, possible support of an educational adviser, sharing of skills between teachers, laboratory technician's task description, possible support of an educational adviser, sharing of skills between teachers, laboratory technician's task description, dynamics in the classroom between the teacher and the students, collaboration between teacher/students/experts (curricular or extra-curricular).

Rules: Standards, conventions, implicit and explicit habitual ways of maintaining and regulating actions and interactions within the school; explicit ways: establishing schedules, use of school space and time; and implicit ways: experimental methods in the lab, teaching practices, subject-specific teaching framework, emphasis on the acquisition of concepts, importance of exams, performance of the school at national level.

As was mentioned above, the poles of an activity system represent key nodes that at an initial level of analysis require some characterization. But though they may be analyzed in isolation from one another, they must also be placed in relation to one another in order to facilitate a systemic interpretation of the teacher's activity.

Once the poles were characterized, I engaged in a systemic interpretation through an analysis of sub-triangles (three poles at once) (Class 2001). Each pole making it possible to highlight the interrelations between three poles of an emerging activity system as the planning of the awareness campaign went on. In the context of this contribution, the

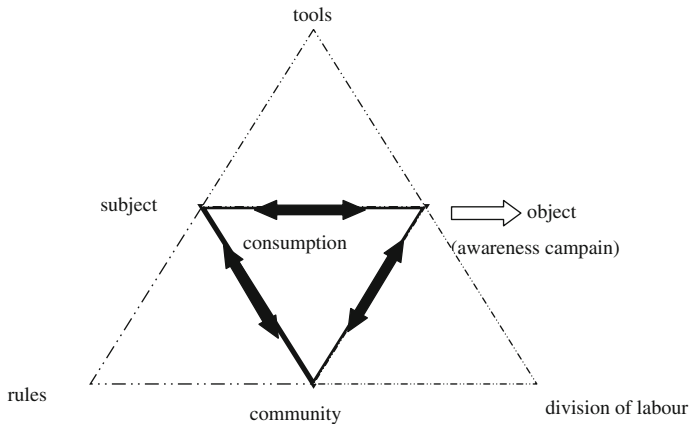


Fig. 2 The sub-triangle “consumption”

sub-triangle I chose to describe shows how the new TLS was consumed by some members of the school community (Fig. 2).

As my data contributed to enrich each pole, I performed a more exhaustive description of the interrelations between the entire set of poles. This enabled me to identify activity systems illustrating the unfolding of the awareness campaign, the tools that mediated the activity, and the way division of labour and rules were negotiated amongst different members of Catherine’s school community to make it happen (Bracewell et al. 2007). The identification of activity systems came into sharper focus through the characterization and correlation of the six poles (subject, object, rules, division of labour, community, tools), the charting of how they meshed with one another, and the modelling of the tension-resolution process.

Discussion of findings in relation to activity theory

Experiential trajectory of Catherine’s practice through some of her autobiographical narratives

Catherine chose the theme of the risks of tanning salons for students’ health because she had noticed for some time that several of her students frequently used these salons: “We often heard about this problem in the school, and all of us teachers began to become seriously concerned!” This situation was a source of serious concern to her. She was unsure of how to go about addressing it in her classes or how to engage in dialogue on this subject with her students. She wanted them to construct an informed opinion about the dangers of tanning salons for themselves. This theme did not figure in the curriculum, but she saw in it an opportunity to engage into a new approach to course-planning and thus, momentarily, depart from the prescribed curriculum. The goal of this TLS, which she would plan on her own without following a teaching guide, was to organize an awareness campaign concerning the risks of tanning salons for the entire school community. She had the full support of the principal of the school.

