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Using the Deficit Model, Public Debate Model and Co-production of Knowledge Models to Interpret Points of View of Students Concerning Citizens' Participation in Socioscientific Issues

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In the first part of this article I propose a conceptual framework – based on the deficit, public debate and co-production of knowledge models articulated by (Callon, 1999) – with which to examine students' appropriation of de socioscientific issues (SSI). The second part of this article presents the way a group of three post-secondary/pre-university students described the attitudes, interests and capacity for understanding of citizens concerned by the controversy surrounding the use of cellular telephones, and how they viewed the conditions under which citizens could contribute to public debates. This study was conducted on the basis of an ethnographic approach. Participant observation was performed by the researcher for three hours during each of fifteen weeks. Findings indicate that the group of three students ascribed to citizens deficits of knowledge and comprehension, and authorized a limited participation of citizens in public debates. Implications for science teaching are discussed. It is argued that the use of the conceptual framework set out in this article in a science classroom would, on the one hand, enable teachers to "problematize" SSI in a way accounting for citizen participation in sociotechnical debates and, on the other hand, provide students with a basis for developing an understanding of SSI management that breaks with an interpretation centring on the deficit model as applied to relationships between citizens and scientists.

Key Words: citizen participation, deficit model, co-production of knowledge model, public debate model, socioscientific issue.

Introduction

The notion of scientific literacy constitutes a cornerstone of current science education (Aikenhead, 2007; Cross & Price, 2002; Fourez, 1997; Laugksch, 2000; Roth & Désautels, 2004). While the meaning and import of "scientific literacy" remain a considerable bone of contention (DeBoer, 2000; Fensham, 2002), there is widespread agreement among researchers as to the value of engaging young people in the study of current socioscientific issues (SSI) with a view to giving people the means to communicate about science, deal with everyday situations involving science, activate human and non-human resources (course contents, metaphors, etc.), and take an active part in discussions and debates with those scientists who are called upon to express their views in the capacity of experts (Turner, 2008;

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Sadler, Barab, & Scott, 2007; Zeidler, Sadler, Simmons, & Howes, 2005). In the same vein, numerous studies in the field of science education have been conducted into students' appropriation of SSI (for a review, see Aikenhead, 2006; Sadler, 2004; Zeidler et al., 2005). A number of them have identified the values that young people bring into play as they work out a position toward SSI (e.g., Grace & Ratcliffe, 2002; Sadler & Zeidler, 2002), while others have explored the links between the ways young people conceive of the nature of science and the position they adopt toward SSI (e.g., Sadler, Chambers, & Zeidler, 2004). Yet other studies have attempted to analyze the ways young people evaluate the information on science presented in the media and use evidence in arguments for and against subjects of controversy (e.g., Kolstoe et al., 2006; Tytler, Duggan, & Gott, 2001). Finally, there are a number of studies that have documented the argumentative apparatus deployed by young people when discussing SSI (e.g., Albe, 2008; Jiménez-Aleixandre & Pereiro-Munoz, 2002; Osborne, Erduran, & Simon, 2004) or examined how students make use of science content for socioscientific argumentation (Sadler & Fowler, 2006; Sadler, Barab & Scott, 2007).

Studies conducted to date in the field of science education concerning students' appropriation of SSI have provided insight into various aspects of students' decision-making and the argumentative devices and values activated by young people. At the same time, however, they have provided little information concerning the way young people conceive of the relationships between citizens and scientists with respect to the way that SSI take shape and are managed. Now, it is my view that research into students' conceptions of the roles falling to various social actors concerned by SSI (scientists, industries, citizens or governments) in public debates or into students' descriptions of the relationships they maintain toward people whom they consider to be scientists can contribute to current reflection on achieving science education of a kind that can empower people to take part in debates over sociotechnical issues and in policymaking (Cross & Price, 2001; Roth & Désautels, 2004). The comments of Tutton, Kerr and Cunningham-Burley (2005) provide illustration of the view according to which the manner in which young people conceive of the legitimacy of various actors in the handling of SSI and structure their positions toward scientists asked to provide their expert opinions on a particular subject shapes their behaviour, particularly in respect of their participation in public and political debates and discussions: "What people bring to [these] debates, and the extent to which they are heard or can influence policy, depends on construction of expertise and citizenship and the different knowledges, experiences and subjectivities implicated in such roles" (Tutton, Kerr, & Cunningham-Burley, 2005, p. 101). Thus with the express objective of documenting this dimension of students' appropriation of SSI, I have, in previous research of mine, undertaken to: 1) analyze the way students voice their opinions with respect to the definition of sociotechnical problems, the constitution of research "collectives" and the dissemination of the resulting knowledge (Pouliot, 2008); and 2) describe their relationships with the people they consider to be scientific experts (Pouliot, 2007).

Now, this article is designed to: (1) present the way a group of three post-secondary/pre-university ("cégep"[1]) students describe citizens' attitudes, interests and capacity for understanding as well as participation in public debates in relation to the controversy over cellular telephones; and (2) propose a conceptual framework centred on the notions of deficit, public debate and co-production of knowledge models (Callon, 1999) with which to interpret students' appropriation of SSI.[2]

To begin with, I sketch out a brief, partial portrait of current topics of reflection in the fields of science and technology studies and public understanding of science in relation to the conditions framing citizens' participation in the management of SSI and in setting the agendas for science research and policy-making. Then, I introduce the three-fold conceptual framework used to interpret the group's point of view. Following this, I draw on excerpts

from conversations among the group members to illustrate the terms which they use to describe the citizens concerned by cellular telephone issues and the participation of the latter in managing this controversy. In my conclusion, I highlight a number of implications of this study for science education research and a form of science teaching that directs attention to citizen-scientist relationships and the political aspects associated with the management of sociotechnical controversies (Bucchi & Neresini, 2008).

Background and Conceptual Framework

According to Lynch (2008), never has concern for citizens' participation in the management of SSI – and specifically, the recasting of conditions under which citizens may engage in the debates and decision-making processes relating to current controversies – been as pervasive as at the present time. The strength of this interest is attested by, on the one hand, the articles of Callon and Rabeharisoa (2008), Chilvers (2008), Stirling (2008) in *Science Technology & Human Values*, along with Wynne (2008)'s reply to the article by Durant (2008) in *Public Understanding of Science* concerning Wynne's research on theoretical conceptualization of lay actors, and, on the other hand, the chapters authored by Bucchi and Neressini (2008), Evans and Collins (2008), Lynch (2008) in the *Handbook of Science and Technology Studies*, edited by E. J. Hackett, O. Amsterdamska, M. Lynch and J. Wajcman (2008). Moreover, the desire to document the terms of citizen participation in science policy-making in various countries is manifest in the articles of Epstein (2008), Kerr, Cunningham-Burley and Tutton (2007) and in the chapters authored by Keeley (2005) and Rusike (2005) in *Science and Citizens* (Leach, Scoones, & Wynne, 2005). These empirical and theoretical contributions have helped to chart some of the potentialities and limitations of lay participation in science policy, to articulate questions that future research should address and to illustrate how some of the models of lay participation in the shaping and managing of SSI offer a picture of citizens destined to assume only the slightest of roles or to choose among a range of pre-determined options rather than to play an active part in setting research agendas or in the determination of actions to prioritize (Lengwiler, 2008). As has been noted by Leach, Scoones and Wynne (2005):

> [T]here is now an expanding array of overt engagements between science and citizens. Along with the recognition of the ways in which scientific discourses and notions of human agency and citizenship have for long been tacitly interwined and mutual, the proliferating encounters force us to break down established analytical categories to recognize new synergies between expert and lay knowledge, new linkages between local and global processes, new relationships between state and non-governmental action, new networks of international activism, and a variety of hybrid forms of public and private control and ownership that frequently transcend national boundaries (p. 3).

