



A tool for exploring the dynamics of innovative interventions for public health: the critical event card

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Abstract

Objectives Public health interventions are increasingly represented as complex systems. Research tools for capturing the dynamic of interventions processes, however, are practically non-existent. This paper describes the development and proof of concept process of an analytical tool, the critical event card (CEC), which supports the representation and analysis of complex interventions' evolution, based on critical events.

Methods Drawing on the actor-network theory (ANT), we developed and field-tested the tool using three innovative health interventions in northeastern Brazil. Interventions

were aimed to promote health equity through intersectoral approaches; were engaged in participatory evaluation and linked to professional training programs. The CEC developing involve practitioners and researchers from projects. Proof of concept was based on document analysis, face-to-face interviews and focus groups.

Results Analytical categories from CEC allow identifying and describing critical events as milestones in the evolution of complex interventions. Categories are (1) event description; (2) actants (human and non-human) involved; (3) interactions between actants; (4) mediations performed; (5) actions performed; (6) inscriptions produced; and (7) consequences for interventions.

Conclusions The CEC provides a tool to analyze and represent intersectoral interventions' complex and dynamic evolution.

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Introduction

Models are tools for representing and managing complex reality, which inherently means a simplification of reality (Bilodeau et al. 2004). Traditional ways to formulate, implement and evaluate health promotion interventions produce simplified and standardized models mostly incompatible with multifaceted problems and the contexts they address (Potvin and McQueen 2009; Potvin et al. 2005; Sanson-Fisher et al. 2007). Complex problems often require non-structured or reflexive answers (Rittel and Webber 1973), frequently leading to having to develop innovative interventions. Innovative interventions share some characteristics that correspond to complex systems. Among their features one notes: (1) multiple interacting components, (2) adaptable and participatory planning processes (Shen et al. 2008); (3) unexpected consequences (Hawe et al. 2009; Potvin et al. 2012), and (4) dependency upon contextual conditions (Rychetnik et al. 2002). Thereby, stakeholders including evaluators, need knowledge about intervention's actions and interactions with context, including how these are mutually modified through these interactions (Sanson-Fisher et al. 2007; Hawe et al. 2009; Mantoura and Potvin 2013; Potvin et al. 2010).

This paper presents the conceptual basis, development, and proof of concept of an analytical tool, the critical event card (CEC), appropriate for participatory evaluation research of complex and dynamic public health interventions. This tool describes and interprets critical events that characterize the evolution of innovative interventions' implementation.

Complex problems require innovative, evolving solutions

Over the past 30 years, ecological interventions, which embrace comprehensive views of problems and possible solutions, have been replacing programs based on deterministic patterns of risk factors. Ecological interventions include multiple interactions among program components, various actors, and flexible strategies which vary according to context (Hawe 2015; Hawe and Riley 2005). Local norms, organizational values, and scale of expected effects inform the planning and implementation of ecological interventions (Hawe and Riley 2005; Trickett 2009; Richard et al. 2011; IOM 2012). Innovative interventions that address complex health problems share most of these characteristics. Their improvement, sustainability, and

scaling up, require in-depth knowledge about their evolution, adaptation and transformation as well as those occurring in their context (Pluye et al. 2004, 2005).

Because innovations consist of trials and errors, tentative steps, and adaptations to changes occurring in context, evaluating innovative interventions presents numerous challenges (Callon et al. 1999; Hond 1998). As demonstrated by Bisset and Potvin (2007), a possible response to these challenges is the reconstruction of the program implementation evolution. This work highlights program's evolution as the product of complex interactions between context, health professionals' interests, program participants, and stakeholders (Bisset and Potvin 2007).