Over the 4 month period, the planning and implementation of Catherine’s nine classes involved members of her school community and entailed not only the renegotiation of some

Table 2 TLS on awareness of the risks of tanning salons: nine, 75-min classes

Class	Description of activity
Class 1	Lunch-time talk for all grade 9 students by a dermatologist concerning the risks of UV exposure for human health. Three out of four 9th grade classes attended the conference. Some of Catherine's colleagues attended the presentation too and showed great interest.
Class 2	Discovery activity on skin functions. Inductive approach in laboratory setting. The protocol was not given to students. Students brought material from home.
Class 3	In order to identify what was worth studying in the context of the study of the danger of tanning salons by the students themselves: information search by students and team development of a network of concepts.
Class 4	Lecture-based course on the electromagnetic spectrum. At this point, Catherine felt she had to go back to a more "formal" science class setting to integrate the elements identified in the first three classes.
Class 5	Back to the lab. Inventory of the list of ingredients of sunscreens provided to Catherine by a colleague who also worked in a pharmacy.
Class 6	Forming of teams and launch of work to develop the awareness campaign for the entire school community.
Class 7	Continuation of teamwork.
Class 8	Presentation of posters in a public space of school.
Class 9	Production of a moisturizing cream in laboratory by the students. Technological design of a product. Reinvestment of Class 5.

operating rules in the classroom but also a temporary redistribution of the division of labour within the classroom and between her and some of her colleagues at school who had to accept a change in their teaching schedule in order to allow Class 1 (the conference) to take place. For eight of the nine classes, she chose to depart from the textbooks that she habitually used, and accepted the insecurity associated with her option. She gave more space and power to her students as they had to seek information by themselves, and also relate to an expert in the field of skin care. She also chose to seek out resources in places where she did not usually go to find them—namely, outside the school (a dermatologist and a pharmacist). In Table 2, I summarize how Catherine planned and implemented (produced/reproduced) in nine classes the goal of launching an awareness campaign in the school.

In the following sections, I focus on Catherine's evolving thoughts and reflections on her actions as she started collaborating with me. The following themes represent a chronology of Catherine's thinking and reflecting over the 4 month period of planning and implementing the awareness campaign through the lens of activity theory.

Catherine's academic education

Catherine started her education at the university in 1997 opting then for an undergraduate degree in Physical Education that she completed. While at the university, she taught figure skating classes for 5 years and really enjoyed it. After graduating and not really knowing

what she would do with her degree, she decided to go back to school to become a high school biology and mathematics teacher.

After completing this second undergraduate degree, the direction taken by her career path could be glimpsed in relation to two main factors: an interest in the practical aspect of her university training and education as well as the considerable importance she accorded to being with young people: “For sure, being in close contact with young people—that was a major factor that influenced my choice. Being with young people.” When I asked her to reflect on how much she had enjoyed her studies and how this had oriented her at the beginning of her career, she pointed out to me:

The theoretical courses I received at the university, I can’t say they played a decisive role in my teaching personality. It was more the student teaching sessions [practicums] that helped me find out what kind of teacher or what my personality, as a teacher really was. It was really directly in the field [that this discovery took place]. (Interview 1)

Still, reflecting on the university classes in the lab, and referring to her academic training Catherine replied,

Like, actually, there weren’t a lot of discoveries; we didn’t discover much at all. They’d say: here’s the theory—what it is—and we’re going to put it into practice and you’re going to verify whether it works or not. (Interview 1)

Catherine’s evolving practice

When I asked Catherine to describe and assess how her practice had evolved in the last 5 years, she immediately confirmed that her teaching approach had undergone a major shift in the time since she started into her career. This shift concerned the way she personally viewed herself in the classroom with her students, the teaching approaches she now favoured (like open inquiry in the lab, concept mapping, team work), her increased confidence in respect to the subject matter she taught, and the role she assumed in her dealings with her students. She commented, “I’d say there was a 180° shift. I don’t see myself at all the way I saw myself as a teacher 5 years ago ...because [now] I’m more at ease in front of classes of students.”

Again, in hindsight, Catherine took a critical view of what she qualified as her university education’s traditional approach to laboratory work. On the one hand she strongly emphasized the need of refusing to fall into a routine and, on the other hand of throwing into question one’s teaching practices.

