Study of scientific workshops for students conducted in the context of a school-university partnership

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STUDY OF SCIENTIFIC WORKSHOPS FOR STUDENTS CONDUCTED IN THE CONTEXT OF A SCHOOL-UNIVERSITY PARTNERSHIP

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Abstract This work focuses on the development of a tool that aims to better understand how scientific workshops conducted by university researchers are helping to provide a scientific literacy to students between 10 and 17 years old. This study presents firstly a methodology for developing a questionnaire, and also focuses on the first data analysis. It is based on a questionnaire of 91 assertions, associated with four choices (referring to a Likert scale) to check students' opinions on scientific research from viewpoint epistemological, social and personal. This questionnaire was distributed to 101 students and internal consistency of the questions has been verified. We present here the most significant results according the three aspects of analysis: epistemological, socio-economy and personal. On the epistemological aspect, students acknowledge science as a human construction in permanent evolution. However, about challenges and dynamics of research was obtained more mixed response. About social aspect, students recognize that science is conducted in connection with the needs of society, but they have an elitist view of science. Concerning the result about divulgation of science, the students say the public is not sufficiently informed, because researchers don't make enough effort to popularize their work. As expected, personal aspect obtained the most negative responses; the majority of students has a disaffection for science and do not intend to follow a career in science. Finally, this work reflects above importance a need for a school-university partnership, because it is possible to improve the design form students about the nature of science and to learn more about scientific work.

Keywords: informal education; scientific literacy; attitudes to science, school-university partnership

INTRODUCTION

In recent years, the importance of scientific literacy and diversification of its access modes is a lively question in society (Roberts, 2007; Falk, Storksdieck, & Dierking, 2007). According to Anderson (2007), "Scientific literacy is a term that can be used to designate the science-related knowledge, practices, and values that we hope students will acquire as they learn science" (p. 5). Many reports have been published in the last twenty years to encourage a shift in science education approaches in order to develop scientific literacy. Amongst other recommendations, the idea of developing extra-curricular activities is recurrent, with the involvement of scientists, industry or civil society (European Commission, 2015). Such ideas are motivated by a disengagement of many young people from science observed in many countries for the last twenty years (Henriksen, 2015). As such, many of these informal or no-formal activities are thought to encourage young people to embrace future science studies and science carriers.

A very large range of extra-curricular activities are proposed for teachers and students leading to collaboration between schools and other institutions. As well as the development of cooperation between science museums, sciences centers and universities can be play an important role in increasing interest in science and science-careers (European Commission,

2015). However, the effect of such activities is difficult to measure, especially when it comes to its effect on educational choices (Jensen, 2015). Several studies question the effectiveness of these extracurricular activities, to the extent that some experimental approaches appear too often stereotyped and consequently, leave little time for reflection on experience and not always generate the expected motivation (Hart, Mulhall, Berry, Loughran & Gunstone, 2000; Hodson, 2006). It has been noted that out of school scientific learnings can often seam random and incoherent, however, it offers « potentially a more holistic approach to science education, one that better integrates school, work and leisure time learning experiences … [and] could be a more robust approach to long term gains» (Falk, Storksdieck, & Dierking, 2007, p. 456). Specifically, interactions with scientists provide opportunities to understand the real way science is conducted, as opposed to the artificial nature of science as presented in school textbooks (Stocklmayer, Rennie & Gilbert, 2010, p. 29). This scientific literacy is thus part of an epistemology of science based on the paradigm of complexity by Morin (1990).

In the project presented here, we focus on science workshops conducted within a university in France, promoting meetings between researchers and students (10-17 years old). These workshops are organized by the university to allow teachers to bring their classes for half a day at university. A large number of workshops are offered to teachers to choose from. According to the university, these workshops aim to foster curiosity and taste for science through experimental approach, and develop critical thinking and civic mindedness on issues of science. It also aims at presenting the university to students and the world of research and possibly promotes scientific studies and careers.

In the French context, the reasons to explain students' disengagement for science and/or scientific studies can be grouped, according to Boilevin (2013), in four factors: 1) ideological: image of science deteriorated and obsolete science, far from reality ; 2) socio-economic: deficiency of knowledge of the diversity of scientific careers and poor conditions offered by scientific carrers ; 3) social: scientific study perceived as difficult, only accessible for an intellectual elite and not for women ; 4) pedagogical/didactic: school science tend to be abstract science, fragmented, compartmentalized, away from the science that is done.