A current vein of discussion centres on the extent to which the interpretative conceptual frameworks prevalent in the field of science and technology studies can be profitably applied to research in science education (Aikenhead, 2007; Duschl, Erdurant, Grandy & Rudolph, 2008; Pouliot, 2008; Turner, 2008).[3] In that connection, moreover, it is worth noting that my interest in students' appropriation of the controversy surrounding cellular telephones and its links to the way these young people describe the relationships between citizens and scientists has stemmed primarily from how this controversy was and continues to be a major "story item" in the world's media. On the one hand, there are those scientists who claim that the use of cellular telephones is harmful to human health while, on the other, there are those that

hold that the microwaves emitted by cellular telephones are harmless (see www.powerwatch.org.uk, a Website dedicated to surveying the various studies on the subject and that highlights their main findings). Furthermore, this controversy shows up the tension occurring between various manners of conceiving of citizens' understanding of SSI and the participation of lay citizens in public debates (Drake, 2006). As noted by Drake, who analyzed the viewpoint of the members of a protest group fighting the installation of a mobile phone mast in their village, "protesters' concerns often focus on the claimed ill effects of mobile phone technology, which are frequently dismissed by industry and scientific experts" (p. 387).

The deficit model, public debate model and co-production of knowledge model that I have used to interpret the viewpoint of the three cégep students on the subject of the citizens concerned by cellular telephone controversies were previously articulated by Callon (1999) with a view to covering the range of possible modes of representation by non-experts in science and technology debates. They stand out from one another particularly in terms of the visions they provide of the legitimacy ascribed to the participation of citizens and scientists in debates, of the value and potential contributions of the knowledge held respectively by lay citizens and scientists, and of the roles of citizens in the production and dissemination of scientific knowledge.

It goes without saying that there are both advantages and limitations of using the deficit model, public debate model and knowledge production model to interpret the shaping and managing of SSI. The main advantage of such a conceptual framework is the basis that it offers for examining the shaping and managing of a controversy from angles that take into account the relationships between citizens and scientists with respect to the legitimacy of their participation in debates, to the potential contributions to be derived from their respective forms of knowledge, and to their roles in the production and dissemination of scientific knowledge. The main limitation of this conceptual framework consists in its apparent rigidity concerning the representation of the nature and roles of citizens and scientists in terms of handling contemporary SSI. Actually, however, this conceptual framework is rather malleable and lends itself well to interpreting current and hybrid management situations. As has been noted by numerous authors (e.g., Bucchi & Neresini, 2008; Callon, 1999; Chilvers, 2008; Jasanoff, 2003; Lengwiler, 2008), although SSI management practices provide evidence of a predominant pattern, the conditions surrounding the relationships between citizens and experts are themselves often hybrid, evolving and specific to the contexts encompassing and structuring them. The second main strength of this conceptual framework stems from the first – namely, its potential for further developing and refining reflection on SSI appropriation of a kind that enables young people to position themselves as legitimate, competent partners in the SSI-related discussions with which their society must grapple (Cross & Price, 2002; Roth & Désautels, 2002).

The Deficit Model

The deficit model, which is also referred to as the "public education model," is equated with the most widespread type of SSI management (Kerr et al., 2007). It has come in for severe criticism owing to its normative and epistemological implications (Sturgis & Allum, 2004). This model works from the premise according to which only scientists are able to grasp the full complexity of SSI (Callon, 1999). The result is a dual divide between citizens and scientists concerning the right to express one's views and the roles they are to assume in the production of legitimate knowledge (see Figure 1). In short, according to this model, scientists are the ones who should be granted the roles of defining what counts as a problem, determining the make-up of research collectives, and producing and disseminating scientific knowl-

edge (Bucchi & Neresini, 2008; Callon et al., 2001; Irwin, 2001). Under this model, exchange between scientists and citizens is predominantly unidirectional – namely, researchers inform a public that is considered as having a deficit of the scientific knowledge needed to shed light on the issues being debated.

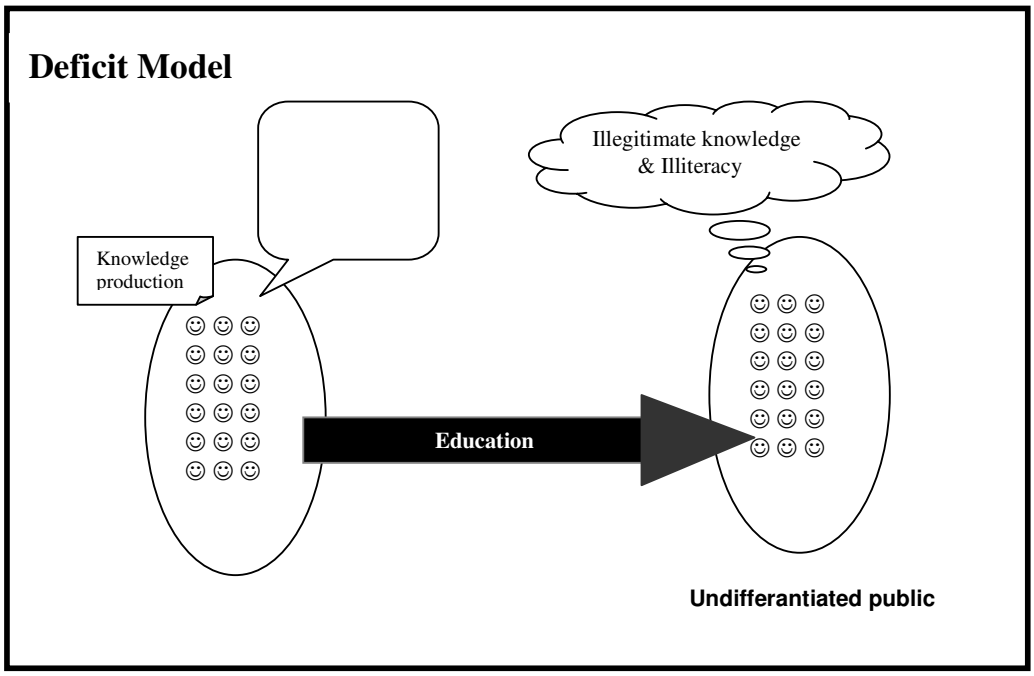

Figure 1. The Deficit Model.

The Public Debate Model

The public debate model reconfigures the playing ground in terms of the right to express one's view: scientists and citizens interact in spaces of public discussions (referendums, surveys, focus groups, consensuses, symposia, etc.). In this conception of things, citizens are not necessarily unanimous in the expression of their views, but instead form sub-groups (concerned groups) having occasionally divergent opinions. As well, citizens' knowledge, though different from that of scientists, is conceived of as enriching and complexifying the problematization of sociotechnical issues. As with the deficit model, however, the public debate model ascribes roles in the production of scientific knowledge in asymmetrical fashion, with this activity remaining the private preserve of scientists (see Figure 2).

