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Teaching Science to Elementary School Deaf Children in Brazil

Ana Claudia da Fonseca Flores[1,2], Vivian Mary Rumjanek[1]

[1]Instituto de Bioquímica Médica Leopoldo de Meis, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil
[2]Instituto Nacional de Educação de Surdos, Rio de Janeiro, Brazil
Email: vivian@bioqmed.ufrj.br

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Abstract

Discussions related to teaching deaf students in Brazil are mainly focused on language problems, and only a few address other issues, for example, teaching science for this group. During the observation of the recurrent successful results obtained by the experimental methodology used in science short courses for secondary school Deaf pupils, performed by the Deaf Project—UFRJ, the possibility of offering this kind of activities to younger deaf pupils took place. As a result, a new approach for teaching science was attempted by creating the Science Space—EspCie1, destined to the first classes of the elementary school, inside the National Institute for Deaf Education. There are a number of difficulties in deaf education, mainly at these early stages. This action intended to increase children scientific knowledge using an investigative approach and also to provide reflections on new ways of teaching for the teaching staff and undergraduate students from a Pedagogy course. The results suggested a very positive impact. The experimental methodology led to an increased interest in science by the elementary school children and most of the pupils who took part in the activities presented language refinement, increased self-esteem and self-confidence. In addition, there was a good acceptance by the school community and teaching staff.

Keywords

Science Teaching, Deaf, Elementary School Pupils, Active Learning, Special Education

1. Introduction

Brazil had its first school for the deaf in the nineteenth century by imperial decree, and had as its founder and first director a deaf teacher from the Instituition Nationale des Sourds-Muets. The history of deaf education in

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Brazil has suffered constant changes throughout the years following the various international movements, originally using sign language, followed by oralism, total communication and now bilinguism. The present state of educational process, as well as the educational rights of the Deaf in Brazil, has been recently reviewed (Dias et al., 2014).

Similar to what is seen in a number of other countries, Brazilian Deaf students lag behind in language and literacy skills. As a result, the whole educational process is affected and the general knowledge of this group is also impaired, as they, in addition to not hearing, do not read or write properly. A number of other differences may also be ascribed to this group and, as discussed by Marschark (2005), one should not treat deaf children simply as hearing children who cannot hear. However, initiatives focusing on new ways of teaching this group are scarce. Concern for deaf education has always been linked to learning the oral language even if related to that language in the written form. Particularly, the study of sciences for this group is less discussed than other areas (Moores, Jatho, & Creech, 2001).

The collaborative learning method involving inquiry has been particularly studied and discussed in learning activities and education in general (Bell et al., 2010). Kahn, Feldman and Cooke (2013) argue that the distance between deaf and hearing-related knowledge in the scientific area is very large. Among other factors, the authors suggest that deaf students are highly dependent and without autonomy, and the development of an investigative capacity and questioning is essential to their advancement in science (Kahn, Feldman, & Cooke, 2013). The use of inquiry in teaching deaf students was discussed in Wang's work (Wang, 2011). It is a truism that the formation of citizens in our increasingly technological society necessarily involves the understanding of the scientific process, but a methodology of teaching science to deaf youngsters that involved experimentation to answer their own set of questions, using an inquiry, collaborative, hands-on approach, led to much more than just understanding the scientific process. These students developed a critical mind, autonomy and an increased self-esteem (Pinto-Silva, Martins, & Rumjanek, 2013).

Studies comparing the efficacy of traditional classes versus active learning, that is, classes that the focus is on the student, have shown that even with hearing students exposed to active learning, the grades of these students as well as the level of approval examination were higher compared to traditional lecturing (Freeman et al., 2014). However, teachers usually favor the expository approach to science instruction (Graham, 2012).

There is evidence that children are not adequately exposed to science (Trundle & Saçkes, 2012). It was suggested by Tilgner (1990) that elementary school teachers try to avoid science education because they consider that their knowledge in this area is inadequate. This creates a vicious circle in which these same children show, later on, low levels of proficiency in science. If this occurs for teachers of hearing children, it is probably also true for teachers of deaf students.

Considering that active learning in scientific topics produced positive results among profoundly Deaf secondary school students (Rumjanek et al., 2012; Pinto-Silva, Martins, & Rumjanek, 2013), the present work attempted to identify some aspects of science teaching that could favorably engage elementary school deaf pupils toward science. Furthermore, it involved undergraduate students of a Bilingual Pedagogy Faculty so that they could experience a new method of teaching Deaf children trying to avoid teaching through lectures.

2. Methodology

This research was developed for five consecutive years during the period comprised from 2010 to 2015, at a special school the Instituto Nacional de Educação de Surdos (National Institute for Deaf Education) situated in Rio de Janeiro, Brazil. Elementary School in Brazil is divided into two segments, the first segment covers the first five years and the second segment goes from the 6th until the 9th grade.

2.1. Sample

Pupils—A total of 56 elementary school pupils of both genders participated of this study. They were all enrolled on the 5th grade. As this study lasted for five years, there was an average of 18 pupils per year, and exceptionally there were 24 in the first year. All children were severe or profoundly deaf and the mode of communication was through Brazilian Sign Language, known as Libras.

Teachers—A total of five elementary school teachers of the 5th grade participated in this study. It should be mentioned that there is more than one class of 5th grade pupils per year. A total of ten teachers of other elementary school classes also participated. They were the teachers of younger pupils belonging to lower grades (see

results).