I’m also more at ease with the content and, at the beginning I was insecure and had a tendency to stick closely to the teaching system I had experienced as a student, meaning in math and science. There’d be a little bit of theory [followed by] exercises. Same thing during the following class—[it was] the same routine in every class.... At the beginning of the current [school] year, I was OK with doing things that way, but then later I found myself to be really dull to be continually teaching that way. I said to myself, ‘There’s no way my career is going to be like that! I’m gonna have to be motivated and change my teaching strategies.’ It was at that point that I expanded my horizons and realized that there was a load of resources around me, but [at the same time] there was more than just my textbook and my exercise booklet. (Interview 2)

So Catherine chose to distance herself from lecture-based teaching approaches which she saw as being boring and unstimulating for her students. Since the new Science and Technology Program had been implemented 2 years before, she threw into question the relationship to authority that she had been maintaining with her students and now saw herself more in the role of a guide coaching them along in their learning process: “I’m there just to guide students, provide information at the right time, so as to enable them to gradually move ahead in their project.”

Catherine’s innovation in teaching science

In my opinion, Catherine was a dynamic, motivated teacher. She also had a desire to grow as a teacher. She stated, “But speaking for myself, even from 1 year to the next, I rarely could do the same projects. Since, I figure after 10 years, you can’t keep doing the same projects. That’s just unthinkable!” She accepted the insecurity associated with renewing her practice, and while planning the awareness campaign, she chose to be confident about the unforeseen events that were likely to crop up, but was still not sure how to plan and what to do regarding the new curriculum.

All the same, I feel far from all that [the curriculum]; I need a better vision of my situation before I take that step [getting involved in a form of activity planning that is designed to be innovative]. ...Honestly, [about] this activity [the new TLS], I don’t know how I’m going to present it. (Interview 2)

Her motivation for teaching was quite high and she demonstrated a positive attitude not only in respect of teaching but also in relation to the context of the reform being implemented in her school. Despite the fact she did not at first understand all the underlying principles, she gained confidence and focus in teaching the lessons.

Yes, I knew I would do it, but I wasn’t able to be specific. But during the entire process of preparing the situation, it came into focus. (Interview 5)

Whereas now, there are so many ways to establish a link with everyday life. That is what I really like! This way, the theoretical notions are made tangible. It’s more meaningful for students, under this approach, [under] the reform. (Interview 4)

The predominant concern that Catherine had was to “develop students’ autonomy and get them to discover concepts on their own, and also establish links between these various concepts.” To develop each student’s autonomy was linked to the way she redefined her role as teacher—i.e., in terms of being a guide. Accordingly, she made a point of fostering both the resourcefulness and the reflexivity of her students. Her lab technician was fully supporting her and the rules in the lab changed. Protocols were not given to the students. This changed the division of labour in the lab: the technician would not display the material needed, he would wait for the students to ask him. The teams would not necessarily do the same thing at the same time since each of them decided independently how to investigate a problem such as analyzing a sample of sunscreen or producing a skin moisturizing cream.

She was particularly mindful of the girls’ personal development. Likewise, she laid stress on developing her students’ capacity for critical thinking, but always in relation to their daily lives. This concern did not extend far beyond the framework of students’ personal lives (particularly the aspect relating to their physical health) to empower them with better citizenship. For example, during Classes 2 and 3, problem-solving was her preferred approach for advancing her classroom goals.

I seek to develop resourcefulness, avoid giving students information right away but instead [try to] guide them, aid them to reflect so that they finally manage to discover certain notions or establish parallels between certain concepts. I have to admit [that this way of teaching is] demanding. ... I'm going to give them just enough information so that, eventually, a light bulb goes on in their head and they are able to establish a relationship between the concepts. (Interview 3)

I was able to witness how she had the students achieve that goal: she showed me the concept maps they produced after seeking information by themselves.