The Co-production of Knowledge Model

The co-production of knowledge model is characterized by a redistribution of the roles of participation in the production of scientific knowledge that are integrated into the (political) decision-making processes.

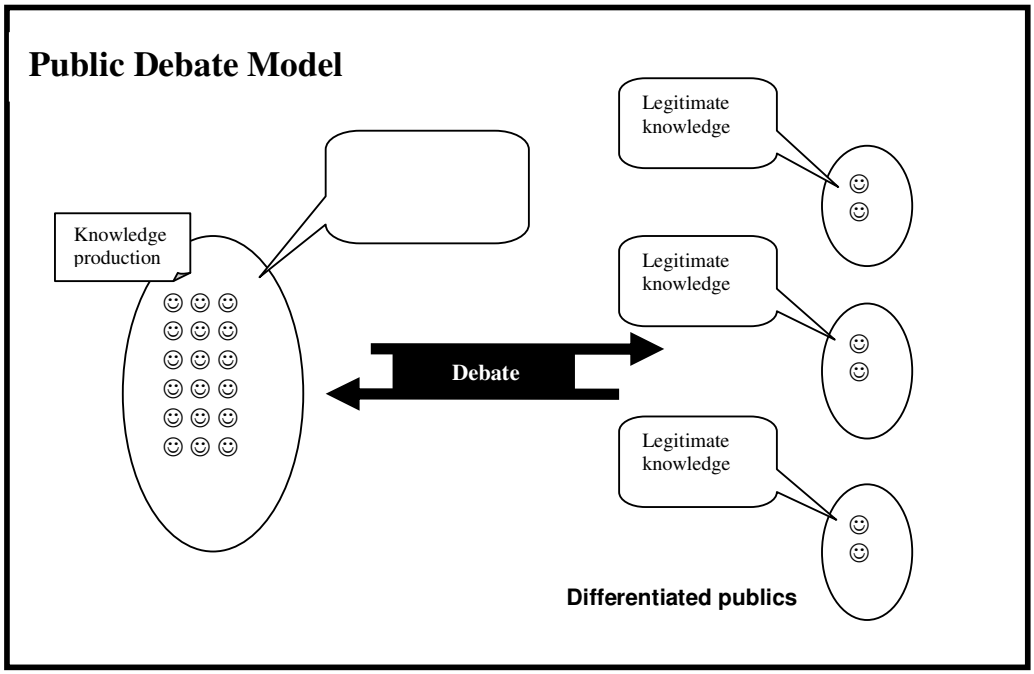

Figure 2. The Public Debate Model.

Whereas the deficit model and the public debate model do not recognize citizens' competency in respect of the production of scientific knowledge, the co-production model ascribes to citizens the cognitive and discursive competencies required for the creation of knowledge useful in SSI management. It follows that, beyond taking into consideration citizen's scientific knowledge as a means of enriching the views of scientists (as with the debate model), scientific knowledge is held to be the product of processes on which citizens and scientists collaborate closely. As such, this model is framed by the idea according to which citizens possess experience that is relevant to the situation at hand and are sufficiently competent to contribute to defining what counts as a problem, determining the make-up of research collectives, and producing and disseminating scientific knowledge and know-how that is drawn on in discussions and debates (see Figure 3). An illustration of this model is to be found, for example, in the involvement of associations of disease-sufferers in the production of life narratives, the identification of singular or atypical cases, or the creation of photographic databases (for an articulated illustration of this type of citizen participation in the production and dissemination of scientific knowledge, see Callon & Rabeharisoa, 2008 and Epstein, 2008).

Before I present the methodological approach adopted in this research project, I feel it is important to point out that it is not a question here of suggesting, naively, that one model is better than another (and that the deficit model is outmoded). Such a debate is behind the scope of this paper. As has been noted by Bucchi and Neresini (2008), recalling the views of Callon (1999), "the model of knowledge co-production, undoubtedly commonplace in certain areas of biomedical and environmental research, does not seem equally applicable in other fields of scientific inquiry such as theoretical physics" (Bucchi & Neresini, 2008, p. 466).

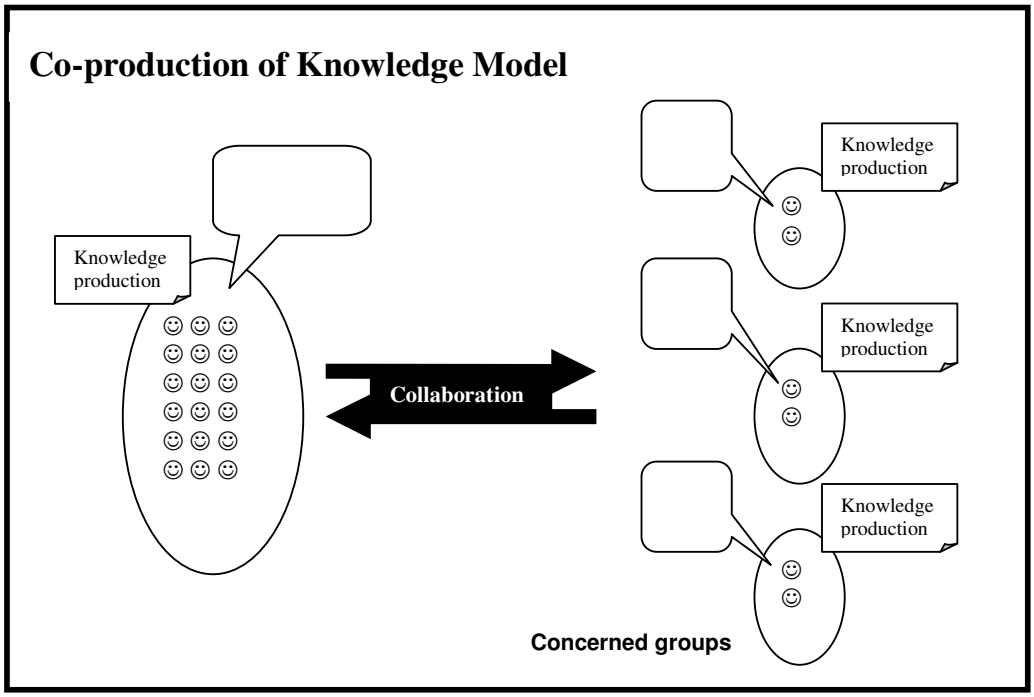

Figure 3. The Co-production of Knowledge Model.

Instead, it is a question of proposing that the deficit, debate and co-production of knowledge models constitute conceptual tools having the potential to enrich our understanding of students' appropriation of SSI by shedding light on young people's views concerning citizens' understanding of SSI and concerning citizens' participation in debates and in the production of scientific knowledge.

Methodology

Overview of the study

The objective of the study from which this article has stemmed was to examine the terms used by a group of post-secondary students to frame a controversy and describe the relationships they hold toward people whom they consider to be scientific experts (Pouliot, 2007, 2008). The data used in this study were produced in the context of a project funded by the Canadian Social Sciences and Humanities Research Council (SSHRC) (Fountain, Désautels, Larochelle & Daignault, 2002) and designed to provide young people with the opportunity to position themselves as people having the capacity to express their views on the local and global technoscientific issues concerning them. The project took place among two classes enrolled in a science course that is taken during the last session of a two-year pre-university "natural science" program (province of Quebec, Ministère de l'Éducation du Québec, 1994). This so-called "integration" course is not based on lectures but is instead designed, in the institutional context, to essay the "general goals" pursued by the cégep-level natural science

program and to provide students with an introduction into interdisciplinarity (generally involving biology, chemistry, physics and mathematics but also including the humanities).

