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PhD students involved in telling science: the possibilities of comic medium in science communication

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The approach to science communication through storytelling should be closely examined, as its assets of attractiveness and efficiency are not without constraints. The French Stimuli association supports devices and research on the impact of comic language on science communication and education, giving an active role to the PhD students. Two devices are presented and discussed: i) the “Comics&science workshops”, in which a PhD student provides a scientific presentation to a group of teenagers invited to create a one-page comic strip from the scientific theme provided, ii) the “Science through comics” trainings throughout young researchers are informed how to transpose his/her research into the semiotic codes of graphic narration. In both cases, the PhD students are guided to adapt their discourse to the public, to be watchful on the visuals, languages, and metaphors they deliver and/or they validate. If they assume the role of co-mediator in the workshop, they become co-author during the training, fruitful experiences in term of appropriation of scientific narratives. The specificities, the benefits and the limits of both situations are presented according to their impact on young researchers’ implication in sharing science to different audiences.

I. INTRODUCTION

At a time when scientists are becoming increasingly involved in sharing knowledge with society, the possibilities of engagement of PhD students in outreach projects are variable and eclectic. Their engagement may depend on different parameters among which the government’s policies (Trench and Miller, 2012), the institutions and laboratories (Courty and Dematteis, 2015), the disciplines (Jensen and Croissant, 2007), the personal involvement (Daelli and Rodari, 2014). Whether it is voluntary involvement in dissemination of scientific information, or enhancing their research through institutional projects, young researchers are willing to engage with the public with an attitude of openness to dialogue and participation (Cerrato et al, 2018). This new approach to science communication, far from the old-fashioned top-down model, is not without constraints, on the contrary.

One of the challenges is that this current dialectical tendency between researchers and the public expectations supposes effective scientist’s skills in science communication.

In this perspective, a wide range of media trainings has been offered to PhD students (Frey-Klett et al., 2015; Trench and Miller, 2012). Actually, dialoguing and participating with the general audience involves science communication competences like knowing the public prerequisites, translating the specific jargon into useful and careful metaphors (Taylor and Dewsbury, 2018), or mastering the storytelling techniques.

In this last domain of communication, the narratives and storytelling tools constitute a mode of sharing the science that underlie an additional challenge for the professionals of the science communication, and therefore for the PhD students. Dahlstrom (2014) explains in a review of literature on narrative communication that “science communicators have to decide when and how narratives can effectively and appropriately help them communicate to non-experts about science”. According to the study, narratives may facilitate audiences to comprehend scientific content and help the public find them more engaging. Even so, narratives are intrinsically persuasive, and may represent a non-ethical influence on the non-experts depending on the theme, the medium and the target public.

For these reasons, the French Stimuli association that produces and supports devices in science communication and education with the help of comic storytelling invite the researchers involved to be guided and/or trained to the specificities of the comic medium.

Two postures are proposed to young researchers with regard to the storytelling of their research. One of them places the young researchers as trainee-mediators during a workshop where teenagers are led to transcribe PhD research or scientific content associated into comic strips. In this first situation, PhD students are “escorted” all along the process by a science communicator and a comic artist. The other, corresponding to the “Science through comics” Stimuli’s training, gets them into position of future co-writer of comic strip projects in which they will have to find their role within a team, choose the target public, define the subject and characterize the treatment of their project in this context. In this second situation, PhD students have to collaborate and overtake the traditional costume of the scientific expert: they become co-authors.

The purpose of this communication is to present and compare the conditions of engagement and the parts of the PhD students involved in science communication storytelling projects consecrated to comic medium. The communication starts with the devices presentations including portrait, role-play and feedback of the young researchers involved in each of configurations. Then the impact of the storytelling and design comic strip practices is discussed. Finally an open question is proposed on the balance between the PhD students' involvement as expert and commitment requiring the acquisition of professionalizing skills in the light of the experiences studied within the Stimuli association.

II. COMICS AND SCIENCE WORKSHOPS

1. Preamble

The French Stimuli association is a group of scientists, comic artists, teachers and science communicators involved in science and comics projects since 2007. The Stimuli group supports devices as workshops and classrooms for teenagers, webcomic series for science teachers, trainings in comic medium for practitioners. Stimuli is also partner of the science education research unit Laboratoire de didactique André Revuz (LDAR of Paris Diderot University, France) to lead research projects on the role and the impact of comic medium in science education (De Hosson et al., 2018).