Drawing on the actor-network theory (ANT), we propose that intervention elements compose a sociotechnical network (ST-N) (Potvin and Clavier 2012). Those elements are human actors (people and groups of people) and non-human actants (knowledge, instruments, and resources) acting in a flexible and dynamic ways. ST-N create activities and events in support of the intervention transformative functions (Potvin et al. 2012), and in response to contextual conditions (Rychetnik et al. 2002; Hawe 2015; Riley 2005; Trickett 2009; Richard et al. 2011; Potvin and Clavier 2012; Levin 2002;). Such events and activities aim to connect intervention's actants/actors to negotiate interests, to (re)configure identities and roles according to intervention's purpose (Callon et al. 1999; Latour 2001, 2005; Law 1992). Innovations stem from relevant sociotechnical network modifications and bring forth reconfigurations that arise out of changes in context. For example, plain packaging tobacco interventions aim at changing the role of a pack of cigarette, from a representation of its owner's identity (the Marlboro cowboy) to a functional, generic and bland container of cigarettes.

Observation and analysis of ST-N in public health interventions can reveal their dynamic evolution and their social nature (capacity to adapt, innovate, and act appropriately to solving local problems) (Rychetnik et al. 2002). Events that change or reinforce an intervention's trajectory become markers of its evolution (Pluye et al. 2004, 2005). We call critical events those that generate consequences and lead to the reconfiguration of an intervention ST-N.

Finally, controversies are often observed in innovative interventions, (Bisset and Potvin 2007). They arise from differences among various actors' positions, viewpoints, social and political projects, or anything else at stake among those involved (Potvin and Clavier 2012; Latour 2005). Controversies can destabilize routines and relations among actors. Although not all controversies produce critical events, critical events are linked to controversies, for a system cannot be modified without prior destabilization of pre-existing certainties.

To understand how complex interventions implementation evolve in time and in relation to context, this study presents the development and proof of concept of the CEC. This analytical tool intends to appraise and characterize critical events that mark public health interventions evolution.

Methods

This study is based on three public health interventions implemented in different contexts in northeastern Brazil. One project was a healthy community intervention in a rural area in the state of Pernambuco. It was designed and managed by a partnership between university and the state public sector organizations. Volunteer community health agents were enrolled to act as mediators between public organizations involved in intersectoral interventions and community target groups. Another project was led by the municipality health sector in Recife (Pernambuco) and aimed at providing leisure infrastructures in urban poor areas. The intervention was directed at people living in areas with high prevalence of obesity, diabetes, high blood pressure, and isolated elderly. It involved physical activity and health professionals, as well as community, university and other public sectors actors and stakeholders. The last project focused on a primary health care reform in Camaçari (Bahia) led by the municipal public health sector. This was one of the first experiences in family health programs based on the implementation of a territorial approach, which involved coordination between general practitioners, nurses, and community health agents.

All projects were aimed at increasing health equity based on a multisectoral partnership. All projects had taken part in participatory evaluations and worked with training programs, using innovative teaching approaches. At the time of the study all interventions were institutionalized as they all had financial, political and organizational support (Pluye et al. 2005).

For the current study, we developed a three-stage participatory research design, carried out with intervention partners involved in the three projects. The first stage consisted in defining the analytical categories that characterize critical events and their organization within a CEC. The second stage was the development of a timeline for each project to identify potential critical events. The third stage was the CEC's field-testing and proof of concept, using the previously identified critical events.

The CEC development

Stage 1: according to ANT, actors and their relationships within a ST-N define an action system (Law 1992). In well-

structured situations (such as routinized programs), connections that link network's actors (human and non-human) tend to disappear in black boxes. However, in innovative interventions those links are less stable, leading to controversies, conflicts, and resistance that arise from differences among actors' positions (Potvin and Clavier 2012; Latour 2005; Law 1992). Controversies and critical events that indicate destabilization and subsequent stabilization episodes can be identified and interpreted revealing the dynamics within the ST-N. These situations emerge contextually and affect the evolution of the intervention (Hawe et al. 2009; Bisset and Potvin 2007).

Critical events are produced through interactions both within the ST-N and between the ST-N and context. They leave observable traces throughout the intervention evolution (Latour 2001). For instance, new partners who bring significant financial resources may lead to reformulating an intervention's objectives or strategies. Such shift may or may not be supported by existing partners and could potentially create controversies needing to be solved through negotiations and compromises (Bisset and Potvin 2007).

