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The scientists and their contribution to science education in Rio de Janeiro countryside schools

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Abstract

The objective of this work was to promote a closer relationship between students who never had contact with a scientist. Two simple questions were selected to be answered experimentally in the school laboratories: How important are the pigments in plants? Which molecules make up the food? Two Scientists from UFRJ, who research in these areas, participated in the real-time experimental activity, by video conference. Then, the scientist and the students talked freely, whose goal was to know both the school and science in daily reality. A semi-structured interview was conducted with students before and after the experiments. We perceived two anchors in the discourse of them: i) the humanisation of the scientist and ii) science driven by questions. The facts strongly suggest the need for direct interventions in the school environment and the offering of a rapprochement between university–scientist–school for the implementation of effective science education.

Keywords: Science education; research; experimentation; video conferencing.

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1. Introduction

Teaching research in science has been widely discussed over the past few years; however, it is still not widespread in Brazilian schools. For some authors (Grandy & Duschl, 2007 apud Sasseron, 2015), this approach is highlighted by leading the students to the understanding of what is scientific research. Taking it as a teaching strategy allows the teacher to put the student in touch with the scientific knowledge and the opportunity to engage in discussions with natural phenomena, problem solving, analysis and evaluation, i.e. issues widely used in scientific practice (Sasseron, 2015).

According to Olson and Loucks-Horsley (2000), teaching by research, it has been presented as a teaching approach essential to scientific learning and also contributes to the definition of scientific literacy by allowing students to partially replicate the activities of the scientists, develop a more sophisticated image of science and scientific research, contributing to the intellectual and personal development, in addition to interfering in solving everyday problems (Deboer, 2006). This learning is understood as an epistemic activity in which there are also suitable criteria for assessing the knowledge and methods that considered as legitimate within the scientific community (Jimenez-Aleixandre, 2006; Kelly, 2005 apud Silva, 2009).

To Trivelato and Tonidandel (2015, p. 99), 'are reasons like these that lead teachers, educators and researchers to seek and appreciate practical activities, experimental activities and investigative activities'. Also according to the authors, these activities contribute to approach the students with the scientific culture, familiarity with the practices related to science and the way to build knowledge. Some authors (Galiazzi et al., 2001 apud Gomes et al., 2016) reinforce the trial as fundamental to good learning since it decreases the gap between theory and practice.

Some studies point to justify resistance and difficulties in the use of experimental activities investigative lack of time to prepare them due to excessive workload, lack of materials and lack of infrastructure to conduct the trial (Salvadego et al., 2009 apud Gomes et al., 2016). This context is emphasised by Borges (apud Gomes et al., 2016), which stands as the main obstacle for an excessive number of students per class, deficiency in continuing education teacher, update bibliographies, insufficient class time for the implementation of activities and the absence of a laboratory.

Given the above scenario, it appears that there is still 'a big gap between science taught in schools and science practiced in universities' (Munford & Lima, 2007, p. 92). At school, the concepts are presented in abstract form, 'ready' and distanced from where they produced the context. The same authors point out that the student learns scientific knowledge already consolidated, while the universities, it is produced.

However, there is nothing new in teaching science for research, however, approaching the school science as academic science is not an easy task and could be an alternative to correct distortions. However, there are essential differences between these two spaces. Scientists have technological contributions and materials in general, more advanced, sophisticated equipment, appropriate facilities and the support of a team specialised in the subjects they investigate. At school, on the contrary, the science teacher has limited resources and infrastructure to carry out investigative activities and have no work team (Munford & Lima, 2007). Given these differences, the same authors question:

> it would be possible to promote a rapprochement between science education and science of the scientists? To what extent this approach is possible without caricaturing and trivialize the complexity of scientists working in our classrooms, or not to promote a stereotypical view of science? (2007, p. 94)

There are few studies that, in fact, propose closer ties between the scientist and the school (Costa et al., 2011; Watanabe et al., 2015). The main difficulties are the distance and displacement. For many

schools, visits to universities and other research centers cannot always be performed by distance issues and the lack of financial resources (Garcia, 2011).

The proposal of this work is to create actions that just promote the approach between the students and scientists in order to bridge the gap between the two communities: educational and scientific, using these investigative experimental activities through interactive actions with technology support video conferencing.

1.1. Purpose of the study

The purpose of the study was to promote a closer relationship between the scientists and students of basic education in the state of Rio de Janeiro, who never had contact with each other because they are geographically very distant from each other, through interactive activities with the technological support like video conferencing.