This may develop your brainpower or your capacity for resourcefulness and logical thinking, as well as a critical attitude toward the information you receive, and not take this information for absolute truth. Try to understand why it's that way, justify your choices. (Interview 3)

As I was collaborating with and witnessing Catherine's actions, putting these teaching methods into practice was, in her opinion associated with the introduction of new ideas and new ways of teaching. This could in turn improve how a TLS was experienced in the classroom or in the school right now. She mentioned the importance of trying out new things. In her view, it was also important for an innovation to have a positive impact on other teachers who would subsequently rally as a group to this cause. She compared what she was doing now with what she had been doing in the classroom the previous year. She was also of the view that innovative practices had begun to become grounded in her school, and innovation should have "an impact on other teachers" and that "everyone is coming on board." She felt that the new ways of teaching were "going to remain in science." The teachers in her science department appeared to have an influence or spillover effect on her. She noted that one of her colleagues would be retiring the following year and that her science department would be receiving an infusion of new blood; at the same time, however, she pointed out that the departing teacher was someone who was open to change. Still, Catherine was optimistic that the innovations would become a common practice in her school.

Yes, I am convinced of it. [The innovation] is already well implemented in grades 7 and 8; the [Grade 7 science teachers] have an influence on me, are a great source of motivation for me. Now, for sure, in grade 10, there's somebody coming up for retirement this year. It's true this person was well informed; I'm sure she would have come on board, no problem. And the person replacing her is, I'd say, rather young, since the older teachers, well, it's not that they're less motivated by it... All in all, this person [the hiree] has been involved in the new curriculum movement for some years now, so I'm sure it's going to go forward (Interview 5)

During the second interview, her interest in the theme of awareness about tanning salons came into greater focus, and she mentioned the possibility of implementing a campaign throughout the school. She informed me that by taking action she had begun to appropriate the spirit of the new program. At the end of the 4-month period and once the campaign was over, Catherine pointed out that she had the full support of her principal for her project. The goals Catherine developed for the awareness campaign were coherent with the educational project of her school, and this was something that satisfied her principal.

The overarching educational project of the high school is to develop students' capacity for critical thinking and their autonomy, to enable them to make sound

choices; that's the kind of education we're going to do with this presentation. Following that, students will be better equipped to make a decision about going to the tanning salons. (Interview 5)

While I am mindful of the limitations of investigating Catherine's teaching, I take away that she indeed possessed a strong motivation to teach, a passion for her profession, a concern for pushing back her limits, and a positive attitude toward the education reform being implemented in her school. The reform created some anxiety with teachers the 2 years before it was adopted. But the reform was enough motivation for Catherine to launch into a new way of doing things in her biology class.

Emerging activity systems

In the following section, which is presented in a slightly different format, I will continue to present the findings of the study and offer a discussion in conjunction with activity theory. This will allow me to make more explicit connections to the changes in practice that Catherine had undergone, inasmuch as when discussing how the poles of an activity system are interrelated, I am also discussing activity theory as a means of interpreting the findings.

The subject and the development of the activity

On the basis of the characterization of the pole "subject", it is possible to make out a few aspects of the evolution of her practice in the science classroom. I had met with Catherine in the context of the implementation of the new curriculum 2 years before we started our collaboration and she had expressed great anxiety about it. Actually during this time, I was still involved with the Ministry of Education of Quebec and was giving talks about the new science and technology program. But she decided to collaborate with me 3 years later. I wanted to better understand how Catherine approached the changes in her practice without my direct guidance. She met with me so that I could learn about the awareness campaign she chose to do with her class.