In the inaugural study seminar, attended by researchers and practitioners from the three projects, the critical events that marked each project's evolution were identified and discussed. This discussion enabled participants to formulate critical event descriptors which were redefined into analytical categories based on ANT's concepts. These categories are: (1) brief event *description*; (2) *actants* (human and non-human) involved in the event; (3) *interactions* between actants; (4) *mediations* performed to solve the controversies; (5) *actions* that took place; (6) *inscriptions* produced; and (7) *consequences* for interventions orientation.

Stage 2: during this seminar, participants drafted a first version of each intervention's timeline. These preliminary timelines pointed out critical events that marked projects' evolution along four dimensions: (1) project's context; (2) the coordination of intersectoral collaborations (project's governance and implementation); (3) participatory evaluation research and (4) project training components. These initial timelines were used as intermediary results to elaborate key informant interviews.

CEC proof of concept

Stage 3: data collected for CEC proof of concept consisted of projects documentation and key informant interviews. Eight key informants were identified for each project: four people involved in intervention and intersectoral coordination, two informants involved in the training and two in the evaluation components of each project. For two projects, face-to-face interviews were performed. For one

project, interviews were replaced by two focus groups (one conducted with 10 professionals involved in program delivery and another group with 4 project coordination professionals).

Interviews and focus groups began with questions about the project's evolution according to informants' recollection. This was followed by in-depth and detailed descriptions of each event identified. Three research assistants conducted interviews and focus groups. All material was recorded and transcribed. Analysis began with developing a timeline to identify critical events. For each interview, an information matrix was created describing each event (Bardin 2000). Events were further identified as being critical if different informants had repeatedly referred to them and if they had led to reported or documented changes in the project.

Critical events data were coded and analyzed by two researchers simultaneously using ANT's categories previously identified as potential critical event descriptors. The analysis generated memos related to methodological issues that linked empirical material with the theory. Memos contained a brief narrative of empirical material for each issue raised, a literature review on the conceptual aspects of the issue, and implemented solution. Memos were discussed in regular meetings among co-authors. Although empirical material from all three projects was used to elaborate definitions, for reasons of clarity and coherence, only data from Project 2 (the City Academy Project in Recife) were selected to illustrate the CEC's usefulness for reconstructing an intervention trajectory.

To ensure validity, a preliminary version of timelines and CEC were presented and discussed in a seminar to researchers involved in the three projects. The final version presented, discussed and validated in three meetings conducted with each project's stakeholders.

Results

Results are organized in two sections. The first presents final CEC descriptors. The second reports on the timeline of Project 2 and provides a table with an analysis of the six critical events that mark the project's evolution, based on the CEC.

CEC descriptors

Eleven analytical categories form the final list of CEC descriptors. For each of them we provide a name (italicized) and a definition or a justification based on ANT. Whenever, possible qualitative data are presented to illustrate the category.

1. *Title*: a descriptive/analytical title of the actions that took place to form the event.
2. *Narrative description*: brief summary of facts, in a text or bullet point format that synthesizes the information taken from all data sources.
3. *Actants involved in the event*: human and non-human entities who share a common situation or problem. Each entity is listed along with its identity, interests, and manner in which it interacts with others. Actants in the network may be individual or collective actors, always endowed with autonomy and capacity to build strategies. Strategies are made of the actions deployed by actants to pursue their interest.

"I was [coordinator] from 2003... before 2003 [...] there was a sports doctor, and he was the first coordinator...in 2001–2002. In the middle of 2003, I joined and stayed until 2005. In 2005, I left coordination to become a consultant... because we were working together already in 2003."

"In fact, I brought a public health view more than anything else, from public health to physical education.

4. *Actor's interests*: rationale action is based on interests; actors seek to maximize gains and minimize losses and costs from conflict, negotiation, and integration. Interests express the underlying rationale of an actor's actions, whose strategies depend on his/her own interests and resources, as well as the strategies and tactics adopted by other actors in context.