For this, it will be sought:

1. Identify the preconceptions of students about the profession 'scientist';
2. To promote interactive actions involving daily activities of scientists (experiments) so that both participate in real time, using video conferencing technology;
3. Analyse the discourse of students and scientists about the interactive actions taken;
4. Build and make available a free E-book with a guide to perform interactive actions involving scientists in schools, mediated by video conference.

2. Literature review

2.1. Education for research

The Science Teaching is growing and undergoing some changes over the years, and especially in the area of Science Education, and discussions are becoming more frequent. Several methodological aspects of the existing research result these discussions in order to improve the quality of science education (Ataide & Silva, 2011). One of these aspects is teaching by research that 'has been highlighted in discussions and research in the field of science education in recent decades' (Sa, Lima & Aguiar Jr, 2011, p. 79). This type of education is seen as an approach that partially reproduces the scientific activity, as it involves the students with questions, research and problem solving (Deboer, 2006).

In a didactic approach, Sasseron out that education for research,

> denotes the intention of the teacher in enabling active role in your student in building understanding of scientific knowledge. For this reason, it is characterized by being a form of work that the teacher uses in an attempt to make the class to engage in discussions and at the same time catching contact with natural phenomena, the search for solving a problem, exercise practices and reasonings of comparison, analysis and evaluation widely used in scientific practice (2015, p. 58)

Some authors understand that teaching by research is that which is closest to the activity of scientists and their professional practices (Chinn & Malhotra, 2002), while others consider that teaching science research consists of practical work in the classroom (Azevedo, 2004; Gil Perez & Vades Castro, 1996 apud Sasseron, 2015). There are also those who work in the perspective of the investigative activities are a kind of problem solving that empowers students to confront them with questions without immediate obvious answers (Gott & Duggan, 1995 apud Sasseron, 2015).

For Bianchinit (2011, p. 22), 'the objective of developing investigative activities is to lead students to think, discuss, justify, argue, apply knowledge to new situations, make them participate in their

own learning and feel the importance of this'. Therefore, it requires the teacher put into practice the skills that help students in solving problems, promoting interaction with colleagues, with the materials and the systematic and existing knowledge, in addition to highlighting errors and inaccuracies revealed by the students, confront the hypotheses and value the small actions of labor (Sasseron, 2015).

Furthermore, it is believed that the construction of knowledge and the promotion of scientific literacy in the classroom project the students to the key issues of scientific work, where the relevant skills to the process are developed and achieved (Sasseron & Carvalho, 2011).

Given the above, it is worth noting the importance of education for research as a pedagogical approach in science education for the promotion and development of critical, reflective and scientific thought both for faculty and for the students.

2.2. Scientist science and the school of science

The school as a solid field in the formation of the individual which must provide science education based on two guiding principles: teaching of science content and content about science. However, at school, scientific knowledge is still presented as scientific truth, reinforcing positivism. Karl Popper said

> the value of a theory is determined only when it is put to the test. Resistance to criticism does not lead to knowledge of the truth, but only the possibility of giving a chance precarious status identificidade (1977, p. 166)

In addition, one must understand that the construction of knowledge is a human construct, whose subject is the scientist and, therefore, their behavior has necessarily to change over the years. Also know that the social organisation of scientific work has changed considerably over time, the fact highlighting to have progressively passed from one individual work to teamwork (Polanyl, 1964). Therefore, to address these aspects, students and teachers need to know the scientific universe, their daily lives and their subjects.

In turn, the scientists need to share their experiences, their open spaces, sharing the emerging logic ordering the facts which motivate you to articulate data and produce knowledge from the results of their investigations. And above all, school is the place where the knowledge is generated and shared with the society.

However, according to Munford and Lima (2007), there is still a large gap between academic science and the science of scientists, since science taught in schools is abstract, which is offered to students in immutable concepts and is opposed to the work of scientists who think and problematise to produce socially constructed meanings and knowledge (Brown, Collins & Duguid, 1989).

The investigative approaches would be a way of bringing students to the practice of scientists. However, one can list some key differences between these two sciences, determining effective challenges that contribute to the detachment thereof. One refers to scientific knowledge taught in schools, which is already 'ready', while scientists are always looking for new knowledge. The other is the lack of resources in schools, time and little experience of most teachers, unlike the scenario of scientists (Munford & Lima, 2007).

Taking into account the points raised, it should raise some questions: Can perform investigative activities in schools? How to approach science school science scientist?

The trial has been highly linked from the investigative approach to teaching practice and can contribute to the construction of meanings, making effective learning. In addition to engaging students in solving everyday problems also contributes to the rapprochement between theory and practice (Gallet, Megid & Camargo, 2016).