2. Principle, context and objective

The comics & science workshop (C&S workshop) is a short, science-based comic strips dispositive in which a group of volunteers aged 10 to 16 years create a one-page comic strip about science in their leisure time or in classroom (Bordenave, 2012). In this creative workshop, the science is delivered to the teenagers by a scientist who presents and discusses on a scientific theme associated to his/her research. To create their comic strip, the teenagers are guided by a comic artist for the basics of the comic design (character, expression of emotions and feelings, composition of a frame, sequential movement, etc.) and by a science communicator for the basics of the storytelling (protagonist, exposure, climax, punch line, etc.) adapted to the scientific content (care of science visual representations, language and metaphors).

Between January 2011 and June 2018, 31 workshops have been conducted, including 16 co-facilitated by a PhD student or post-doctoral researcher (whom one of them interacted in 3 workshops). Other situations involved researchers, engineers, teachers or science communicators in the role-play of the scientist. The sessions involving PhD students took place in science and culture centre's (10), in classrooms (4) or in public libraries (2), during a 12-hour workshop led for a total of 116 teenagers aged 9 to 19 years old.

3. Portrait of the PhD student in C&S workshops

The profiles of the 14 C&S workshops PhD students are various, consisting of 9 females and 5 males. Most of them were engaged in the device during their first (6/16 workshops)

or second (4/16 workshops) year of thesis. Three PhD students enrolled during their last year and 3 were post-doctoral researchers at the time of their participation. They spent 6.6 hours total (on average) in the workshop with a minimal duration of 2-h and a maximal duration of 12-h.

Tab. I shows that most of the PhD students are affiliated to natural science graduate schools, with a large distribution among the scientific domains of research. None of the selected workshops were devoted to human and social science in that selection. The obtained distribution of the major areas of research is the result of policies of institutions on which the development of a workshop by Stimuli association depends. Most of the workshops were requested and/or sponsored by French scientific organisms (Institut national de recherche médicale - Inserm, Commissariat à l'énergie atomique - CEA) or by scientific and cultural centres in parallel with a scientific cultural event. This organization had an impact on the choice of disciplines, and thus on the doctoral student research domain.

TABLE I. GRADUATE SCHOOL AFFILIATION OF PHD STUDENTS INVOLVED IN 16 C&S WORKSHOPS BETWEEN 2011 AND 2018

Domain of research	Graduate school (number of PhD students)
Sciences of universe and matter	Science, technology and society (1)
	Sciences of universe (1)
	Astronomy/Astrophysics (1)
	Physics (1)
	Physics and chemistry of materials (1)
Life sciences	Chemistry (1)
	Life and health science (2)
	Neuroscience (1)
	Experimental and clinical pharmacology (1)
Mathematics	Medecine, toxicology, environment (1)
	Cognitive science (1)
	Computer science (2)

4. The role of the PhD student: a co-mediator

The functions offered to PhD students involved in a C&S workshop are to present through a dialogue with the teenagers the elements of knowledge around a scientific subject based on a slide show. They are also invited to present their research project in the context of the scientific themes selected. The preparation of the oral presentation, the design of the slide show and the face-to-face with the young public are elaborated in collaboration with the scientific communicator ahead. In this context, PhD students were guided all along the activity by a professional of science communication that allows him/her to get into position of co-mediator.

Among the media supports, the slide show is an essential element as it constitutes for the teenagers the main visual

support on the scientific content and, as a consequence, is considered as a reference source by the participants. A recent study led on 7 C&S workshops between 2014 and 2017 with the analytical support of LDAR unit shown that teenagers are largely influenced by the images showed by the PhD student (scientific images, drawings, diagrams) and some elements of the slides could be directly reinvested in the comic strips (de Hosson et al., 2018). Then the influence of their presentation is directly identifiable making the C&S workshop as possible educative tool for the PhD students.

In addition, the workshop is often the first opportunity for teenagers to meet a young researcher. This meeting visibly influences adolescents for whom the world of research is very abstruse and the stereotypes of the untidy hair researcher may still be alive (Karaçam, 2016). This influence is clearly observed through the created comic strips in which teenagers frequently represent young researchers in their working environment. It is true that classical scientist stereotypes remain prevalent in some of the participants' stories, probably in connection with the nature of the comic strip medium in which the figure of the scientist is one of its cornerstones (Allamel-Raffin and Gangloff, 2007), and turns out a useful character to dramatize a story. Nevertheless, it is highly probable that this encounter with young adults, women or men, with whom teenagers can directly exchange, offers a new picture of the scientists to the young participants. By breaking with the usual stereotypes of the scientist as in the project of the "11 theses in comics" of the Lorraine University (Beck et al., 2016), we could argue that this science communication device in which PhD students are science representatives may help young public to apprehend the place and the real occupation of a scientific researcher.