Over the 4-month period, my data show that her relationship to the way information circulated in the classroom was undergoing change. This is a tension I identified and that she resolved—going from a more transmissive teaching approach to a more interactive classroom dynamic. With a new program that focused on development of competencies (less on content), she saw an opportunity to change in her biology class. As I pointed out previously, she started viewing students as important actors in the science laboratory. Some rules and division of labour between the students themselves and Catherine then changed. Catherine was doing the best she could to avoid a transmissive mode of teaching. She asked several members of her school, i.e., colleagues, principal, lab technician, TIC technician and the students, to share the tasks to be performed within the framework of the nine classes that she had planned for the awareness campaign. Over that period, she also contacted an expert from outside the school and invited him to address her students. By inviting a dermatologist to school, Catherine delegated power in the class by allowing an outsider to come in and teach her students: this is an example of how rules and division of labour changed. Catherine got the idea of inviting a dermatologist to meet with her students after consulting with one for her own skin care. The visit to her doctor happened between our first informal interview and the first recorded one. I recall her being very happy about it and it gave her a first boost to start something different with her classes.

Also, the invitation to invite a pharmacist came when she was in another teacher's room talking to her colleagues about her project and a newly hired teacher told her she had a background in pharmacy and was actually working part time in a pharmacy to make a bit more money. Her colleague approached her boss, described to him Catherine's project, and he then offered to lend sunscreen lotions to Catherine's students. As part of the awareness campaign, students listed the ingredients so that they would better understand the role each ingredient played in skin protection.

Catherine made many modifications and adjustments to her teaching practice. In the process of making change, she encountered several tensions in how to change from old to new ways of teaching. Over the 4 month period, Catherine became aware of the dialectic relationship of producing/reproducing. She really tried hard to overcome the habit she had of engaging in a lecture based class. For example, she resolved some of the tensions she faced in order to make a change in her practice during the nine lessons by not only changing her practices but allowing students to make adjustments also (Table 3), and these changes are also indicated through an activity theory lens (Fig. 3). Although Table 3 presents the tensions identified and resolved separately, these two plans are interdependent: they mutually constitute and presuppose each other.

Concerning Catherine's general planning process, all the class and out of class actions relating to the Teaching and Learning Situation were aimed at building awareness among the girls about the impacts on skin from exposure to UV rays in tanning salons, primarily through an awareness campaign conducted in the school. Her goals found support among the teaching and student activity units for the awareness campaign. The underlying intentions were shared among the community, and collaboration with peers and students began to take shape. Both the teaching and student activity units gave the green light for organizing the exhibition. The information circulated and was shared throughout the school, including teacher's room, among the members of the student activity unit or among students. For the final project or culminating activity of the nine classes, there was a showing of student posters. The activity triangle relating to the production and displaying of the awareness campaign posters at L'Atrium and elsewhere in the school which took place after class 8. "L'Atrium" is a public place where students spend time in between classes, in the morning, at noon-time and after school. It is located between the student lockers in an area through which all school staff members may pass several times a day.

Catherine's capacity to engage in critical learning and reflecting on her practice and her willingness to work through her limits were indicative of her change in practices. Her motivations in relation to the implementation of an awareness campaign for the entire

Table 3 Tensions identified and resolved: subject-division of labour-object

Tensions identified	Tensions resolved
Siloing of information	Circulation of information among members of school community
Passive student who follows a laboratory protocol provided by teacher	Modification of the role played by student in lab: protocol developed by active students (classes 2,5, 9)
Teacher is transmitter of knowledge	Teacher guides students in their learning process (all classes except 4)
Specific tasks assigned to members of the school community	Tasks shared with a view to rearranging students' schedules and arranging for the use of public space (classes 1 and 8)