In this context, it is undeniable that the school science and science practiced by scientists assume different roles, since 'the main objective of the school is to promote the learning of a consolidated knowledge, while, on the other hand, the main objective of science academic is to produce new scientific knowledge' (Munford & Lima, 2007, p. 6) and bringing them is no easy task. For even the authors, comparisons indicate that there are major distortions between the reasoning of scientists engaged in authentic research and the ways of thinking that students have involved at most in simple investigations. For example, scientists generate their own research questions, while elementary school students participate in activities in which the questions are provided (Munford & Lima, 2007, p. 17).

In this sense, simple investigative activities of epistemology become so distinct from authentic investigations and may be considered opposing epistemologies (Munford & Lima, 2007).

However, even identifying more complex activities developed by researchers in the field of science education, as the experimental activities, hardly more complex and abstract concepts could be envisaged because of the insufficiency of resources available for carrying out the activities (Munford & Lima, 2007).

Considering the identified distortions, it is interesting to note the importance of research and experimentation as a pedagogical approach to develop in students a more interactive teaching, dialogical, critical, reflective and based on issues related to science education.

2.3. The digital technologies use of information and communication in education

With the advent of digital technologies of information and communication (TDICs), we now live in the digital age, interactivity, where a lot of information reach us, almost in real time. It is common at present, finding the technologies in all sectors of society, as they permeate even our homes. The generation of this century was born steeped in technology (Prensky, 2001) and, therefore, deal with TDICs no means a necessity, but the possibility of interaction and integration in the contemporary world (Almeida & Silva, 2011; Joly, Silva & Almeida, 2012; Levy, 2010 apud Scorsolini-Comin, 2014).

According to Scorsolini-Comin (2014, p. 448), 'the TDIC can be understood as versatile tools present in many contexts beyond the possibilities of analogue technologies' because they have ease of communication and access to more information (Joly, Silva & Almeida, 2012 apud Scorsolini-Comin, 2014). For the same author, the TDIC has been widely discussed in the educational context with a view to adopt them in the educational processes and promote a new reading world in schools. 'They are considered a renewal or a possibility of facilitating the teaching–learning process' (Scorsolini-Comin, 2014, p. 449).

We can see the strong presence of TDIC and its significant changes in our environment through Kenski claims

> The digital style engenders obligatorily not only the use of new equipment for the production and seizure of knowledge, but also new learning behaviors, new rationales, new perceptual stimuli. Its rapid spread and multiplication, new products and new areas, forcing us to not ignore their presence and importance (1997, p. 61).

According to Castells (2007), the current society is inserted in the 'culture of real virtuality', which enables a full integration of media by digital and electronic media, encouraging interactive networks, integrating oral and written communication. Levy (1997, p. 3) reinforces that we should 'learn from the contemporary movement techniques' and this implies the use of new methods, especially digital and interactivity. However, it means the total abdication of traditional practices, but the integration and communication between the traditional methods with new techniques.

Thus, TDIC starts to contribute to a change in teaching practice in both the teaching and learning relationships as in the acquisition and organisation of materials and methods and developing a new environment in school spaces (Almeida & Silva, 2011). Some studies highlight challenges related to the incorporation of TDIC in the educational environment, the need for integration and ownership of individuals in this context and the lack of technological infrastructure and political and economic problems (Castells, 2007; Kenski, 2008).

The integration of technology in the school context is growing along with the provision of digital tools like the Internet, and contributing to the viability and flexibility in educational processes (Chang et al., 2006 apud Giannella & Struchiner, 2010). In science education, integration of TDIC requires the restructuring of the curriculum and teaching practice and most familiarizing teachers with new technologies (Martinho & Pombo, 2009). For them, the use of the Internet in science classes favours information and interactivity among students.

2.4. Video conferencing in science teaching

Video conferencing is a digital technology tool, establishing itself as one of the possibilities of Distance Education and its use is growing in Brazil in initial and continuing teacher training (Garcia, 2011). It is considered 'a form of remote, two-way communication that allows synchronised transmission of audio, video and data in real time' (Garcia, Malacarne & Tolentino-Neto, 2013, p. 11) approaching people located in different places. According to Cruz and Barcia,

> The technologies used in distance learning, video conferencing is the one that comes closest to a conventional situation of the classroom, since […] enables the two-way conversation, allowing the teaching/learning process takes place in real time (online) and can be interactive between people who can see and hear simultaneously. Because of the teaching tools available in the system, while the teacher explains a concept, you can add other teaching resources, such as graphics, video projection, Internet research, two-dimensional images on paper or transparencies, computer files, etc. The system also allows the student to distant rooms take your questions and interact with the teacher at the time of the class, using the same learning resources for communication (2000, p. 2).