Both classes were subdivided into groups of three students each that, over a semester (15 weeks), worked on elucidating the issues surrounding a sociotechnical controversy present in Quebec or Canada (there were five such controversial subjects altogether: the rearing of triploid trout in Gaspé Bay, Québec; the construction of a toxic waste incinerator in Belledune, New Brunswick; stem cell research; federal draft legislation to legalize marijuana; and the use of cellular telephones). The teaching model known as "interdisciplinary rationality islands" was used (Maingain, Dufour, & Fourez, 2002): In a nutshell, this model is designed to prompt young people to (co-) develop a representation of a sociotechnical controversy that takes into account a range of issues and considerations – be they social, ethical, economic, historical and scientific. Within the framework of this teaching model, a one-page text outlining the given controversy was, at the outset of the investigation process, handed out to each student triad. These groups also perused specialist and general public texts, consult fellow students, teachers and sometimes even scientists. At semester-end, they produced a public presentation on the ins and outs of their controversy before an approximately 200-strong audience made up of parents, friends, fellow students and cégep instructors. All groups took part in this public presentation, with each group member presenting different aspects of the controversy thus investigated. The last excerpt of a student conversation presented in this article (below) concerns this public presentation. It will serve to show, in relation to the aims of this article, how this specific group of students describes the position of the audience respecting the use of cellular telephones.

On the subject of the tasks that were presented to the students, it is worth mentioning that students were not explicitly prompted to adopt a position respecting the attitudes, interests and capacities of citizens concerned by the controversy being investigated. The group of which it is a question in this article spontaneously took up the question of citizen participation in SSI management, doing so for the first time when inventorying the actors concerned by the cellular telephone controversy. In the context of the approach based on interdisciplinary rationality islands, the students were invited to sketch out a "panorama" of the controversy (as though dealing with a panoramic photograph of a set of components, several of which would be reserved for producing a final portrait of the controversy), which included a list of the actors concerned. Furthermore, the group also deployed – spontaneously and on several different occasions – its point of view concerning the attitudes, interests and capacities of citizens within the context of discussions concerning the subject of the controversy and the preferred lines of action relating thereto. In other words, while the group was mandated to investigate a socioscientific issue, it was not, on the other hand, explicitly requested to work out a position concerning the attitudes, interests and capacities of citizens concerned by this controversy. As will be noted, however, when the group addressed this question within the context of informal interviews I held with them, I put questions to them that were designed to elicit specifics from them about their viewpoint (as shown in a number of the excerpts appearing below).

I personally monitored the progress of two triads, one of which investigated the controversy concerning the use of stem cells and the other the controversy surrounding cellular telephones. These groups were selected, in keeping with advice offered by Stake (1995), and Yin (1994), on the basis of the participants' interest and of the success of efforts to build a useful database (for additional details on this subject, see Pouliot, 2007). In other terms, both groups displayed an apparent interest in participating in the project and showed enthusiasm about their assigned controversy; further, prior to the launch of the project, they exhibited no detectable reticence with respect to the instruments used to format the data sources (and specifically toward the tape recording of discursive interactions).

Data collection

The approach used to sound out the group's views drew on the case analysis tradition (Stake, 1995). Thus with both groups I engaged in participant observation (Kawulich, 2005) lasting 3 hours once a week for a period of 15 weeks (one semester). In particular, I recorded and transcribed in the form of verbatim records all of each group's spontaneous discursive interactions (referred to by Horton-Salway as "naturally occurring interactions"; 2001, p. 173); as well, I conducted and transcribed, in the form of verbatim records, open-ended conversations (14 of which and whose duration ranged from 4 to 30 minutes) for the purpose of prompting the group to clarify its point of view (the starting point of the conversation was defined ahead of time, whereas the remainder varied depending on how the group responded; Kvale, 1995; Patton, 1990). The main reason behind the decision, concerning the present article, to document the viewpoint of the group interested in the controversy surrounding cellular telephones consists in how the members of each group interacted among themselves. The group interested in the stem cell controversy to a very great extent (and, from the half-way point in their investigation, almost exclusively) communicated with one another by chatting – even when they were in the same classroom (which was fitted out with upwards of 10 computers). The group involved in investigating the controversy concerning the harmfulness of cellular telephones functioned according to an entirely different approach, discussing the controversy together at the same time and via oral interactions. It thus proved easier to tape record and transcribe in verbatim form all the discursive interactions of this group.[5] The group was made up of Jimmy (aged 19 years and 7 months), Rémi, (aged 27 years and 2 months)[4] and Sophie (aged 19 years). They were on track for university studies in animal health, forestry and physiotherapy, respectively. All had followed the typical academic path outlined in the collegial natural sciences program and thus had taken one course in biology, two courses in chemistry and three courses in physics. None of them had taken courses in sociology or the sociology of science.

I then relied on a methodological procedure similar to those advocated by Brown (2004) and by Kelly and Crawford (1997) (see Figure 4). Once the verbatim versions of the taped recordings of the students' discursive interactions had been completed, I identified the processes engaged in by the group as well as the themes of their discussions. For each of the participant observation periods (which occurred generally once a week), I developed a kind of template that enabled me to identify discursive sequences, which I then grouped together into theme-based documents, entitled, for example: "Descriptions of the controversy"; "Descriptions of the experiments"; "Descriptions pertaining to the experiments and the efforts to meet someone whom the group considered to be a scientific expert"; "Descriptions of the actors concerned by the controversy"). The document entitled "Descriptions of the actors concerned by the controversy" provided me with a basis for identifying the sequences that represent the group's point of view concerning citizens' interest for the issue of the potential risks associated with the use of cellular telephones, citizens' grasp of the ins and outs of the controversy and, finally, the conditions governing citizens' participation in public debates in relation to the controversy. The descriptions presented in this article stem from the naturally occurring interactions among members of the group and from an open-ended conversation conducted with them during the last week of the project.

This study, which by definition is exploratory, provides a perspective intended to complement those developed in science education on the subject of students' appropriation of SSI. Given that the group was made up of three students, the sample size is both small and unrepresentative, statistically speaking. On this point, however, I find support for my views in the comments of Potter and Wetherell (1987, p. 161), as clarified by Wright and Nerlich (2006), in a study showing that the deficit model is an important part of a culture of argumentation shared by both scientists and members of the public, and drawn upon as

explanations of the public understanding of science.

Steps of the analysis
1. Tape recording of spontaneous group's interactions and open-ended interviews
2. Translation into verbatim of all the interactions and open-ended interviews
3. Identification of the processes engaged in by the group and themes of discussion
4. Grouping of discursive sequences into theme-based documents
5. Discourse analysis (Potter, 1996)

Figure 4. Steps of the analysis.

