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## Learning Science through the Conception of Comics: the SARABANDES Research Project

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### Abstract

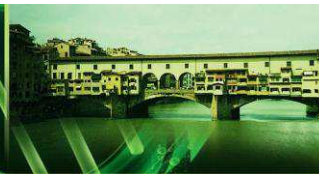
*Artistic medias as tools for the learning and the communication of science has been very little studied by science education research. Nevertheless, a lot of science communication projects promote and use artistic media (theatre, movies, comics, etc.) for a more motivating science education and communication. Most of the time, the artistic work is co-created by both science communication specialists and artists, and the target audience does not take part in the creation process. In this context, comics are sometimes used to promote scientific literacy via education and communication [1] but again, the elaboration of such medium does not include the future reader. Unlike this current practice, “Stimuli” science communication association promotes the creation of short comics strip as a powerful process for learning altogether elements of science, art and language [2]. In concrete terms, 12-16 years old volunteer teenagers (as Trainee Science Communicators, TSC) are led to create a short comic strip about science during a 15h long-lasting spare-time workshop (named Comics’n Sciences workshop). In this workshop a scientist (PhD student) is invited to present to the TSC a scientific content connected with his/her research; this content is the target of the comic strip produced by the TSC; the process of creation (both visual and narrative) is assisted by a professional drawer and a science communication specialist. This environment forms a four-actors dynamic system {scientist/drawer/communicator/TSC} wherein a scientific knowledge circulates and is transformed. This oral presentation documents the aims of a research project (the SARABANDES<sup>1</sup> project) conducted in order to evaluate the cognitive and motivational impacts of the Comics’n Science workshop on the TSC involved. Here, the “mediatic transposition” [3] is used as a theoretical framework to analyse the scientific content transformations while it circulates from the scientist to the TSC along the comics design process. We wonder to what extent the artistic practice leads TSC to learn efficiently elements of science and art knowledge. This requires studying the specificities of the comic strip medium in the context of scientific knowledge exhibition. It also requires the analysis of the complementary actor functions involved in the process of creation.*

### 1. Introduction

Artistic media as tools for the learning and the communication of science have been very little studied by science education research. Nevertheless, a lot of science communication projects promote and use artistic media (theatre, movies, comics, etc.) for a more motivating science education and communication. Most of the time, the artistic work is co-created by both science communication specialists and artists, and the target audience does not take part in the creation process [1]. Compared to this common practice, Stimuli science communication association promotes the creation of short comics strip as a powerful process for learning altogether elements of science, art and language; In concrete terms, 12-16 years old volunteer teenagers (as Trainee Science Communicators, TSC) are led to create a short comic strip about science during a 15h long spare-time workshop (named Comics’n Sciences workshop). In this workshop a scientist (PhD student) is invited to present to the TSC a scientific content connected with his/her research; this content is the target of the comic strip produced by the TSC; the process of creation (both visual and narrative) is assisted by a professional drawer and a science communication specialist [2]. Here, we documents the aims of a research project (the SARABANDES project) conducted in order to evaluate the cognitive and motivational impacts of the Comics’n Science workshop on the TSC involved.

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<sup>1</sup> The SARABANDES project is supported by the Region Ile de France; it involves the Université Paris Diderot (France) and the Stimuli association (<http://www.stimuli-asso.com/>)



## 2. Theoretical framework

The major part of the SARABANDES research project consists in the analysis of the scientific content transformations while it circulates from the scientist to the TSC along the comics design process. We wonder to what extent the artistic practice leads TSC to efficiently learn elements of science and art knowledge. This requires studying the specificities of the comic strip medium in the context of scientific knowledge promotion. It also requires the analysis of the functions of complementary actors involved in the process of creation. These questions will be answered through two theoretical frameworks developed and used in science education research: the “mediatic transposition” [3] and the “instrumental genesis” [4].