5. Feedback from PhD students after C&S workshops

Five of 14 young researchers joined the Stimuli association after their first experience in a C&S workshop, either to participate to a new session, or to take part in other science communication activities of the group. Among them Olivier, PhD student in microbiology, expressed the importance of the face-to-face experience within the framework of informal discussion with non-experts: *"It brought me some distance by recontextualizing my thesis but also something more important: it made me breathe. The thesis is a rather solitary experience, and being able to discuss it with an interested public does a lot of good. I'd love to do it again."* Other accounts (evaluation questionnaires) should be useful to evaluate the impact of this experience on the science communication curriculum of the PhD students involved.

III. "SCIENCES THROUGH COMICS" TRAINING

In a context of deployment of storytelling tools in science communication, comic medium has become a new tool for science communication institutions. Recognized as an attractive medium for the general public, and carrying of media qualities through its iconic-textual essence, the comic strip makes it possible to transmit scientific information efficiently (Tatalovic, 2009). However, few studies exist on this real

informative scope, even less on educational impact, and on the future of scientific knowledge sifted through the constraints of graphic novel. In France, the majority of large-scale editorial projects, i.e. collections of so-called "scientific" comics, although still endorsed or co-written by scientists, are carried by editorial structures whose intentions and challenges are not always those of science communication. Therefore, training young researchers in the understanding of the semiotics and use of the comic medium seems to be a crucial point to guarantee fruitful inter-professional collaborations between researchers and creators, and thus enrich the diversity and the quality of future comics and science communication projects.

1. Context and objective

Proposed by Ombelliscience association, a scientific culture structure established in the north region of France, the PhD student training "Sciences through comics" is part of a broader training offer on the storytelling of research ("Sciences through the tale"). It is within this framework that the Stimuli association developed, for the first time in France, a training programme on comic medium specifically intended for PhD students.

In partnership with two graduate schools (Human and Social Sciences on the one hand, Science, Technology and Health on the other) of the French University Picardie Jules Verne, the Stimuli association has designed and led a doctoral training on the graphic narratives of research. Since 2017, two sessions have been scheduled to train a total of 17 PhD students over a 3-days session. This training is financially supported by Hauts-de-France region and by an investment programme of the French State.

The session is designed to make young researchers aware of the semiotic codes of comics and to initiate them to collaboration with artists on future projects to promote their research through comics. The tutors are one specialist of science and graphic novels links, also scriptwriter, and one professional drawer.

The training program consists of theoretical and practical elements organized in 3 stages (Tab. II): a state of the art on comics, manga and Franco-Belgian scientific comics with the tools for decoding its particularities (place of the scientific contents and of the scientists, visual representations, etc.), a focus on script writing methods and on the collaboration with a comic artist, and finally a practical design session to create a short comic strip on the doctoral student's research topic. This last step is the innovative educational point of this program, funded on the bias of the PhD students to put into practice the technical basics of comics through the realization of a short comic strip.

TABLE II. SUMMARY OF THE PHD TRAINING PROGRAM "SCIENCE THROUGH COMICS"

State of the art on scientific comics	Typology of scientific graphic novels Roles within authors involved Scientific themes and disciplines in science
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	comics Articulation and formalisation of the contents
Script writing methods	Comic script writing tools Collaborate with a professional comic artist
Practice of comic medium	Write and produce a comic strip on research project (theme, script, storyboard) Reading, critiquing and improving other comics research storytelling projects

2. Portrait of PhD students trained in telling the science with comic medium

A total of 17 PhD students (11 females and 6 males) signed up to the 2 sessions of training, 12 registered in their first year of thesis, 4 in their second year and one registered in master degree. The distribution of their domain of research was eclectic with a predominance of life science and social science, that resulting of the scientific area research of the graduate schools associated to the project.

TABLE III. DOMAIN AND DISCIPLINE OF RESEARCH OF PhD STUDENTS TRAINED IN COMIC MEDIUM (2 SESSIONS)

Domain of research	Discipline of research (number of PhD students)
Sciences of universe and matter	Physics (1)
Life sciences	Biotechnology (1) Neuroscience (3) Ecology (1) Biology (1) Health (4)
Human and social sciences	Psychology (2) Anthropology (1) History of communication (1) History of Art (1)
Mathematics	Computer science (1)

Among the participants, one of them was engaged in a PhD student conference programme for general audience during which the comic strips of the PhD students were exhibited.