"I had a preliminary project, but it was too much geared toward clinical issues."

"Theoretically they were two very different ways of thinking, because we came from the National Health System and public health, collective health, broadening health conception, discussion about health promotion, cross-sector cooperation."

"From a management point of view, it is also a change related to theories that were being discussed at national level ... so this paradigm, and its conceptual perspective that is healthy cities and health promotion, I think this was also an important landmark from management point of view."

5. *Interactions*: relations and connections established among actors. Interactions are necessary for network emergence and stabilization, including network expansion. The emergence of a critical event requires that actors form alliances and connections with other actors or networks, and create facts and opinions regarding the program (potential) success.

“We had the evaluation’s people from there, from University of Pernambuco (UPE) and Federal University of Pernambuco (UFPE). So, there were people who worked well, and there was nutrition participation, all of it from UFPE. So, it didn’t happen in other Federal projects, two universities, and Municipal Health Secretary (MHS).[...] in the end, I think that combination was quite interesting.”
 “G...was part of a group in Ministry [of Health] which discussed the National Policy for Health Promotion, and also brought many discussions to [the project]... that has also resulted in the reformulation of thought model.”

6. *Mediation*: understood as a process which entails situation transformation such as the creation of new actants, recruitment of new partners, or reconfiguration of relationships. The mediation process aims to align interests among different actors, producing an event, a passage, or a modification in relations and working processes or in the ways in which information circulates (Latour 2005; Davallon 2003).

“one of the first initiatives was asking professional to produce a territory map, [identifying the] existing spaces already used by population for physical activities and recreation. We began to talk about recreation, because we were only talking about physical activity, almost as though it were a medicine. And others which were not occupied but could be occupied, [as consequence of] the territorial mapping... This was a fundamental proposal. You break down barriers between professionals and propose something to do in a public health way.”

“we carried out a broad process of the territorial mapping, and this was fundamental for getting knowledge on how things happen in the place where we work. So I think this was also a first step towards reaching out to the community.”

7. *Actions*: identify actors’ practices, activities, and working processes in the emergence, implementation, and stabilization of events.

“this brought another kind of work; we began to discuss not only what had been done at the units [but] what working process was used.”

“far beyond technical training, it ended up bringing elements of physical activity, elements of the intervention context that led to discussions about training, human development [like]:’who am I; what I think about the world, in very simple situations. Such as taking a breakfast on Mother’s Day when we discuss solidarity: who cannot afford, bring a dish for the collective table; [...] together, not just talking on but

in practice, we decided on the location, the working process.”

8. *Consequences*: outcomes that express changes in the intervention as a consequence of the critical event.

“we spent one whole year, 2004, making this break, but there was a cut in the program. It was cut, the program changed, there was progress.”

“so the theoretical health promotion point of reference, the way it is viewed, I think that it helps to produce and maintain this liveliness that J. was talking about, that has no end, because it is dynamic, because it deals with people, relations and thus continues in that way forever.”

9. *Inscriptions*: these are “all the kinds of transformation that give an entity its material form in a sign, an archive, a document, a piece of paper, a trace. Usually, but not always, inscriptions pertain to more than one dimension of the entity it represents. They are always mobile, which means they can be translated and articulated in other context while maintaining some forms of relation intact” (Levin 2002).

- A new version of the project (2003–2004) relating the program as health promotion initiative. Also, brings a project version relating to practices of health service humanization.
- Last project version (2009) updates the program’s presentation. Brings it in line with priority projects of the municipal health sector, such as: healthy community; restoration and re-appropriation of public spaces; fighting violent crime and defending civil rights; emphasizing social participation, joint action with the municipal health sector and cross-sector cooperation and actions promoting healthy behavior. Briefly describes actions development and presents positive outcomes achieved.

10. *Location*: settings wherein actions involved in a critical event take place. May be a place within an organization where coordination team works, and decisions are taken, places where professionals work, or spaces for social participation.

Municipal health sector linked to Department of Primary Care—Sanitary Districts, Health Networks. City academies spread across the six sanitary districts of the municipality where the activities are being carried out.