Because one is interested in language use rather than the people generating the language and because a large number of linguistic patterns are likely to emerge from a few people, small sample or a few interviews are generally quite adequate for investigating an interesting and practically important range of phenomena. For discourse analysts the success of a study in not the least dependent on sample size. It is not the case that a larger sample necessarily indicates a more painstaking or worthwhile piece of research. Indeed, more interviews can often simply add to the labour involved without adding anything to the analysis… the value or generalizability of results depends on the reader assessing the importance and interest of the effect described and deciding whether it has vital consequences for the area of social life in which it emerges and possibly for other diverse areas (emphasis in original, Wright and Nerlich, 2006, p. 335).

In other words, the value of analyzing the point of view of this triad of students, as I propose to do so here, stems much less from its representativeness (and the resulting generalizability) than from the relevance of the interpretations thus put forward and the fruitfulness of the articulated conceptual framework for envisioning other research projects in science education and formal science instruction – all the more so because research into students' appropriation of SSI have not until now grappled with the question of the point of view of students concerning the relationships between citizens and scientists concerning the shaping and managing of controversial issues.

Results

In this section I present a number of descriptions that are representative of the group's point of view concerning not only citizens' attitudes, interests and capacity for understanding with respect to the controversy in question but also the conditions under which citizens could take part in public debates. I also examine a conversation among the group concerning the position of citizens who attended a public presentation given by the group; in this conversation, the group's point of view evolved from that of qualifying the lay citizens' position as being inconsistent to one that held the citizens' position to be consistent.

The citizens concerned by the controversy

Over the course of its conversations, the group gave form to descriptions of citizens concerned by the controversy. In the following sequence, citizens were described in terms of their attitude toward the controversy and their inclusion in an age group:

> Jimmy: I did, I thought about it. When you get down to it, there are, like, three sides. One side is of, like, "up in arms" citizens, who are really interested in [the issue], who… are trying to do something. One side is made up citizens who don't give a damn. People who aren't interested, who have never given any thought to the matter. And there are the companies that try to shut up the people who want to air their gripes. There are people in the middle… like your average Joe, who've got one [a cell phone] and who figure that… who've never gone on the Internet to check whether it's dangerous or not. Who haven't really thought about it.
>
> Rémi: There's also an age group [factor]. At least where my dad's concerned. There's a "give a damn" attitude that goes with it. Like, "What me worry?" My dad's in the 50-to-65-year-old group. Sometimes I talk to them about it and, like, [their answer is]: "There's nothing to worry about." They've all got a cell phone.
>
> Jimmy: There are a lot of people for whom "there's nothing to worry about." (IIIA 299; 2004-03-24)

The preceding interaction closely corresponds to the conception of the deficit model as an explanation of citizens' behaviour. To a sizeable proportion of the citizens concerned by the controversy surrounding the potential harmfulness of cellular telephones, the group ascribes a deficit of interest in the question ("people who aren't interested"), a lack of concern (as illustrated by the phrase "'give a damn' attitude") and an unawareness of the potential risks ("who haven't really thought about it"). However, whereas the better portion of this description concerns citizens having little or no interest in the controversy, Jimmy points out, in the beginning of his comments, that there are people who take this issue seriously ("One side is of, like, "up in arms" citizens, who are really interested in [the issue], who… are trying to do something"). At no time did the group include depictions of this category of citizens in its descriptions – unless, as will be seen, it was to suggest that citizens participating in public debates should be authorized to give their views in keeping with their knowledge of the controversy at hand.

The group's point of view respecting the attitudes and capacities of citizens concerned by the controversy emerged during the twelfth week of their investigation of the cellular telephone controversy, as the group began commenting on the results of an opinion poll it had conducted among parents, friends and fellow cégep students (the group had built its own opinion survey). During the following conversation sequence, Jimmy and Rémi come off as being rather sceptical, voicing their doubts over the validity of the survey results. Each in turn suggested – regardless of the actual survey results according to which 66% of those surveyed claimed to be aware that the use of cellular telephones was open to doubt – that the survey-takers lacked knowledge ("There are a lot of people who don't want to admit [that they didn't know]" or did not have the necessary capacity for understanding ("who don't understand the question"). The response given by a survey-taker concerning the meaning to be ascribed to one of the questions was used by Rémi as an example of a deficit of

understanding common to citizens.[6]

> Jimmy: We have the number of people 18 years of age [and over] who, "yes or no," have a cell phone. Then, we have the number of hours of use for everyone [who took the survey], and the number of people who didn't know that the [potential] impacts had not been determined. Sixty-five percent (65%) of the respondents who claimed they knew that the impacts hadn't been determined, and 30% who didn't know. I have my doubts, because I think that some people said "Yeah, I know" who didn't actually know.
>
> Researcher: What makes you think they might have lied?
>
> Jimmy: There are a lot of people who don't want to admit that [inaudible]. I think so, at least.
>
> Rémi: Or who don't understand the question.
>
> Researcher: Which question was it?
>
> Rémi: "Did you know that the side effects of using cellular telephones have not yet been identified?" Because, at one point, there was one person who asked me: "Yes, meaning I know, or no, meaning I don't know?" (IIB 198; 2004-03-24)

The preceding excerpt provides a portrait of citizens lacking in knowledge and capacity for understanding that presents a strong parallel with the deficit model. The group would hold on to this position throughout their entire investigation of the controversy and, on several different occasions, burden citizens with a deficit in knowledge and capacity for understanding the questions in the survey will be drawn on for argumentative purposes in the context of discussions during which the group will emphasize the necessity of informing citizens about the risks associated with the use of cellular telephones:

> Jimmy: In our survey, there's what, 35% of the people who are unaware?
>
> Rémi: Yeah, 30 or 35%.
>
> Jimmy: Who wasn't aware that no one is certain of the long-term impacts at this time? People think that it's all right. They need to know. If it was written down that there could be unknown side effects, then at least they could say, "I won't get one," or "I'll get one, but I won't use it as my main phone." (IIB 254; 2004-03-24)

During the previous conversation, Rémi and Jimmy noted the proportion of survey-takers who had replied that they were unaware that the long-term impacts of cellular telephone use were as yet unknown. The two fellow students emphasized the potential value of informing citizens so as to empower the latter when making decisions with respect to the use of cellular telephones.[5]

Citizens' participation in public debates

At different times in its investigation of the controversy, the group addressed the question of the participation of citizens in public debates. As will be clear from the following conversation excerpt, the deficit model provided the terms in which the group articulates its point of view concerning the framework in which discursive interactions take place. For one, the group depicted citizens as being ignorant of the ins and outs of the controversy. In addition, it authorized only those people who were informed about the controversy to take part in the discussions and debates. It is also important to note that the group was not unanimous in its opinion concerning some of the conditions framing citizen participation. In Sophie's opinion, it was imperative to maintain some control over input into discussions. She suggested that in the framework of public debates, an authority should take on the role of ensuring the relevance of the views voiced by citizens. Jimmy was opposed to this viewpoint ("I think that they [forums] shouldn't be controlled") and instead put forward the idea of ensuring that relevant information be made available ("that everyone should have access to what they need to know"). Sophie went along with the idea of facilitating access to information but again emphasized, with Rémi's support, the importance of having some external oversight over the types of contributions citizens made to debates and discussions.

Jimmy: Because there's lots of people who can't take part in the debates. When you don't know what [the controversy] is, you can't take part, you aren't informed.

Rémi: Yeah, you're out of it.

Jimmy: If you're out of it, you can't take part.

Sophie: Although there are some who will anyhow.

Researcher: What do you mean?