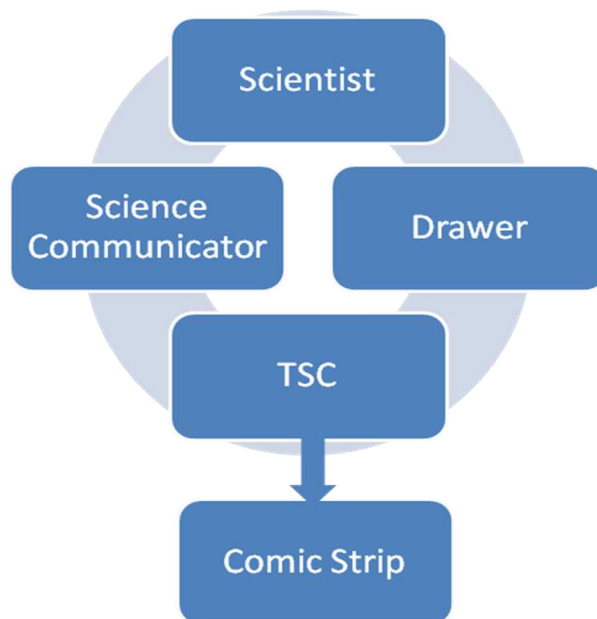


Fig. 1: This diagram shows the dynamic of the articulation between the actors of the action of communication (the Comics'n Science workshop) and the created medium (i.e.: the short comic strip).

### 2.1. The mediatic transposition framework

The mediatic transposition is an adapted form of the “didactic transposition” created by Chevallard [5] in the 80’s that focuses on the general mechanisms which govern the crossing of a knowledge from the scholarly sphere where it emerged (e.g.: the laboratories, the research teams, etc.) to the educational sphere where it is taught (e.g.: the schools). The didactic transposition relies on the following assumption: the transmission process of a given knowledge is forced by specific elements (e.g.: the previous knowledge of the students concerned) that inevitably transform the knowledge if considered in its initial (or scholar) form.

Adapted to the science communication sphere, the mediatic transposition analyses the way the scientific speech (or content) is processed when a science communication project is being created. In the context of the SARABANDES research project, the mediatic transposition allows us to conduct a systemic analysis that connects discourses analysis (that of the scientist, that of the scientific communicator, etc.), interplay analysis (between the different actors of the system) and an analysis of the final short comics strip produced by the TSC. Indeed, the Comics’n Science workshop forms a four-actor dynamic system {scientist/drawer/communicator/TSC} inside which a scientific knowledge circulates and is transformed (see fig.1). The evolution of this system leads to the short comic strip and depends widely on the interplays between the different actors involved.

### 2.2. The instrumental genesis framework

The short comic strip is considered here as an “instrument” that formalizes the knowledge as much as it constructs it [4]. In this perspective, the production of a short comic strip by the TSC can be



examined in the light of the instrumental genesis framework; if the strip is disconnected from its aim of communicating science it appears as an *artefact*. But when it is associated to its mediatic function by the TSC, this *artefact* becomes the instrument we wish to focus on in this research (the appropriation of the *artefact* by a subject –here, the TSC- that makes it becomes an instrument is what Rabardel calls the instrumental genesis). Thus, its production forms the result of a completed activity during which the TSC have imagined the future use of this *artefact*. The instrument includes a part of this *artefact* but also a part of the subject himself who allocates some functions to the *artefact*.

### 3. Overview of the research and research questions

The strips' analyses associated with the discourses and interplays' analyses along the strips' production processes allow us to document the following issue: studying the impact of an action of scientific communication based on the production of a short comics strip, on the scientific knowledge structuring and transforming. This issue is explored through three research questions that all fall within the scope of Science Education Research.