3. PhD students' account

At the end of the two training sessions, the participants answered an evaluation questionnaire designed by the Ombelliscience association, which makes it possible to identify their motivations for the comic strip medium as well as to evaluate the impact of raising awareness to the importance of promote their research through comics or other media. Nine of the seventeen participants answered to the questions.

There was no typical PhD student profile engaged in the comic medium training. The expectations and needs of PhD students are diverse. They may expect general knowledge like "Getting a better understanding of the process of setting in comic book a scientific content" or specific skills like: "Learning how to make a comic book script, and find ways to disseminate my research".

Although that most of the participants had not particular skills for drawing or telling a story, they have all played the game of the creative practice on which the training is based. Some of them expressed the satisfaction of designing a one-page comic strip on their own: "I discovered how good comics could be in promoting our research to the general public. This training gave me a new understanding of science communication, and I am really happy that I was able to follow it."

The questionnaire pointed out the possibilities of using concretely the comic medium in future science communication projects asking if the "Science through comics" training make them want to use or integrate comics in their presentations to a scientific or non-expert audience? Some answers drawn the attention of the real interest of the media and, at the same time, some restriction on the realization in concrete terms. Véronique, involved in anthropology domain and familiar to the use of drawing answered: "Yes, it is currently envisaged that comic strips will be integrated into my thesis (as a presentation of the subject, or to illustrate writings). I also think of using it in other settings (for example, to exchange with the people I interview in the form of a comic strip.)" On the reverse, Audrey, PhD student in environmental and biological research, with not effective skills in drawing techniques declared: "This training actually made me want to use comics in my presentations. I would even like, if possible, to integrate a one or two-page comic strip in my thesis. Currently I have no drawing or scriptwriting skills. It is obvious that if I really decide to carry out this idea to integrate comics in my thesis, I will need collaboration with specialists. I'm not thinking about it right now though."

The training, although specific, proved useful to the majority of the participants in term of science communication skills. In the second training session, 6 (out of 7) PhD students answered that they could foresee reinvesting the content of the session into scientific or popularized presentations on their research topic. In addition, the possibility of insertion of short comics in their thesis manuscript, even if not generalized, indicates another application of the training that will have to be taken into account in the future.

IV. PhD STUDENTS ENGAGEMENTS ACCORDING TO THE DEVICE

Through the two types of science communication devices presented in this communication, young researchers get experiences in practices of comics strip storytelling to share their research. The particularities of doctoral students' involvement in each of the science communication mechanisms show common points and differences that may be useful to highlight for future implications.

First of all, if the PhD students in both cases are always accompanied by science communication and comic medium professionals, their use of storytelling is different in the workshop and in the training. Placed as scientist and "expert" in the workshop, they are not directly involved in the choice of the framing and/or the image setting, acts produced by the

young participants. In this situation, the PhD student is, above all, co-mediator of the scientific knowledge (Fig. 1), and, in regards of the comic medium, raised awareness to the comics constraints, through exchanges with adolescents, and as critical reader of the one-page comic strip obtained.

In terms of production, the one-page comic strips created by adolescents have a more or less informative scope depending on the workshops, disciplines, themes and participants (De Hosson et al, 2018). Their comic strips may deliver a more or less scientifically rigorous message, but, far from being a sign of incomprehension, the freedom taken in view of scientific content by young authors is a sign of a necessary reinterpretation to the specific constraints of comic medium (distance and time scales, choice of personification of an inert entity or concept, etc.). During the workshop, PhD students are thus indirectly confronted with the choices of representation of their own discourse and slide show made by the young authors. Then the "one-page comic strip" constitutes an ideal storytelling object where one can experiment comic framing without the usual editorial constraints. For this reason, the C&S workshop may be considered as a congruent experience for the first engaged comic storytelling about science of young researchers.