About this digital resource, some studies emphasise their strengths and advantages in the educational field (Cruz, 2001; Garcia, 2011; Moran, 2005). Among them, we can highlight the live interactive participation, the construction of knowledge collaboratively, contact with experts and researchers, reducing costs displacements, research, conducting courses, lectures, workshops and projects (Tutle, 2008 apud Garcia, 2011).

Some disadvantages such as the broadband connection, technical assistance, quality of equipment, low quality of sound and image, lack of knowledge on the part of teachers and the presence of the participants in real time need considerable attention to integrate video conferencing in the pedagogical process (Tutle, 2008 apud Garcia, 2011).

However, one of the biggest benefits of video conferencing is the possibility of collaborative activities with opportunities for interaction and discussion between the individuals from distant locations and arousing the interest and motivation of those involved (Garcia, 2011). In teaching, the outstanding potential of this feature is based on the fact possible for rapprochement between public school students and experts from several universities that are geographically distant.

3. Methodology

3.1. Research and nature

This study is qualitative in nature, since there is a dynamic relationship between the researcher and the subject, with an indissoluble link, devoid of methods and statistical techniques (Prodanov &

Freitas, 2013). Considering the method, it was decided to perform an action research. According to Thiollent,

> Action research is essentially to engage research and action in a process in which the actors involved participate, along with researchers, to reach interactively to elucidate the reality in which they live, identifying collective problems, searching and experimenting with solutions in a real situation. Simultaneously, there are the production and use of knowledge. The active dimension of the method manifests itself in action planning and evaluation of their results (2009, p. 2).

The choice of action research as a methodological approach to conduct this study was motivated mainly by involving interventions and knowledge production, **combining theory with practice** (Toledo & Jacobi, 2013 grifo nosso).

Considering the characteristics and definitions mentioned by several authors, as well as its importance in education, action research used in this study addresses education for research and experimentation with the approach between the students and scientists through video conferencing.

3.2. Research subjects

3.2.1. The students

The study was conducted with 30 first graders Normal Course in Middle level, aged between 15 and 17 years of school in the interior, in Paty do Alferes, situated approximately a distance 120 km from the city of Rio de Janeiro.

3.3. The scientists

Two simple questions were selected to be answered experimentally in the school teaching laboratory: How important pigment in plants? What molecules make up the food? Scientists working in these areas, Amanda Santos de Souza and Dulce Gilson Mantuano, both from UFRJ, participated in real-time experimental activity by video conference, answering questions and posing new questions to students.

3.4. Video conferences

Video conferencing considered a pilot to test the instruments of research in order to ascertain whether these instruments would provide satisfactory results (Marconi & Lakatos, 2003) to make possible adjustments, such as consolidating research. An investigative activity took place to practice on 'Detecting carbohydrates: Obesity is mass?' which addresses the issue of nutrients.

The first video conference was about an experimental activity on 'comparative determination of vitamin C in fruits and juices', whose purpose was to verify the presence of vitamin C in foods consumed on a daily basis.

For the second video conferencing, the practical activity was chosen 'Plant Physiology: Photosynthesis X Cellular Respiration' in order to demonstrate, by a colour change, CO_2 consumption by plant tissues with the use of an indicator substance pH.

3.5. Data collection and analysis

The work was based on the first and the second marking periods, following the Pedagogical Guidelines linked Curriculum Biology Minimum and was based on issues related to nutrients, photosynthesis and cellular respiration.

The semi-structured interview before and after the intervention, the observation and the testimony of some students were used for data collection. The statements were recorded after the completion of each video conference to identify their perception regarding the methodology applied. Furthermore, at the end of each video conference, an interview was held with the participating researchers to verify the impressions on the interactive actions. To analyse the interview answers, a database was built using the Microsoft Excel 2007 spreadsheet application.

4. Results and discussion

The study promoted a series of reflections on the strategies in science teaching and the presentation of an innovative and enriching proposal for basic education, especially for students from the interior, geographically distant from where it conducts research. Many students, if not most, never imagined that it would be possible to meet and interact with a researcher, albeit virtually. It is assumed that such methodology entered an even greater expectation among students, encouraging them to scientific questions.

It is found through the testimonials and interviews that the students were enthusiastic about the intervention.

'I thought a scientist was totally different' (A, 15).

'I found a fantastic idea, we do not always have the opportunity of personal contact' (B, 17).

'I just knew scientist and a university laboratory on television' (C, 17).