Sophie: Take forums, for example. Imagine that the forums aren't controlled, anybody can get in them, anybody can rant on about anything. If a forum ever became accessible,… Because usually it's held in a hall, but a Web… somebody's going to have to control it. I don't know…

Jimmy: I think that they shouldn't be controlled; everybody should have access to what they need to know.

Sophie: Sure, they should get the information, but there's also got to be someone who makes sure that whatever is said is well founded.

Rémi: [Has the required] authority.

Sophie: Yeah, right, the credibility of the person who's talking. (IIA 060; 2004-01-28)

In the public debate model, citizens are considered as possessing knowledge that may be turned to good account with respect to exploring issues under consideration from perspectives that are both original and that complement those being explored by scientists. It is true that during this conversation, the point of view generally characterizing this group fit with a deficit model-inspired logic according to which participation in debates should be allowed or encouraged in proportion to the knowledge that participants have of the controversy at hand. Nevertheless, Jimmy's proposition advocating that citizens be provided with access to "information" in public forums recalls a point on which science and technology studies researchers agree, namely that "participatory processes should provide

sufficient resources (information, expertise, time) for effective participation" (Chilvers, 2008, p. 159); it is a point, moreover, that elicits some reserves with respect to notions pertaining to the restriction of citizens' participation in debates.

Conversation of the group and softening of position ascribing a deficit to citizens

During the 14th week of the project, the group staged a public presentation attended by some 200 people. At the end of this presentation, the group put the following questions to the audience: "Are you for or against the use of cellular telephones?" and "Would you agree to use a cell phone as part of performing your job?" In the next several paragraphs, I will examine the views of the group concerning the contents of the audience's positions (as stated in writing) concerning the use of cellular telephones. As will be seen presently, the group initially portrayed the audience's position on the subject as being contradictory; then, as the conversation continued on, the group recast its description of the citizens' position in different terms, claiming that it resembled their own. The main thrust of this excerpt is to show that the views of the group concerning the audience's position shifted from a focus on inconsistency to that of consistency; as a result, moreover, they began in a certain way to step back from ascribing a deficit to citizens.

At the start of the conversation, the group became involved in describing the audience's position concerning the use of cellular telephones:

> Researcher: You made a presentation during the public event on the evening of the 21st [April]. Did you check out the comments?
>
> Jimmy: What comments? I didn't see any comments.
>
> Sophie: I didn't see them either.
>
> Rémi: I'm the one who had them.
>
> Jimmy: I [saw]
>
> Sophie: He kept them all to himself.
>
> Jimmy: Gotcha. 'Cause I saw the chart [of the results] that you had set out on the table of the exhibition booth [put together during the week following the public presentation].
>
> Rémi: Yes. I'm the one who made the chart the night before [the exhibition booth was set up]. (laughter)
>
> Jimmy: The [results is what I saw]. But I didn't see anything else. I didn't see any comments.
>
> Researcher: So, what was the gist of the comments?
>
> Rémi: Hmm. How should I put it… 'Cause it's all contradictory. A total mess. To begin with, it's: "But of course, it benefits society" but at the same time, "Nah, I don't have to use it for my job, so I won't be using one in that case." As soon as it directly involved the person, their opinion changed immediately. Then the story turned into: "No, we don't want to use one full time, but it's good for society." Which amounts to saying: "It's fine for others but not for me." (IA 305; 2004-05-05)

For Rémi, in the context of this conversation, the audience's interpretation of the personal and social issues is inconsistent. To describe the public's position concerning the use of cellular telephones in terms of its contradictions, he resorts to the term "a total mess". Potter (1996) has noted that the use of this type of expression (the rhetorical device referred to as extrematization) is particularly handy for defending a point of view whenever the issue at stake is sensitive. In this case, the situation was indeed sensitive because it was agreed among the instructors that the group would familiarize itself with the audience's views before it set out its final position on the controversy. In other words, by articulating a position that defines citizens in terms of an incoherent, contradictory interpretation of socioscientific issues, Rémi is able to justify his decision (which had remained implicit up until that point) to have refrained from sharing with Sophie and Jimmy the contents of the responses produced by the members of the audience at the public presentation. That being said, the perspective from which Rémi launched into his description is not extraneous to the position adopted by the group respecting the citizens concerned by the controversy, as has been illustrated previously (see the excerpts analyzed above; see also Pouliot, 2007, 2008). On many occasions, the group held that citizens were insufficiently informed for making spontaneous well-advised decisions and, for this reason, steps had to be taken in order to educate them about the risks and uncertainties surrounding the use of cellular telephones. From this point of view, it can be said that the group's description of the audience's position carries over, initially, the deficit model.

Though Rémi started off describing the lay public's views of cellular telephone use as being contradictory, he had to shift his position when Sophie and Jimmy spoke up and pointed out that their responses to the questions bore some resemblance to those of the audience:

> Sophie: And yet, on the other hand, if you think about it I would have answered the same thing.
>
> Jimmy: Yeah. (IA 319; 2004-05-05)

The verbal interactions of Sophie and Jimmy reorient the discussion, and indeed cause cracks to appear in Rémi's interpretation. The conversation continues on, though somewhat as if describing the audience's position had been suspended or cast to one side:

> Rémi: For sure, but…
>
> Sophie: I would have answered: "Yes, there are advantages, but with certain restrictions; thus I wouldn't use it on a full time basis." (IA 319; 2004-05-05)

In the previous excerpt, Rémi's statement is followed by that of Sophie, who describes her own position as being similar to that adopted by the team concerning the practical aspects of cellular telephones and about the need to limit the time of exposure to microwaves (as such, the team's position is not documented in this article but is in Pouliot, 2007). As the conversation resumed, Rémi modified his point of view, aligning it more with Sophie and Jimmy's interpretation. The description of the audience position that he then put forward was recast considerably – namely, in terms relying less on the notion of deficit.

> Researcher [speaking to group]: When you get down to it, did you view the [audience's] responses before you adopted your final position?
>
> Rémi: Well... they match up pretty closely with the same points we arrived at.

Jimmy: Yeah.

Rémi: Because they say: "No, we don't want to use it full time because we don't really know what the side effects are."

Jimmy: That's what I... just with the results. People say that aren't against cell phones but basically they wouldn't want to use it full time. Which comes down to my position. For sure, there's no banning cell phones but it's important not to go overboard using them.

Sophie: Yeah.

Jimmy: That's my position, personally. And for people, that seems to be the case too. It amounts to: "Yes but."

Sophie: Yeah.

Rémi: For people, it amounts to pretty much the same thing as to use cell phones responsibly. There's one [comment] here; guy says: "As with any technology, the important thing is not to use it excessively."

Sophie: As with all the good things in life.

Jimmy: Yeah. (IA 330; 2004-05-05)

These were the terms used by the group to wrap up its description of the audience's position concerning the use of cellular telephones. As is clear from this portrait, the position ascribed to the audience lies at some remove from that which was sketched out at the beginning of the conversation, since the group emphasized the parallels to be drawn between its position and that of the audience concerning the use of cellular telephones.