This work is part of a larger study to better understand the influence of such workshops on students' ideas taking into consideration these four factors. For this, several views are taken into account, that of the students, teachers, mediators' workshops, and the nature of the tasks performed in the workshop. In the context of this preliminary study, we focus our attention on students before they attend a scientific workshop when it has been already presented to them by their teacher. Along with preliminary results, the idea of this presentation is to develop a tool to measure the effect of such workshops on students. From the perspective of students: which indicators show that a partnership is significant?

This study leads to the design of a tool to measure the effect of such scientific workshops on students' representations of scientific research.

Therefore, the aim is to make the link between the central idea of scientific culture (NOS, more specifically epistemological, social and personal aspects of students) with the educational factor and teaching approach, which in our case it 'is the scientific culture of a school-university partnership. In this first stage of research, we consequently consider also the motivation expressed by the students that will attend workshops at university and meeting researchers.

METHODOLOGY

The study used a questionnaire addressed to students a few days before going to a scientific workshop. The nature of the workshop had already been presented by the teachers and the students knew they were going to a workshop at the university. The questionnaire was made of one opened question about student's interest in the workshop and 91 assertions. The open

question asked the students to give three reasons why they would like or dislike the workshop. The 91 assertions were each associated to four choices for the students: “I disagree”, “I partially disagree”, “I partially agree” and “I agree” (in reference to a Likert scale).

The assertions corresponded to three aspects of analyses. The first aspect, “epistemological” focused on the nature of science, its constant development, the tools and methodology associated to its development. The second aspect, “socio-economic”, highlighted the links between science and society, the implications of scientific research for social and economic growth or critical thinking and civic mindedness. Finally, the third aspect, « personal », concerned the work of a researcher and the associated stereotypes, including those linked to gender or its elitist nature. It also encourages students to personally position themselves regarding their interest for science and research.

These assertions have mainly been developed from existing assertions from research and reports included in the current of « public understanding of science » et « public understanding of research » (Girault & Lhoste, 2010), from international report (Commision Européenne, 2005, OCDE, 2006(b), The Gallup Organization, 2008) and research on student opinions about science and its links with society (Aschbacher, Li & Roth, 2010 ; Schreiner & Sjoberg, 2004), nature of sciences (Park, 2012), research career (Sjøberg, 2000) and place of women in scientific professions (Owen et al., 2007).

To validate this questionnaire, the data were entered in order to test the internal consistency of the items with the "coefficient Cronbach alpha". Some assertions were removed when they showed inconstancy or answers that were not significant enough.

RESULTS

The questionnaire was distributed to 101 students from 14 to 17 years-old. We present here the main results of students’ answers before they attend the workshop. They concern their motivation to attend the workshop, what they think about scientists and the world of research in reference to epistemological, social and personal aspects.

We were interested to check if students were motivated to go to the workshop. Thus we asked the students: “Are you happy to participate in this workshop at the University?” Three justifications were required by students in relation to their choice ”Yes“ or ”No“.

The principal results of pre test (before workshops) showed that, 86% of them were interested, 13% were not interested to go and the reason was associated to the fact that they do not like science and 1% did not answer. The justifications of the 86 students who gave a positive answer in terms of interest were grouped in five categories. These categories are presented in table 1, they were defined posteriori depending on the content of the answers. The first category regroup answers that demonstrate an interest for science itself, the process of science and scientific subjects (cat 1), the second category regroup answers that are more specifically focused on research careers, the way research is conducted in a laboratory (cat 2), the third category is not specific to science, but rather the university as a place to study and learn new things (cat 3), the fourth category regroup answers that are not linked to any specificity of the context or content of the workshop, but rather on the only fact that student get out of school with a recreational dimension (cat 4). When students did not answers or their answers did not make sense, it was classified in a last category (cat 5).