First, the comic form is governed by certain rules that constraint inevitably the different choices that can be made by a drawer. For example, the boxes' succession can refer to a chronological organization or to a change in the point of view (e.g. a focus on a detail). Thus, it is interesting to explore to what extent the comics support, as a constraint for the knowledge adaptation, is an obstacle or a lever to approach and formalize scientific reasoning (such as systemic and/or instantaneous reasoning where the different variables of a system have to be considered at the same time). More generally, we look for some features of a class of scientific knowledge that could fit with the comic form. Our intention is to promote a classification of the scientific knowledge corresponding to the narrative form involved. This sustains the first research question **RQ1: What are the distinctive features of a scientific knowledge that can appropriately fit the comic strip form?**

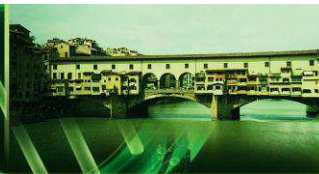
Correlatively, we also wonder to what extent the necessity of rephrasing the knowledge involved in a Comics'n Science workshop (in order it can fit the comic form) make the TSC be aware of the limit of an inappropriate reasoning in science. For example and as mentioned above, the common sense often favours explanations taking the form of « narratives » as a linear chain of implications (this reasoning is known as "sequential reasoning" [6]). The reasoning thus takes the form of a story where terms such as "then", "so", play a determining part in the irrelevant chronological organization of events that should be considered as simultaneous from a scientific point of view. Our assumption is that the process of creation carried out by the TSC will lead them to face this difficulty and to make a decision on the scientific content they will have to exhibit in a relevant way, avoiding usual mistakes or common inappropriate explanations. This sustains the second research question **RQ2: What elements in the process of the comic strip creation favour an effective appropriation of the knowledge involved, by the TSC?**

Finally, it is not so usual for science education research to focus on "learners" activities of rephrasing or/and reorganizing a given knowledge in order to make it understandable by readers (in the context of science communication actions where learners become science communicators). Consequently, it seems necessary to adapt the didactic transposition framework to this special case and maybe to compare the works performed by the TSC and those of education professionals dealing with the same science topic. This aspect adds to the elements developed in the previous section regarding the circulation of knowledge within the four-actor dynamic system {scientist/drawer/communicator/TSC} which is examined in the light of the mediatic transposition. This leads to the third research question **RQ3: What are the transformations undergone by a given scientific content while it circulates within a Comics'n Science workshop?**

### 4. Collecting and analysing data

Our analyses are sustained by data collected in a similar way during six workshops concerning six different scientific topics (different in nature: explanation, description, etc., and different because of the scientific fields they belong to: biology, physics, mathematics, etc.). For each workshop, the body of the data includes the following elements:

- Transcriptions of (audio-recorded) interplays involving the scientist and the professional science communicator during the preparation phase of the Comics'n Science workshop (D1 data).
- Transcriptions of the 12 hours-video-recorded workshop (D2 data).