Discussion

Judging from various discussions ongoing in the fields of science education, science and technology studies and public understanding of science, it is clear that the question of the terms under which citizens could participate in the management of SSI is a lively one. It is generally agreed among researchers working in these fields that the unforeseen consequences of the production of scientific knowledge (which may also be referred to as uncertainties) make it necessary to secure the participation of citizens in public debates and in the policy-making process (Irwin, 2001; Jasanoff, 2003; Wynne, 2003). The view articulated by Sturgis and Allum (2004) epitomizes, moreover, the current line of thinking in science education: "A scientifically literate citizen is also one that can effectively participate in public debates about science and hold government to account over the speed and direction of science policy" (p. 55). In actual practice, however, as Kearnes, Macnaghten and Wilsdon (2006) and Leach, Scoones and Wynne (2005) have pointed out, the type of SSI management approach most frequently used accords with the logic of the deficit model. For the above-mentioned authors, this model creates a division between citizens and scientists that makes it difficult if not impossible to attain the democratic management of the sociotechnical problems at hand. A similar perspective informs the comments of Stilgoe (2007), who writes: "The pattern of experts telling non-experts what 'correct' areas of concern are is an extension of a deficit model of science and society and is no longer sufficient" (p. 55).

This exploratory study is intended to provide a perspective complementing those that have been put forward until now concerning students' appropriation of a SSI in science education (see Aikenhead, 2006; Sadler, 2004; Zeidler et al. 2005). To this end, I have illustrated the way in which a group of students described the attitudes, interests and capacity for understanding of citizens concerned by the controversy surrounding the use of cellular telephones. I have also shown how the group conceived of citizens' participation in public debates and presented a series of discursive interactions during which the group's members described the position of the audience of citizens (considered to be a lay public) that attended the public presentation they staged on the subject of this issue.

As has become apparent, according to this group most citizens concerned by the cellular telephone controversy lack knowledge and a capacity for understanding about the subject and indeed show little interest in the issue. Accordingly, this group would authorize citizens to contribute to debates in keeping with their knowledge of the controversy. Furthermore, on the subject of the conditions governing the participation of citizens in debates and discussions, the members of the group were not unanimous. For Sophie, it was critical to control discursive interactions whereas in Jimmy's view, the important thing was to ensure that partners in the debate had all the relevant information. As is also clear, moreover, the group does not touch on the possibility of encouraging citizen participation in defining the terms of a given problem, in examining the avenues for action to be given priority and in producing knowledge of potential use to discussions. In short, the assumptions underlying the group's point of view about knowledge, communication and participation[6] (Maranta, Guggenheim, Gisler, & Pohl, 2003) in connection with citizens' grasp of the controversy and the relationships between citizens and scientists correspond to those associated with the deficit model.

That being said, the purpose of this article is not to bring a normative or depreciatory perspective to bear on the point of view articulated by the group on the subject of citizen actors concerned by the cellular telephone controversy. No more than it is to delimit the reasons that prompt the group to mobilize the deficit model. (Actually, the objective is to provide an initial in-depth look at the students' point of view concerning the attitudes, interests and capacities of citizens concerned by a SSI.) On this point, there are a number of avenues open to investigation, particularly in relation to research conducted in the fields of science and technology studies and public understanding of science. One such possible topic for inquiry would be the hypothetical relations between the student group's views of the citizens concerned by the cellular telephone controversy and the dominant social discourses that induce a divide between science and society (Callon et al., 2001; Latour, 2004) or, in other words, between scientists and the lay public (Callon, 1999).

Whatever the case, it is clear that these students, by ascribing to citizens a deficit of knowledge and a limited capacity for understanding and by according little legitimacy to citizens' knowledge, corroborate the findings of other studies, which have amply shown how the deficit model is often carried over into media discourse (Bucchi, 1998; Cook, Robbins, & Pieri, 2006), opinion surveys (Irwin & Michael, 2003; Kallerud & Ramberg, 2002; Peters, 2000; Wynne, 1992) and in discussions in which the participants – who themselves are lay citizens – grapple with the issue of the research avenues pursued by the New Genetics (Kerr et al., 2007) or manage the controversy surrounding foot and mouth disease (Wright & Nerlich, 2006). With these observations in mind, the question arises as to the implications of this study for research in science education and formal science instruction proper.

Implications

In terms of science education research, this study – having shown that deficiency in citizens' knowledge of the controversy is a central concept around which explanations of the citizens'

grasp of the controversy are constructed by the group, and that the group authorizes a limited (supervised, by Sophie's lights) participation of citizens in sociotechnical debates – points to the relevance of developing a program of research into the way that young people conceive of and describe the various social actors concerned by SSI. From this perspective, and further to my comments elsewhere (Pouliot, 2008), the results of the present study highlight the necessity of conceiving of research "that would examine in depth the point of view of young people on the subject of the participation of various social actors in the management of socioscientific issues" (p. 15). More specifically, this article is offered as additional input into the project of science education for action (Roth & Désautels, 2002) or a humanist science education, to borrow from Aikenhead (2006). My own position concerning the importance of lay understanding that is un-naive with respect to the sociopolitical dimension of managing sociotechnical issues is akin to that of Hodson (2003, pp. 650-1), quoted by Sadler, Barab and Scott (2007), according to whom:

> What is clear is that ordinary citizens will increasingly be asked to make judgements about matters underpinned by science knowledge or technological capability, but overlaid with much wider considerations. *Those without a basic understanding of the ways in which science and technology are impacted by, and impact upon*, the physical and the *sociopolitical environment* will be effectively *disempowered* and susceptible *to being seriously misled in exercising their rights* within a democratic, technologically-dependent society (my emphasis; Sadler, Barab, & Scott, 2007 p. 374).

From that point of view, it would be desirable to see further research conducted so as to be able to generate knowledge and emancipative practices toward widespread structures, relationships and opinions (Kerr et al., 2007). It would certainly be possible to mobilize a range of conceptual frameworks and methodological approaches within numerous research paradigms (on the subject of paradigms of value in science education research, see Aikenhead, 2006, pp. 133-5 and Abell & Lederman, 2007).

Science Education and Curriculum

The results of this study, as illustrated by the above excerpts, show that the group perpetuates representations that ascribe to citizens deficits in terms of interest, knowledge and understanding. Likewise, in view of the preceding comments – in particular, those bearing on the social permeation of discourses framed by the deficit model – the group's view of citizens concerned by the cellular telephone controversy are little likely to come as a surprise. While not out of the ordinary, the students' viewpoint, I think it fair to say, gives one considerable pause, considering how the deficit model does not allow students to recognize either the legitimacy of unique lay knowledge stemming from citizens' unique experiences or the contribution of citizens to discussions with scientists. Further, it provides no basis for conceiving of the potential collaboration of citizens in the process of producing scientific knowledge.

In view of the explicit objective of science education to educate people in assuming the position of legitimate, competent interlocutors in the context of discussions and decision-making relating to current SSI (Cross & Price, 2002; Roth & Désautels, 2004), it is easy to imagine the implications of this study for laying the groundwork for explicit instruction in conceptual tools such as the deficit, public debate and co-production of knowledge models. Moreover, there is nothing particularly new to the notion according to which the question of the collective management of socioscientific issues should be taken up in science class (or

indeed, integrated into curricula). Glen Aikenhead (1985), for one, advocated this idea, at the same time emphasizing the importance of inviting young people to make a "thoughtful decision on a societal issue related to science and technology" and pointing out a number of pitfalls into which science teachers are likely to fall. Furthermore, concerning the groundwork to be laid for a kind of science education that is capable of integrating aspects of citizen participation in sociotechnical issues, Sadler, Barab & Scott (2007) recently indicated some promising directions, writing: "Formal education should help students prepare for active participation in modern democracies. Science education, in particular, should assume increasingly more prominent roles in citizenship. *It can no longer remain common school practice for civic issues to be handled only within the confines of social studies classrooms*" (my emphasis; Sadler, Barab, & Scott, 2007, pp. 373-4).