Categories’ reasons about “why they are happy” (N= 86)	
Like sciences (Cat 1)	14%
To miss class at school (Cat 4)	18%
Visit a new place (Cat 3)	25%
Discovering the job of science research (Cat 2)	28%
No answer	1%

Table 1: Interests of students in participating in a university workshop

Some answers to illustrate these categorizations:

Cat.1: “First, as scientific professions interest me a lot "(student 87); "I like to discover new things and I like physics" (student 99)

Cat. 2: "I'll find out how working laboratory researchers" (students 27); "I am a medium student in Science and the university's workshop could make me love a little science" (students 54)

Cat. 3: “I can learn new things "(student 3); "I know nothing of this university" (student 67)

Cat. 4: "to eat in the bus and for fun" (student 45); "because I miss class at school" (student 66)

The answers are highlighting some interesting features. To start with, there is a non-negligible amount of students (18%) who do not consider the workshop for what they are, but only for the fact that it will be a day out of school. If the content of the workshop was supposed to be presented to the students before the workshop and before the questionnaire was passed, it is a question whether the students really knew or understood where they were going. It is also interesting to point out that a minority of student express an interest in science (14%). This is an element that will be further discussed with the closed questions. Finally, less than a third of the students (28%) recognize the potential interest in terms of discovering the world of scientific research.

The epistemological aspect has 36 assertions, 22 of which were in response indicating that students recognize the vast majority (over 80% of students) science as a human construction constantly evolving and that researchers sometimes disagree. However, 14 questions on the issues and dynamics of the research showed more mixed responses. For example, according figure 1, the students show that they are shared or not to agree on the fact that knowledge is constructed by teams in a field of research and that it is dependent on social, economic, cultural and political.

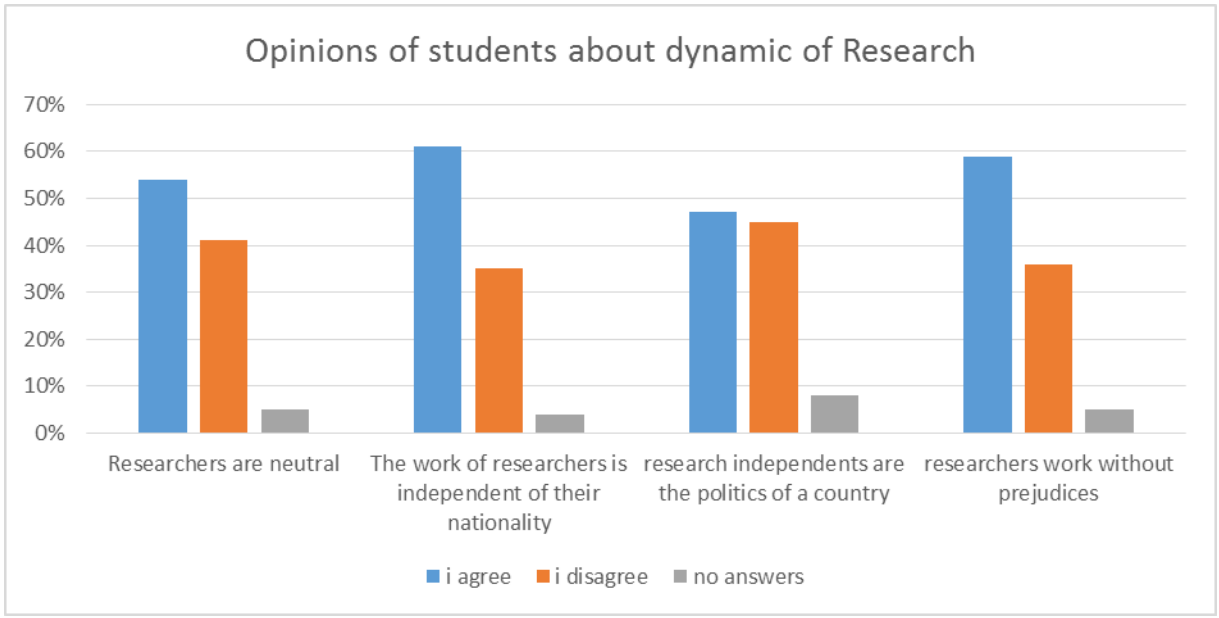

Figure 1: opinions of students before participating in workshops - epistemological aspect (N= 101)

Similarly, the fact that they are divided on the idea that researchers are neutral corroborates the responses above.