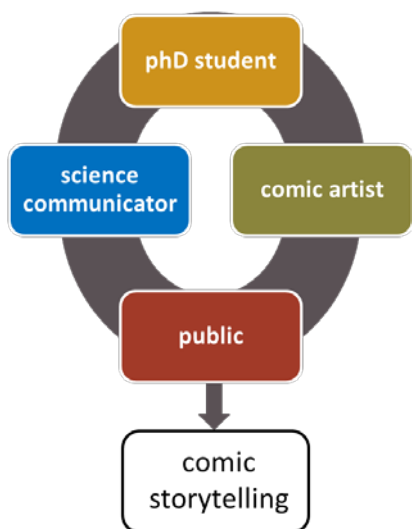


Fig. 1. Place of a PhD student in a comics and science workshop regarding the public (teenagers) and the medium (comic storytelling)

Within the “Science through comics” training, PhD students are directly placed at the heart of the construction of the graphic novel (Fig. 2). In fact, after being introduced to the basics of the comic storytelling, they become author of a story they wish to tell about their own research. This guided practice of storytelling requires them to make choices that only the position of a complete author, i.e. scriptwriter and drawer, can provoke. Thus, although they might not be sole author in the future, but probably co-writer, this test induces an appropriation of the comics and science communication constraints: extracting a topic from a set of data, sequencing actions, defining a protagonist, caring of the visual

representations, etc. Similar to an investigative approach adapted for the creation of media support, this training is a practical awareness that can be adapted to other types of storytelling medium.

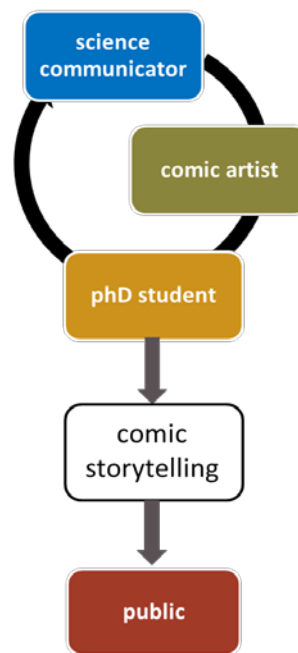


Fig. 2. Place of a PhD student in a “science through comics” training regarding the public (general audience) and the medium (comic storytelling)

V. LIMITS OF THE COMICS AND SCIENCE COMMUNICATION PROJECTS

These projects of graphic narration of science in collaboration with doctoral students can present some limitations. The first concerns the necessary curiosity of the researchers in comic medium that reduces the potential candidate number for that particular engagement. The second restriction could be in term of scientific disciplines or themes that could approach the limits of potential comic storytelling, because of an abstract or abstruse theme of research. The Stimuli association experience indicates that there is not particular counter-argument to transpose into comics any scientific domain but rather more adaptable themes whatever the domain is. For instance, two C&S workshops on mathematics have been led with success probably owing to the theme of cryptography that suits efficiently to the structure of a storytelling (a coded message has to be transmitted between two entities that arouse a mystery). In consequence, it is recommended to engage young researchers considering this point. A third limit could be more specific to the training and the availability of young researchers in term of time and schedule. How to transfer their new science communication skills learned in training into concrete projects, often time-

consuming and partners-dependent? This point appeared in the PhD evaluation of our training partner and should be taken into account for future science communication courses or outreach programmes of universities and institutions.

VI. CONCLUSION AND PERSPECTIVES

In short, the appropriation of graphic narrative by young researchers to disseminate science to general audience is possible and even profitable under certain conditions. The various experiences in C&S workshops or training showed that the one-page comic strip is a congruent model of experimentation for participants who are non-professionals of comics but are familiar with graphic novels as readers, and then capable of appropriate the language of comic medium easily.

Moreover, the experience of the Stimuli association, in workshops or training, let think that close supervision of PhD students is an essential condition for the successful implementation of the science communication projects. This professional support is fruitful in that it allows young researchers to get to grips with communication practices without assuming all the responsibilities (quality of the message, quality of the storytelling and the image settings). In return, this policy is based on a trust given to professional creators whose artistic vision and skills constitute the essential conditions for narrative projects that promote research at a high level of quality.

Paradoxically, published scientific comic books are frequently the fruit of collaboration of comic artists with experimented researchers that have not been trained on that specific media. What are the current perspectives for young trained researchers who would like to participate in editorial support? What are institutional avenues for research dissemination through comics to the general public outside the traditional editorial channel? Through these open questions, collaborative approaches are determining. Effective participation of researchers with science communication or storytelling professionals may address the concerns regarding the risk of distance between scientists and non-experts when only intermediaries choose and decide the message to be conveyed to the public.

Giving young researchers some of the keys to the media vehicle could reduce this distance and allow the scientific knowledge and the scientific method they carry to reach its destination.

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