11. *Time*: may be from the emergence of an event through to its development and stabilization. It is not necessarily a discrete point in the chronology of a

program evolution, it is better represented by a period in this chronology.

“it was in 2004. We began to draft and redraft the project “we spend a whole year, 2004, making this break.”

“So we started, 2004, 2005, I began to see that there was another concern besides exercise for exercise’s sake, there were other concerns.”

The critical events of the City Academy Project

Figure 1 displays the resulting evolution timeline of the City Academy Project. This graphic was presented and discussed with program’s stakeholders. The timeline shows how events emerge and produce consequences that influence other events, practices, and overall context. Some critical events emerge from a group of combined events (circles around some events in Fig. 1). In this instance, six events (grey boxes in the Fig. 1) were identified as critical from the initial set of 14 events. They were mainly concerned with organizational practices coordination, related

to cross-sectoral partnership. No critical event was found concerning participatory evaluation which would mean that this case the evaluation did not impact the trajectory of the intervention.

Table 1 presents a brief analysis of the six critical events as synthesized by the CEC for the City Academy Project (CAP). These six critical events correspond to those in grey boxes in the timeline. This example demonstrates how analytical categories permit to identify which actors are involved in the critical event, what were their interests and interactions, mediations, and what were the consequences in term of adaptation, innovation and program changes.

Discussion

The study aimed to show the development and proof of concept of an analytical tool for identifying and analyzing critical events, their emergence and dynamics as well as their consequences for complex interventions. This process required a continuous appreciation and understanding of conceptual and methodological issues, which were