More generally, answers tend to show content that students may not have the information necessary for the proper understanding of the issues raised by the questions.
For the social aspect with 44 assertions that addressed three sub-level: a) the importance of science to society, students recognize the vast majority (over 70% of students) that science is conducted in relation with the needs of society and that it brings more benefits than damage; b) the social representations of the researcher profession, *the* majority (60%) students have an elitist view of science, reserved for people necessarily very good at math. Nevertheless, 79% of students report that women are as good at science careers like men. Finally, the third sub-level: scientific literacy shown in figure 2, 78% of students say that the public is not sufficiently informed about the progress of research and 51% think it is because of the researchers are not doing enough effort to have popularized work.

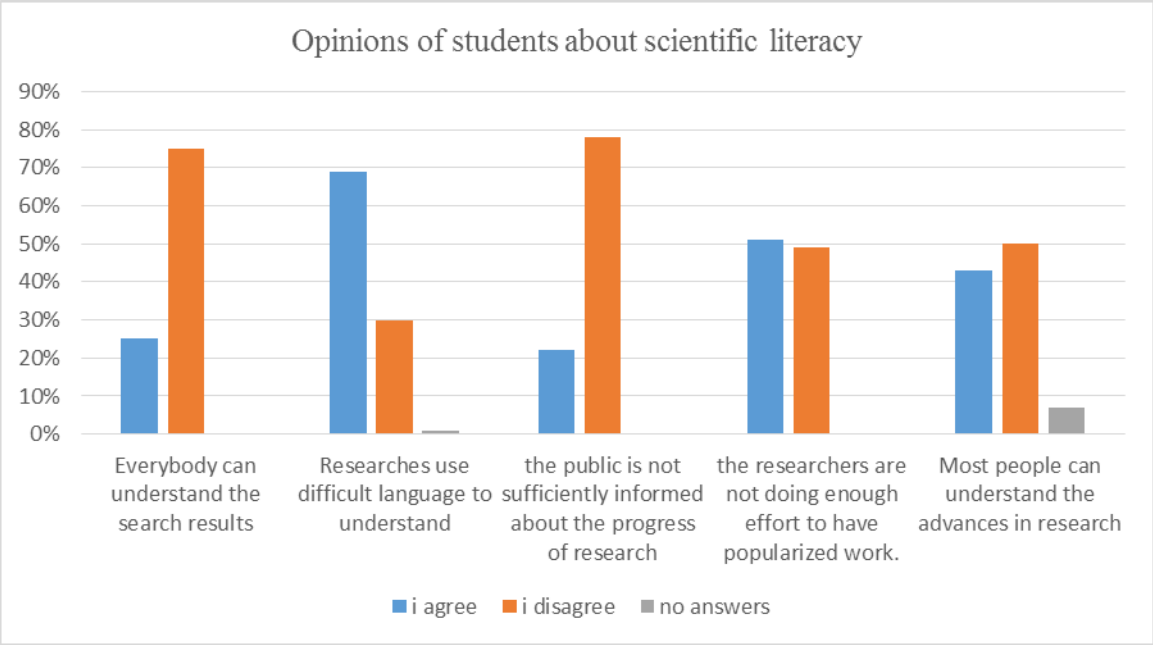

Figure 2: opinions of students before participating in workshops - social aspect (N= 101)

In the same idea, students believe that everyone can not understand the results of science, confirms that the majority of "yes" to the question "Researchers use a language difficult to understand." However, they paradoxically think that most people can understand the progress of science. The problem seems to crystallize a communication problem between researchers and the general public.

The personal aspect was the most that got negative answers (Figure 3), relative to disaffection for science careers (75%); 66% of students answer that becoming a researcher appears to be too difficult. Consequently they do not wish to become researchers or hold a job related to research. However, some students do not completely lose interest in science, considering that research is very important to them (50% yes against 47 no).