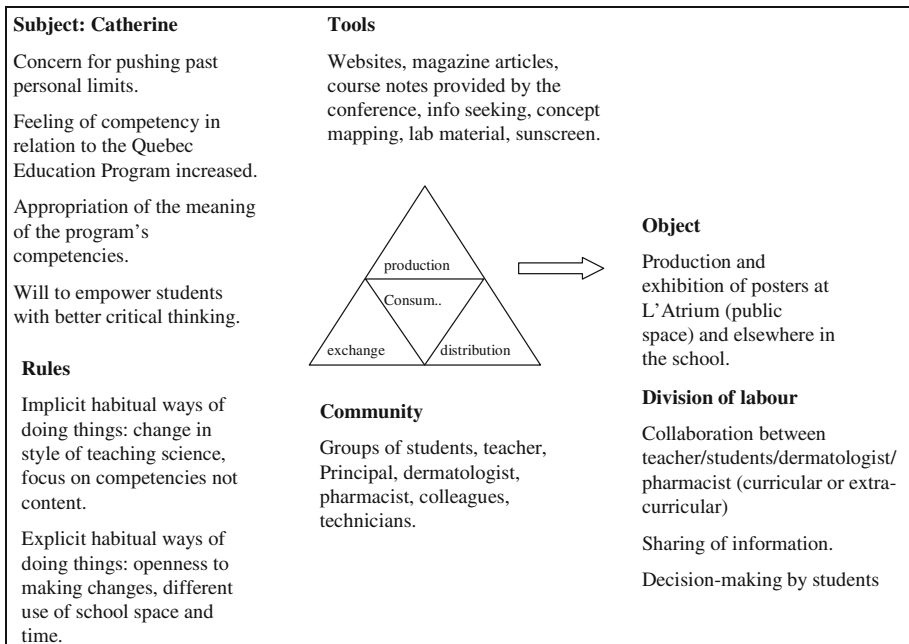


Fig. 3 Awareness campaign through the lens of activity theory

school was closely linked to science and how science is applied in daily life. Putting the posters about tanning salons on display was a project dear to her. It was important to present the results of students' work outside of the classroom setting so as to enable several members of the school community to view them and reflect on them.

The posters developed by students constituted an example of a power shift in terms of in-class relationships. For example, students enjoyed a greater degree of freedom than within the framework of a lecture-style class. Each team designed a poster to build awareness among members of the school community about the effects of tanning salons on human health. Information resources played a major role. The ensuing poster exhibition drew on most of the information resources that had served to mediate the activity during all the classes occurring prior to this event—e.g., Websites, magazine articles, course notes, the remarks of the dermatologist who came and met the students one Friday afternoon, the mapping of concept networks constructed by the students themselves. Several material tools also proved essential and had to be made available—including poster board, drawing materials, PowerPoint projectors and screen, etc.—for easy dissemination of the information generated by the students.

In little under 3 months from the start of my collaboration with Catherine and the *Awareness Campaign on the Risks of Tanning Salons* production, all the activities had been implemented. The various components of this activity system shared the same object—that is, a transformation of the learning environment in a context of a curricular reform that was used to cause awareness of students about a problem specific to their school community.

The sub-triangle: consumption: new forms of participation

Now, to continue a discussion of change in practice in relation to activity theory, I break down the activity system just presented and look at one of the sub-triangles for discussion.

I chose the triangle consumption because it illustrates the way information and collaboration flowed throughout the school as the campaign was being put together and it also shows the way some members of the school community contributed to its success. As I mentioned previously, according to Engeström (2001), the goal of activity (the production and implementation of the new TLS, in our case here) is constantly evolving and cannot be reduced to short-term objectives. New representations must make sense for all. The following illustrates how different members of her school community made it possible for her to innovate in her practice. It is important to note here that Catherine (individual) and the community are dialectically constituted by the activity through shared goals and motives. This explains why the awareness campaign was a success in the end.

The sub-triangle (consumption) (Fig. 4) relates to an interpretation of how the object of study (the transformation of the environment targeted by the actions related to the new TLS) was accepted in the school community. In this connection, I have selected one component of the community that was particularly conducive to the implementation of the TLS in the activity system thus described—namely, the “dynamism” of the science department and the collaboration occurring between the teachers and the laboratory technician.