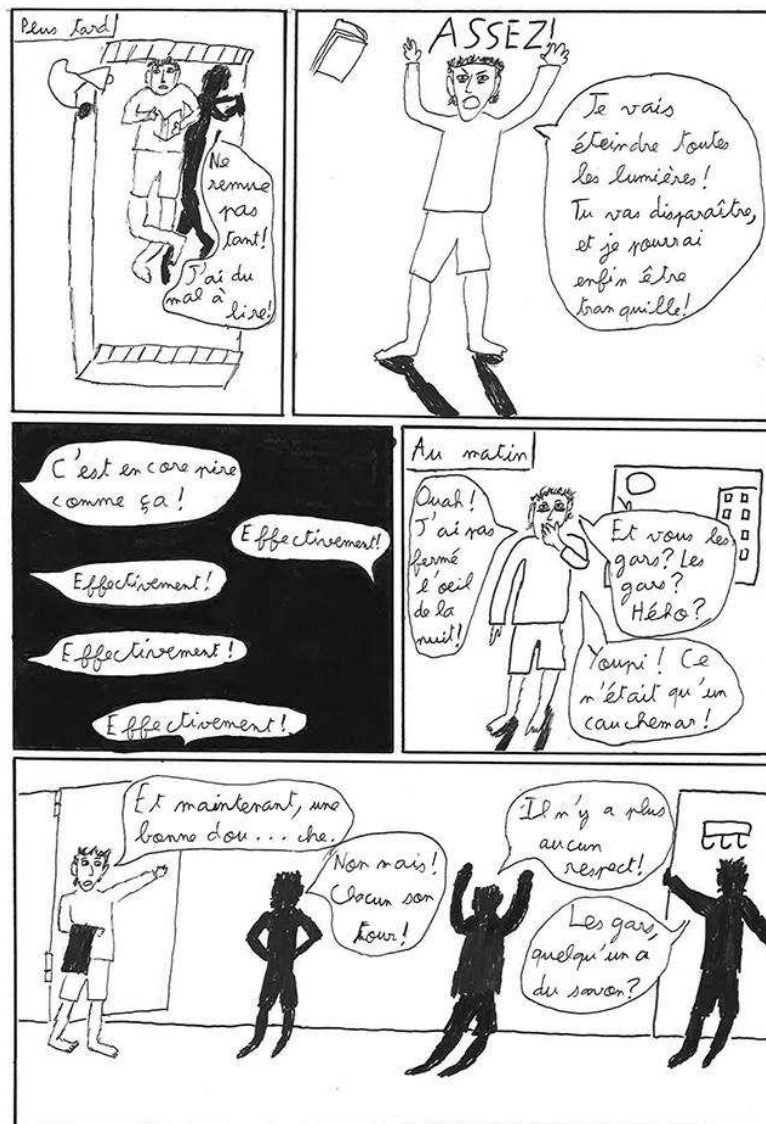
- Set of short comics trip created by the TSC involved in the workshop (D3 data)
- Transcriptions of an audio-recorded post-workshop sequence where the TSC present their creation and the choices they made (in terms of science, technical draw, narrative, etc.). (Data D4).

From a methodological point of view, the transcriptions are analysed with the tools of the “content analysis” framework as developed by Bardin [7]: the scientist/communicator interplays are studied through a lexical analysis that involves the tracking of “meaning units”. The successive transformations of the scientific content involved are rebuilt from these meaning units.

## 5. First findings

As the SARABANDES research project began on January 2014 (it will end in December 2016) it is too early to present effective findings. Nevertheless, Comics'n Science workshops have been held in different formal and informal educational environments for three years. As an example, figure 2 is a short comic strip produced by Emmanuel, a 15-years old TSC involved in the 15-hour “Comics'n Science” workshop on light (April 2013, Reims, France). In the first step of the workshop, with the help of a slideshow, the scientist presented the light as a form of energy focusing on the current use of light in new technologies (e.g. lasers), speaking about photons, light sources, etc. Each of the six TSC involved in the workshop chose a different content and the storyboards remained very different one from another.

Emmanuel tells the story of a man worried by its shadows (box 1 and 2 of the strip figure 2). The only way for him to escape the shadow is to turn off the lights surrounding him. Unfortunately, even in the dark, the shadows are still there, bothering the man while he tries to sleep (box 3). In the morning, the man wakes up, goes for his morning shower (box 4) and when he enters the bathroom, the shadows are there, waiting for the shower to be free (box 5). In this strip, the knowledge involved is the condition of existence of a shadow. The narrative mixes up this knowledge with a common tendency that consists in considering a shadow as a material object [8]; this conscious play between science and common sense makes the comic strip quite funny and surprising. It also shows that the narrative and draw constraints fit quite well with the material/immaterial duality that often specifies the common sense/science duality when considering scientific concepts (such as light and shadows). This could be a relevant element to explore in the future.



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Fig.2. Example of a short comic strip created by Emmanuel, a 15-years old TSC during the Comics'n Sciences Workshop on Light (April 2013, Reims, France).

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