There are grounds for thinking that by familiarizing young people enrolled in science courses with the deficit, public debate and co-production of knowledge models, these students would have a basis on which to develop points of view about citizen participation in SSI management and about citizens' understanding of science that would break with dominant, deficit-centred interpretation conveyed by the media, scientists and by the public too (Wright and Nerlich, 2006, p. 340).[8] Further, it is easy to imagine how the deficit, public debate and co-production of knowledge models could be mobilized to enable science educators to "problematize" SSI so as to factor more fully for citizens' participation in debates, policymaking and what Callon and Rabeharisoa have termed the "primitive accumulation of knowledge" (2008). In the process, they would help to make manageable two main challenges: first, as identified by Albe (2008), "to help teachers to introduce such socio-scientific issues in the classroom that deal with complex, controversial and uncertain questions involving values, technological, economic, ethical, *social and political* considerations (my emphasis, 2008, p. 86); and, more generally, as emphasized by Wright and Nerlich (2006): "to look to other ways of describing the relation between science and society, while recognizing that the deficit model serves scientists, the public and others alike as a resource for political discourse" (p. 331). While limitations of space prevent me from explaining all the ins and outs of this study on curriculum, I should like to close this article by, on the one hand, quickly touching on one of the options available for integrating the models proposed by Callon (1999), and on the other, by identifying three challenges or pitfalls confronting teachers when they attempt to implement a curriculum that emphasizes the deficit, public debate and co-production of knowledge models conceptualized by Michel Callon. My hope is that these concluding elements will be viewed for what they are – that is, an invitation to reflect on the implications of the findings of this study for science education.

The purpose of this article is not to generalize on the basis of the viewpoints articulated by the group – in other words, the purpose is not to suggest that all students mobilize the deficit model to interpret all the SSI of possible interest to them or that are taken up in class. Instead, this article aims, on the one hand, to present a conceptual framework serving to highlight models of interaction between citizens and scientists, and on the other hand, to illustrate how this framework provides a basis for documenting (and potentially enriching or broadening) the ways students describe citizens concerned by the sociotechnical controversies confronting society. That being said, in response to the highly germane question of what is to be done, considering how this group refers almost exclusively to the deficit model when giving its views on the attitudes, interests and capacities of citizens concerned by the cellular telephone controversy, I would like to stake out my own position and stress the relevance (and indeed the necessity) of integrating the mobilization and explicit teaching of these models in science classes, at least at the postsecondary level. Following on from the recommendations of researchers who, for some time now, have examined the contributions of studying SSI in class, integration efforts could, for example, take the form of an addition to the list of

artifacts figuring in school science curricula. It could also, in a less prescriptive manner, be rolled into a kind of science education that accounts for the (social) nature of science and associated practices (NOS) and that is concerned with empowering people to identify the impacts of the technosciences on society and, conversely, the effects of sociopolitical choices on the production of scientific knowledge.

Science teachers who proceed to use or explicitly teach the models identified by Callon (1999) are at risk of falling into any of following three pitfalls (which could be qualified as being epistemological, interpretative and political in nature, respectively).

The first such pitfall involves, on the part of the instructor, adopting an epistemological posture according to which the fact of having scientific knowledge culminates in a single, consensual decision. As Aikenhead (1985, p. 471) has pointed out: "A stronger science background does not ensure that a more thoughtful decision will be made, nor does it augment agreement over an issue." Those science teachers who hold to this view are likely to ascribe to scientists the role of SSI managers. They are also prone to mobilize the deficit model or to interpret the public debate model in terms of the deficit model.

A second pitfall consists in misinterpreting the aims pursued by using models that address the interaction between scientists and citizens. As should be perfectly clear, the purpose of using the deficit, public debate and co-production models is not to augment the consensual character of discussions concerning SSI (Bucchi et Neresini, 2008; Callon et al., 2001; Callon, 1999; Callon and Rabeharisoa, 2008). To repeat, it is, where science education is concerned, to encourage citizen participation in the sociotechnical issues confronting society. Where, more immediately, science teachers are concerned, it is to encourage students to develop a point of view concerning citizens' attitudes, interests and capacities (discursive and interpretative) that moves away from the deficit model; it is to prompt students to articulate representations that accord legitimacy to the statements and experience-based knowledge of citizens and to the collaboration of citizens in the process of producing scientific knowledge.

Finally, for teachers who choose to mobilize the models presented in this article, one of the greatest challenges (or, in a corollary fashion, one of the greatest pitfalls) facing them is summed up by Aikenhead (1985, p. 460), quoting Casper (1980, p. 109):

> Reaching a decision in thoughtful way is one thing; putting that decision into action is quite another. "Literacy is not enough. Information is not enough. People must have the power to act on what they learn."

In this case, the challenge involves how teachers may best mobilize the deficit, public debate and co-production models to transform the showing/use of teaching tools (in the case of teachers) or learning artifacts (in the case of students; Brown, Collins & Duguid, 1989) into authentic conceptual and discursive resources enabling students to structure themselves as relevant, legitimate and politically empowered citizen stakeholders (Roth & Désautels, 2004). This challenge, along with those identified above, provide illustration of the numerous implications of this case study and, to the extent that we hold to the objective of equipping students for actively participating in the sociotechnical issues concerning them, compel collective (re)consideration.

Notes

[1] In Quebec, the specific post-secondary institution is known as "cégep" is equivalent to North American junior colleges.

[2] The explicit link that science education researchers occasionally establish with a form of civic education has come in for some cogent criticism among researchers in citizen-

ship education (Davies, 2004; Turner, 2008). On this point, I would like to point out that this article does not claim to satisfy the concerns of research conducted from one of the various angles associated with citizenship education – that is, according to the terms of the debates and theoretical framework current in this field. Readers interested in learning more about recent developments in citizenship education may with profit consult Davies and Issitt (2005).

[3] Concerning the relationships existing between various fields of research, it is worth mentioning that Turner (2008) recently documented the way in which debates over scientific literacy for all have been largely informed by research conducted in the field of public understanding of science. This author has suggested that debates in education grapple with larger issues of public understanding.

[4] This student had begun his *cégep* studies six years previously but then interrupted them a few months later to take a job in a plant.

[5] It is worth noting, however, that as a result of the modus operandi adopted by the team that investigated the controversy surrounding the use of stem cells, the present analysis could have been performed from within the theoretical and methodological perspective of virtual ethnography described in detail by Hine (2005).

[6] Opinion surveys have come in for considerable criticism in the last several years. Many researchers claim that they are based on a deficit model-inspired logic (Peters, 2000) and constitute an authoritarian point of view designed to show the ignorance of lay actors (Irwin & Michael, 2003; Stilgoe, 2007; Sturgis & Allum, 2004).

[7] I am indebted to Stilgoe (2007) for this turn of phrase.

[8] It is the view of Callon (1999), moreover, that "each [model] should be considered both as a convenient way of making a confused and complex reality intelligible, and as a reference that actors use when they reflect on practical forms of technological democracy" (p. 82).

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