The analyses bring out Catherine’s strong desire to vary her teaching approaches when implementing various actions as part of carrying out the awareness campaign in her school. I previously described certain aspects of her personality coupled with the importance she attached to empowering the girls to make better choices in relation to their health. Catherine understood the school’s overarching educational project. She suggested that one of the aspects of the high school’s overarching educational project was to develop students’

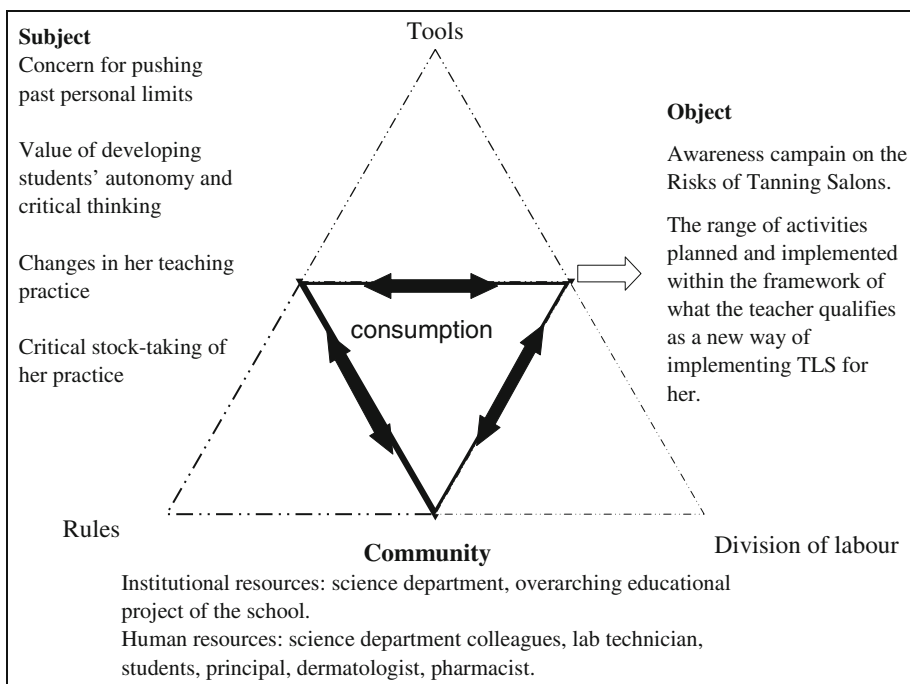


Fig. 4 Consumption (subject-community-object)

capacity for critical thinking and their autonomy, and to enable them to make sound choices in their lives. She also added that the Teaching and Learning Situation that she was seeking to develop fit with the thrust of her school's educational project. The science department appeared to espouse the same vision, with collaboration between its members often coming in for mention by the teacher. Thus, she implemented these school goals into her teaching and changes in practices, and in particular through the awareness campaign.

Even though she was the only 9th grade biology teacher, she talked about those colleagues of hers who had already begun implementing new practices, such as having a more inductive approach in the lab, inviting experts into the school, developing interdisciplinary actions and exchanges with her colleagues who were teaching other subjects, etc.), and frequently shared views and experiences with them. In her opinion, the arrival of young teachers in her department augured a time of renewal. Even when noting a colleague's imminent retirement, she also pointed out that the teacher in question was someone who was open to the introduction of the reform and who welcomed dynamism in the department. She emphasized the collaboration of the laboratory technician, which facilitated the implementation of her lab activities. She mentioned that to a very great extent, she shared experiences and views with the other people in the science department. Whenever she attended training sessions, Catherine commented that she was keen to share her new information with the other people in the department.

Thus, this sub-triangle (among several others I was able to identify) shows that the efforts dedicated to renewing this teacher's practices were well accepted in her community—whether in terms of her department, whose members demonstrate an attitude of collaboration, or in terms of a fit with her school's overarching educational project, which was aimed at developing students' autonomy and capacity for critical reflection. Catherine's evolving thoughts and actions over the 4-month period, and her concern to pushing past personal limits, to not practice lecture-based teaching, and to change her self-perception and teaching style are in accordance an open attitude to accept reform and to make it happen. The overall effect was to allow the *Awareness Campaign on the Risks of Tanning Salons* to be implemented in a spirit of collaboration between her and her school community.