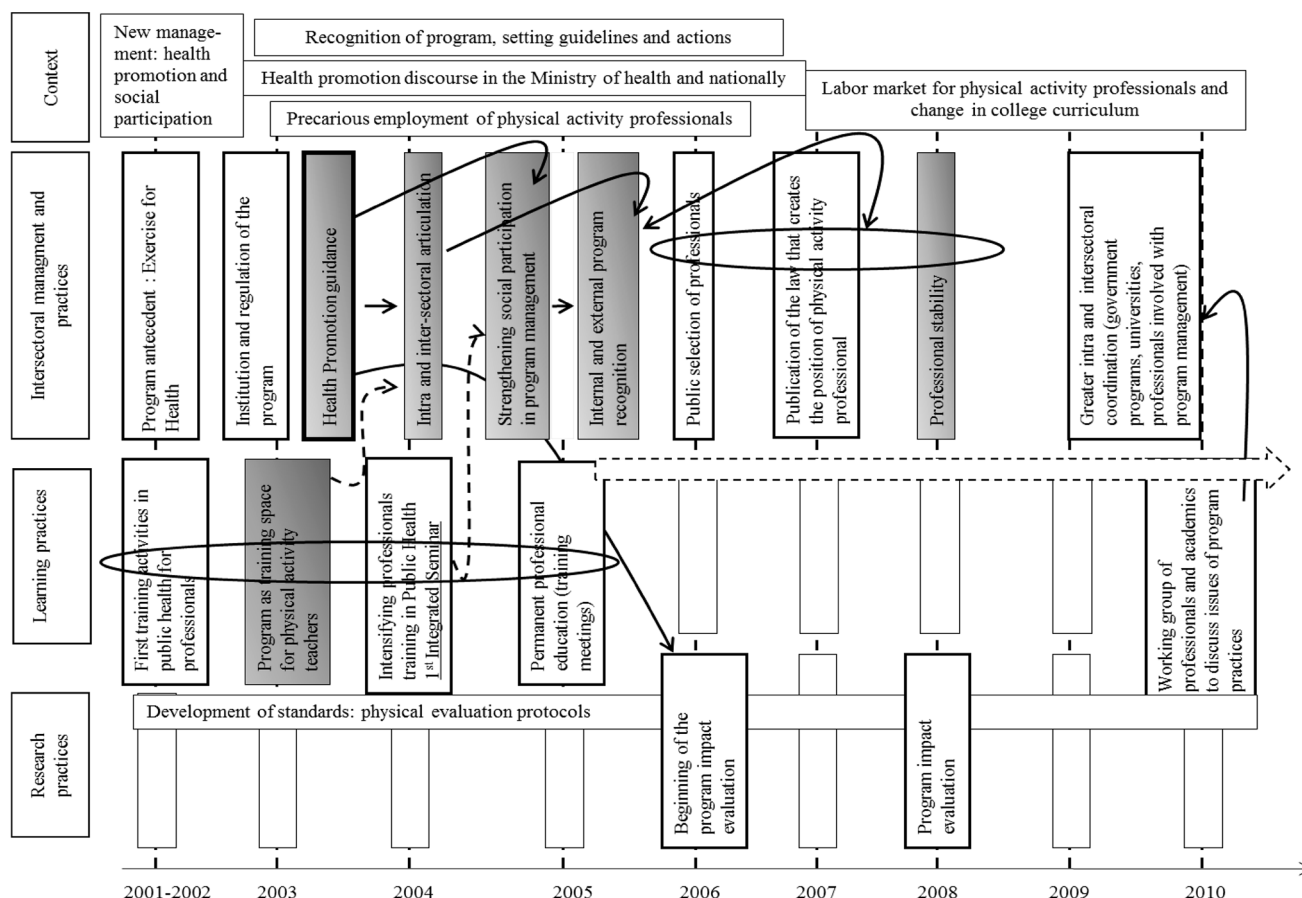


Fig. 1 Timeline—critical events in the evolution of the City Academy Project (Recife, Pernambuco, Brazil 2001–2010)

Table 1 Critical events that marked the evolution of the City Academy Project's implementation and evolution (Recife, Pernambuco, Brazil 2001–2010)

Synthesis of critical events based on each event of the Critical Event Card	Comments based on critical event card analytical categories
<p>Critical event 1: health promotion guidance—changing program's guideline from physical activity to health promotion</p> <p>City Academy Project (CAP) was implemented in 2002 as a physical activity promotion program. At the end of 2003, a new coordinator (a public health professional) was hired. With the help of a new technical advisor, she initiated a program review. During the year 2004, the coordination team along with other health professionals and physical educators redefined the initial purpose of the program into a health promotion proposition. This decision led to a conflict between the first program's coordination team. Some conflicts also came about among physical educators, related to their impression of losing power</p> <p>The new CAP's guideline, which was more closely aligned with health promotion principles, became clearer to program staff when training was initiated. In this process, professionals were asked to prepare a territorial mapping of where activities were developed. The goal was to identify local leaderships, health and other social equipment, users' needs and places. This work was further used to plan physical activity and other events. It initiated a movement to frame users as more active program actors. Therewith, professionals started to figure out the differences between old and new CAP's proposition, and give support to coordination decisions. On the other hand, coordination enhanced staff participation in decision-making. This change in the program orientation also helped Municipality Health Secretary (MHS) to acknowledge the link between CAP and the political discourse of health management</p> <p>Critical event 2: intra and intersectoral articulation</p> <p>At first, the dialogue between CAP and other Municipality Health Secretary (MHS) sectors was considered fragile. The program's goal was identified as too narrow. Opening a dialogue and fostering articulation with other programs and health professionals was a decision taken by the new CAP's coordination. This meant different levels of collaboration between CAP's coordination and others MHS programs such as Family Health Program, Health youth and elder program; professionals, users and communities; coordination and other social sectors of public administration and universities. The new coordinator maintained dialogical practices, and coordination process was recognized as favorable for dialogue and articulation between different actors. As a consequence, there was a reinforcement and acknowledgement of the program as a priority by health management and a growing acceptability of program's coordination decisions, and new propositions by involved professionals</p>	<p><i>Title and description</i> of the critical event is provided in the first line in each one of the critical event</p> <p><i>Actors and actants</i> intend to identify what is at stake for specific actors in the event and/or their particular perspective on the event. Some examples:</p> <p>Critical event 1: "a new coordinator (a public health professional) was hired. With the help of a new technical advisor, she initiated a program review"</p> <p>Critical event 2: "This meant different levels of collaboration between CAP's coordination and others MHS programs such as Family Health Program, Health youth and elder program; professionals, users and communities; coordination and other social sectors of public administration and universities."</p> <p><i>Interactions</i> indicate how different groups and organizations worked together and made changes. In Critical event 4: "Beyond this, the high level of articulation between the program's coordinator and professionals from other programs and sectors (action intra and intersectoral). In addition the program won awards in health conferences, and in national and international health promotion conferences. This brought recognition of CAP as a successful health program."</p> <p><i>Mediation</i>, as described at the Critical event 3, mediation led to a redefinition of the problem and of the relations between actors in the system: "(i) as result of the territorial mapping, performed by professionals who worked in the physical activities poles. At that time, they were able to identify needs and communities' leadership and to initiate partnerships with users and communities."</p> <p><i>Actions</i> seek to indicate what actors do or perform within the system, as pointed out at the Critical event 5: "temporary selection process for physical educators was implemented. The next step was to define physical educators as health professionals [...] The final step was the implementation of a formal public selection process in 2008."</p> <p><i>Consequences</i> reports a rupture emphasizing program changes as a result of the event. This can be observed at the Critical event 6: "the program became an important vector for health education. As consequence of this decision, universities begun organize new courses and modify their curriculum, including public health as a theme"</p>