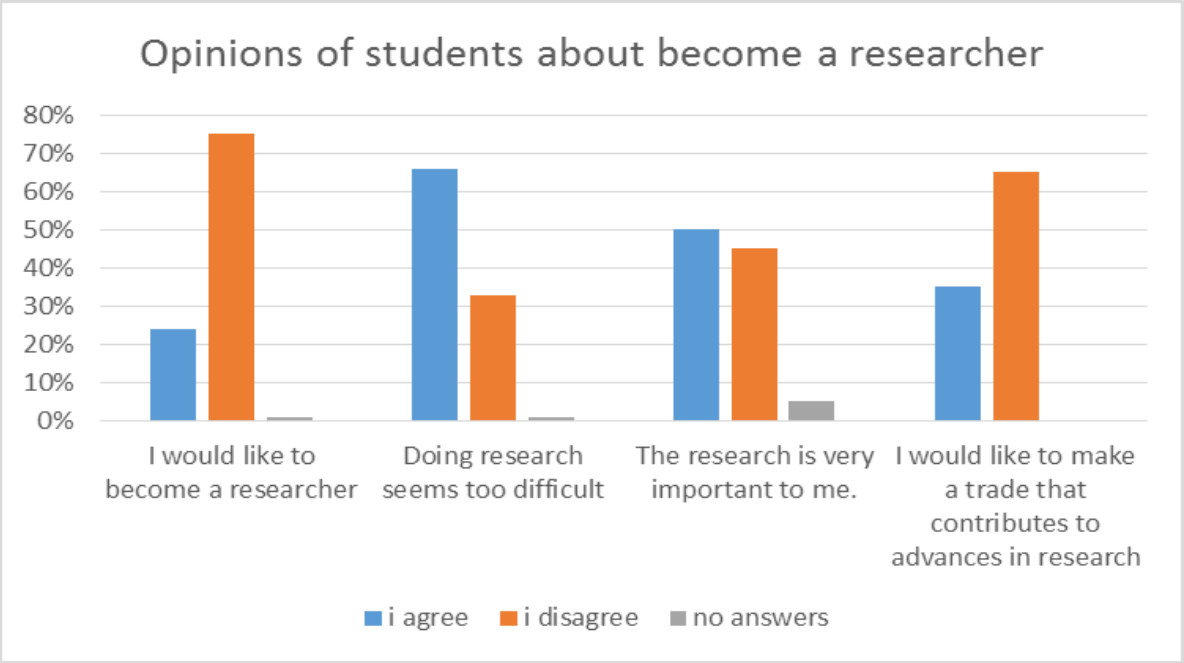

Figure 3: opinions of students before participating in workshops – personal aspect (N= 101)

DISCUSSIONS

This first phase confirms that the results point in the same direction as other studies on the representations of students about research and it is clear that the group of students tested knows little about research, and are not particularly motivated to know more about it or to continue further studies in science. The results show that scientific literacy and scientific interest are complex to assess and touch a multiplicity of factors as define by Boilevin (2013).

Moreover, the data from this research permit to an adjustment to the questionnaire through an internal coherence test between the questions, as well as its relevance. This was done through the Cronbach's alpha coefficient and a new questionnaire is being developed.

In relation to our questionnaire, only 28 students reported being interested in going to the workshop to know the job of scientists. It therefore raises the question of the role of the teacher and its significance to prepare the students to participate to these workshops.

To recall, the purpose of these workshops is to show, through meetings with researchers, what a scientific career looks like and not only offer the most fun experiments able to interest students because of their age.

We can assume that in some cases, prior information as to the content of the workshops was not sufficient; which is why the first workshop objective is not the main motivation for a significant proportion of students expressing interest.

Our result about personal aspect (Figure 3) confirms the results of other studies. For instance, the project STEM book of insights (2014) shows that there is a “negative connotation” for the majority of people surrounding STEM (STEM, 2014).

Finally, this work mainly reflected in the identification of a need for a school-university partnership, since it is a possible form of improving students' conceptions about the nature of science and scientific work. However, we must better understand the role and clarify the relationship between the structural elements (students, teachers, mediator, and workshop) to have real influence workshops according to each specific characteristic.

In the longer term, this project may lead to a better understanding of the effectiveness criteria of such workshops. It could lead to propose more specific recommendations either for

mediators or for teachers, so they can assure to have the convergent vision of research with different speech and approach with students.

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