At this point of my discussion, I want to take the liberty to say that even if I could have considered the changes happening in Catherine's school community (new roles, collaboration, co-construction of meanings) as the object of the activity, in the context of this contribution I have chosen to remain focused on the unfolding of the campaign itself. From another angle, the community could become a tool that would mediate the activity.

Learning as an individual and a collectivity in and through participation

In the context of a science curriculum reform, Catherine modified her classroom practice over a 4-month period. With the goal of having her students make the most of their knowledge of science and technology, she grounded an awareness campaign in one of the broad areas of learning of the Quebec Education Program that deals with issues that are important to students—Health and Well-Being. In the process, she framed her interventions in relation to a problem situation that genuinely figured in the experience of the 9th grade girls—namely, the use of tanning salons. She thus enlisted the assistance of experts and other teachers in order to build awareness among her students as to the risks associated with these salons. She threw into question the way she had been trained at the university.

If we get back to the concept of activity itself and recall that activity is a goal-oriented and tool-mediated action, the activity pursued by the subject is analyzed in its dynamics,

transformations and in its evolution and historical change. By using activity theory, I have presented a chronology of how the pole “subject” has evolved over a short period of time (4 months) and how she engaged in a project she thought was innovative for her. Listening to Catherine and talking to some of her colleagues, the principal, and lab technician, I see that shared construction of meanings did indeed take place and that a common goal was shared in that girls’ school. Hence, anchoring a TLS in the theme *Awareness of the Risks of Tanning Salons* made it possible for her to make an effort to change her pedagogical approach so as to allow the girls to adopt an alternative investigation process in the lab (open inquiry), consulting an expert outside the school (the dermatologist) and by seeking relevant information related to the risks of tanning salons. Many members of the school community who participated in the development of the campaign saw some of their roles and routines change during the activity. These findings are consistent with the way transformations take place within evolving activity systems. It also illustrates the importance of individual/collective relationships.

Will Catherine continue to try and take a different approach to her teaching practice? Further investigation will be required in order to know one way or the other. In my view, this practitioner at least has the merit of momentarily taking an interest in throwing her customary planning process open to question and in grounding her practice in a controversial issue that was taking place in the school, and was able to do so as she also implemented new reform and changes in her teaching practice. It would also be worthwhile investigating whether such a practice did or did not have an impact on the girls by prompting them to exercise caution when considering visiting a tanning salon. Here are some questions that would be worth exploring.

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Appendix

First interview

- What university training and education did you receive?
- Do you think your university education has had a major impact on the way you teach? If so, why? If not, why not?
- What kind of student do you want to educate when you prepare your courses in the context of high school science teaching?
- What is your first impression of the Science and Technology Quebec Program?
- In a few sentences, how do you define yourself as a high school science teacher?
- What led you to become the teacher you are now?
- What motivates you to persevere in this profession?
- Comparing what you were as a teacher at the beginning of your career and what you have become today, how would you describe the main changes?

Fourth interview

- Do you consider the TLS that you produced to be innovative? If so, to what extent is it innovative? If not, why is this so?
- In your opinion, what are the required conditions for pedagogical innovation in a context of science education?

- In your opinion, what could your school do to support your efforts to develop TLSs that are designed to be innovative?
- Could you identify sources of tension that would place a damper on your desire to renew your pedagogical practices or that had the potential to generate constructive changes in your teaching environment?

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Author Biography

Sylvie Barma is a professor of Science Education at the Faculty of Education at Laval University. After teaching high school science for 20 years and contributing to the development of the new Quebec Science and Technology curriculum, she recently obtained a Ph.D. in Science Education. Using the third generation of Activity theory as a theoretical and methodological framework, her work focuses on science teacher's efforts to modify their practice when tools like a new curriculum are introduced in education. Her research takes into account the role of tools, community, rules, division of labour and cultural-historic dimension of different actors in a school community.