Table 1 continued

Synthesis of critical events based on each event of the Critical Event Card

Comments based on critical event card analytical categories

Critical event 3: strengthening social participation in program management

This event emerges as consequence of two processes: (i) increased dialog between program and political practice of health management which favored civil society participation in the public administration through institutionalized spaces; and (ii) as a result of the territorial mapping, performed by professionals who worked in the physical activities poles. At that time, they were able to identify needs and community leadership and to initiate partnerships with users and communities. Therewith, users started to voice their interests related to CAP. These led to an intense presence of users and professionals within spaces devoted to political participation. Implementation of new CAP poles was the first community request in the Participative Budget, in 2004. The program became a genuine interest to public administration once public opinion had approved it. In addition, it increase users participation at all program's poles, discussing their interest, ideas, activities, and wishes

Critical event 4: internal and external program recognition

Although CAP had been implemented by MHS in 2001, it was only a couple of years later that it had been recognized as a part of the organization's political project. This gradual acknowledgment can be observed through some milestones. The first was...a mayor's decree in 2003 defining CAP as a health program linked to primary care. The same year, the program hired a new coordinator who redefines guidelines. Popular demand, asking for more and more poles of CAP, and acknowledgement of the quality of the work done by professionals acting at these poles, produce an electoral and partisan interest about the program. Beyond this, the high level of articulation between the program's coordinator and professionals with other programs and sectors (intra and intersectoral action). In addition the program won awards in health conferences, and in national and international health promotion conferences. This brought recognition of CAP as a successful health program. But, at the same time, professionals had a precarious labor status. Almost all professionals were hired as temporary employees. The mainstreaming of CAP's professionals into municipality labor force came as a consequence of programs recognition by MHS

Critical event 5: professional stability

Recognition of CAP as a successful health promotion program helped to expose the precariousness of professionals working conditions. For six years, professionals had been working under unstable contracts. As a first step in 2006, temporary selection process for physical educators was implemented. The next step was to define physical educators as health professionals. Until then, it was a profession only recognized by the Secretary of Education. The final step was the implementation of a formal public selection process in 2008. After that, all professionals acting at CAPs became civil servants. This change led to new challenges, since many senior and committed professionals, dedicated to the program ideals, were not approved through the formal public selection process. At the same time, more junior and less committed professionals were recruited. While this was seen as problematic, it was also understood as a challenge. At that time professional continued learning was strengthened. Professionals, which were (re)qualified, intensified their activities along with family health program professionals, extending their practice. As a consequence of this professional stability, CAP's recognition was reinforced in the MHS and contributed to open up a new job market to physical educators