'Learning science in this way is great' (D, 15).

Most revealed that found it interesting to know a scientist is given in Table 1.

Table 1. Perception of students to meet a scientist

What do you know of a scientist?	Number of responses
Interesting	9
I thought great, I never thought I would have this opportunity	1
Nice	2
Cool	2
Very good	5
It was a different experience	2
Great	2
An emotion, an honour, an exciting experience	1
An experience you will not forget	1
Nice and instructive	1
A unique and interesting experience	1
A great and amazing feeling	1
A new experience to my knowledge	1
An amazing experience	1
Total	**30**

It can be seen through the answers and observation of students during the intervention that most proved motivated and found it interesting to know a researcher, even virtually. Although it has not been enough studies on the use of video conferencing in science education, this assertion points out that investigative activities involving the scientist arouse students' interest, and brings the science taught in school science practiced by scientists (Munford & Lima, 2007).

When asked about what they thought of conducting experiments by the scientist, the responses were diverse. We can verify the perception through the testimony of some students:

'I found it very cool because maybe if we had tried to make the experience alone, we would not have discovered so much that the researcher explained, such as why the change of things and colors. I would like to personally meet you' (G, 17).

'I really liked, it was very helpful and we could learn more. She explained everything we wanted to understand and it would be interesting if we could meet her in person' (H, 15).

'It was interesting, a new experience. It was very instructive and more open my mind' (I, 15).

'I found it very interesting because I've always been curious to know how it was done an experiment and performing along with a researcher, he took my doubts. Not everyone has the opportunity we had' (J, 16 years).

In addition, we had the testimony of the researchers during the interview:

(…) 'More interesting it was still able to disseminate the research, that is, as academic knowledge is produced. To let them know how the school content was produced in an academic center'.

'This proposal is extremely valuable because it is one more tool available which can be included in the learning process, providing inclusion of different educational institutions, and the public that composes them as students and teachers, expanding the horizons of room classroom beyond the school walls. Given this panorama, it can be highlighted the restructuring of the teaching/learning expanding the possibility of new discoveries. With the advancement of technology every day, almost all students and teachers can benefit from this way of teaching'.

It is realised through the perception of students with great enthusiasm and interest in pursuing a different class and know, even virtually, a researcher and his workplace. In turn, we see also, through the account of researchers and observation during the intervention, a huge satisfaction in participating in the project, and pontuarem the importance of closer ties with students for the dissemination of science, or the academic knowledge, possibility of new horizons and new discoveries in the classroom.

Enabling and engaging students with issues related to the nature of science are extremely important to arouse the interest and the construction of knowledge and decision-making. Even in these terms, the investigative practical activities can approach learning science and 'possibly encourage a taste for the area, and common satisfaction of students in part of it' (Andrade & Massabni, 2011, p. 838).

According to Ried and Kidd (apud Bello, Sastre & Barreto, 2013), one of the differences between the traditional classroom and those using video conferencing is precisely the teacher's ability to promote communication with students, increasing motivation and, therefore, learning. Some authors indicate the importance of continuous verbal contact through questions asked by the teacher during the intervention in order to encourage them and increase communication (Brown, Rietz & Sugrue, 2005).

In our proposal, we still lack the empirical data and bibliographic studies that support our experience. However, we highlight the considerations for further studies on the influence of strategies that use video conferencing in order to approach the scientist universe of basic education.

5. Considerations and future studies

As we can see, the advent of ınformation and communication technologies is undeniable transformation in the contemporary society from this process. In this context, education is also suffering several changes and requirements, including the curriculum and the way of teaching and learning, increasingly demanding teacher the use of strategies and pedagogical methodologies capable of bringing the students of this new reality.

It is known that education based on research and research and experimental activities is effective in building knowledge and promoting scientific literacy, in addition to interest and the development of critical and reflective thinking of the student, and allows the reinterpretation of science.

In view of this methodology, it is noteworthy that it was an unprecedented and innovative strategy and simultaneously challenging, especially at school where it was implemented, and especially by addressing a methodology that is still little known in the school environment. However, we know that using video conferencing in science education to conduct practical activities with scientists is something that further studies because there is not enough experience on their influence on practical science classes, despite extensive literature on video conferencing, especially in higher education (Bello et al., 2013).

Although it is premature to assess whether students actually learn better content addressed by video conference, I consider this extremely as valuable experience. We now have the opportunity to share with our peers in a never experienced intervention in our school and still glimpse some expectations as an opportunity to present and implement this intervention in other schools and bring our students, especially the interior, the scientist routine, humanizing his profession and enabling reinterpretation of science.

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