Table 1 continued

Synthesis of critical events based on each event of the Critical Event Card	Comments based on critical event card analytical categories
<p>Critical event 6: program as training space for physical education teachers</p> <p>Program reorientation and its acknowledgment as a priority program, led to discussing the role of physical educators in the public health field and in health promotion. Several activities were planned and implemented to introduce these themes into the program. The new CAP's guideline, better aligned with health promotion principles, became clearer to program staff when training process was initiated. This continuous learning process was focused on concepts and practices in public health, public health system, and health promotion. Planning was developed in a participatory perspective between the coordination team and professionals. These activities became part of program planning work, requiring the presence of the professionals. Most of the time, professionals were strongly interested to participate. As a consequence the program became an important vector for health education. Also, university programs for physical educators started to organize new courses and modify their curriculum, including public health as a theme</p>	

explored through examination of the literature and team discussions that generated “methodological notes.”

During field-testing of the CEC's categories, using data from three community health promotion interventions, some conceptual issues emerged. The first one was related to the two central concepts in the study: critical events (unit of observation) and controversies.

Understanding controversies as conditions that destabilize routines and expose various perspectives and interests about the program, critical events are conceived as key actions that develop as a consequence of a controversy to solve it. For this purpose, critical events mobilize the intervention's socio-technical network and operate mediations leading to significant changes to the system. Such changes may take various forms: (1) a review of priorities and objectives; (2) changes in key players (managers, decision-makers, stakeholders); and (3) a changes in the level of resources (Latour 2001; Bernier et al. 2006).

As proposed by Hawe et al. (2009) critical events may be taken as events capable of bringing about changes in a system. As demonstrated in this study, critical episodes related to actors' interactions, mediation result in important modifications and learnings. This, in turn, increases the system's ability to meeting challenges and controversies in the future (Mantoura and Potvin 2013; Hawe 2015). Controversies and critical events require that actors seek out new alliances, networks connections, producing facts and inscriptions to successfully pursuing their project (Latour 2001).

Another issue was related to the “interactions” category. Interactions could be understood as expressions of a critical event development, as means by which actors implement their strategies for expanding or consolidating the network. In this sense, this analytical category describes how actors review their initial positions because of new contextual conditions. Sometimes, these reviews are achieved through mediation. The success of such undertakings can be observed through several events: (1) actors get involved in new consensual goals; (2) identification of new actors and networks; and (3) alignment of other actors who engage in the negotiation of common interests (Mantoura et al. 2007). Events, therefore, do not evolve in a pre-determined fashion, but produce new connections, actors or inscriptions.

The meaning of “Mediations” as an analytical category was another conceptual challenge. The notion of mediation involves a transformative situation, which induces an impact on social context wherein it is located. Because of these mediations, an event or passage occurs that leaves nothing unchanged (Davallon 2003). Mediation works to provide an *insight* regarding changes that were needed to solve an initial controversy.

A difficulty encountered in the three evaluated projects was related to how events should be expressed, or the

“inscriptions” category. It was observed that not all situations, even if producing many inscriptions, could be interpreted as critical events. As shown by Pluye et al. (2005) routinized program procedures might be producing many inscriptions, as it has been observed in the three projects here. Once a critical event had brought a new solution, it becomes routinized and, then, produces a growing volume of inscriptions.

Finally, a difficult issue was the expression of a *critical event*. It does not reveal itself as a single explicit key event for all those involved. It usually takes the form of a series of facts and situations that reconfigure the intervention’s sociotechnical network. A critical event is expressed by the introduction of other actants and actors, the emergence of new interests’ and interactions within the network, acting in synergy to make the intervention evolve.

Conclusion

The tool presented here has demonstrated its potential to describe how critical events are milestones in the dynamic of complex interventions, interacting with their contexts. The proposed instrument is promising. CEC’s content enables the assemblage of the events that mark the evolution of an intervention and express the transformative interactions among the constitutive elements of sociotechnical networks.

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