Pedagogy course undergraduate students—National Institute for Deaf Education offers, as well as elementary and secondary education, a Pedagogy courseat university level. The undergraduate students participate as trainees following the teachers in their classes. As trainees in elementary school classes, a total of 14 Pedagogy students participated of the activities in the Science Space in two occasions (see results).

Teachers' team of the Science Space—only three teachers belonged to the Science Space team. The responsible for this research (Flores), who is also one of the authors of this work, has worked for more than 25 years as a teacher for deaf elementary pupils. There was a second hearing teacher that taught deaf children for 20 years and a Deaf teacher who had been working since 2010.

2.2. Organization of the Science Space (EspCie1)

The first step taken in order to enable teaching through an experimental approach was to organize a small laboratory. This was done using an ordinary teaching classroom, originally designed for 10 pupils and a teacher, where four tables were accommodated to function as laboratory benches. This classroom was near a tap with a sink. The Biochemistry Institute of the Federal University of Rio de Janeiro, donated equipment such a microscope, a centrifuge, a precision scale, magnifying glasses, tweezers, pipettes, beakers, volumetric flasks, plastic disposable materials, reagents etc. The National Institute for Deaf Education provided furniture and disposable material. The laboratory was nominated Science Space or EspCie1 (from the Portuguese Espaço Ciências 1, because it was the first segment of elementary school).

2.3. Teaching Activities

The activities of the EspCie1were designed to last for a whole year without interfering too much with the regular classes or the school curriculum. During the whole time the language used was Brazilian Sign Language (Libras). The activities were divided into three categories:

Group 1—It consisted of seven separate activities lasting, each one, one afternoon. The activities involved Observation, Inquiry, Reasoning, Collaboration, Interpretation of the results, Importance of recording data, Facing the unknown. This whole set of activities was performed every year, for five consecutive years. The details of the activities will be presented in the results section.

Group II—It consisted of a short experimental course lasting for half a day for seven days. It resembled in every aspect the courses organized for Deaf secondary school youngsters and described elsewhere (Pinto-Silva, Martins, & Rumjanek, 2013), the only difference being that it was not a fulltime course. These courses had a given theme and 5th grade elementary school children were asked to divide themselves into small groups, to formulate questions, suggest experiments to test their hypothesis, perform their experiments, analyze the results obtained, and present their results for the colleagues of the other groups at the end of the day. This lasted for a number of days, each time getting more complex questions and answers. On the last day all children had to integrate all the information obtained and present what they had learned. A list of the themes covered is presented in the results section. For these courses, Deaf youngsters that were part of a project at the Federal University of Rio de Janeiro for science trainees, helped as tutors. They were never allowed to give answers to the children or to make any kind of indication if what was being suggested was right or wrong, their main action was to help the pupil to perform the experiment.

Group III—It consisted of exposure to other learning environments such as museums, planetarium, exhibitions, visits to natural parks, science shows etc. During these activities 5th grade children acted as monitors for younger children from lower grades.

2.4. Instrument

To assess the impact of the educational intervention, questionnaires were completed by: parents or other people responsible for the child, by the teachers, by Pedagogy course undergraduate students, and by members of the Institute administration. It was a paper questionnaire containing two or three questions (depending on the group being assessed) where they should mark with an X one among five choices in a Likert scale.

Questionnaires for the parents/guardians—The questionnaire had three questions: 1) Rate the interest of your child for science before attending EspCie1; 2) Rate the interest of your child for science after participating in the

EspCie1; 3) Rate the interest of your child for science during his/her participation in the activities of the EspCie1. They should mark in a Likert scale: very interested; interested; indifferent; poor; disinterested.

Questionnaires for the teachers—The questionnaire consisted of two questions. And at the end there was space for comments and suggestions. The first question was: "After following the activities carried out by EspCie1, how would you rate the interest of your students?" The options were: very interested; interested; indifferent; poor; disinterested. The second question "How do you classify the work of EspCie1?" could be answered with the following options: very good; good; indifferent; bad; very bad.

Questionnaires for undergraduate Pedagogy students—Students were asked to follow the experimental course given to the deaf pupils and evaluate the activity marking in a Likert scale (excellent, good, fair, poor, abstention).

Questionnaires for members of the Institute administration—The questionnaire given to this group had two questions and a space for additional comments and suggestions. The first question was "How would you rate the interest of the institution by the science work done by EspCie1?" The options were: very interested; interested; indifferent; very little concern; disinterested. The second question was "How would you rate the science work done by EspCie1?" The response options were: excellent; good; indifferent; bad; extremely bad.

Two of the members of the Science Space (EspCie1) team, one Deaf and one hearing teacher, did not answer a questionnaire but were, instead, interviewed and their answers filmed or recorded. They were asked to describe freely their experience, how did they feel teaching using this methodology, if they did believe there was some kind of impact on the pupils, and how they felt as being two teachers (one Deaf and one hearing) dividing the same responsibilities.

2.5. Data Analysis

The approach used in this work was that of a qualitative research, the data are in the form of descriptive words and even when the number of answers is shown for the questionnaires it is only to indicate the patterns observed.

3. Results

3.1. Group I—Introductory Activities

Once a week, 5th graders at the EspCie1, had an afternoon of activities that introduced them to important features for a research worker. Only a few examples will be given as different approaches have been created throughout this work. It was important to have new activities not to be repetitive in the following years. Furthermore, it also inhibited older students, who had been trough the activities the years before, to comment with the younger ones what they had done.

The need for careful observation was, for example, brought about with a performance where a group of children from other classes entered the room doing a havoc with the exception of one child that entered and sat quietly in a corner. The pupils were then asked to describe what they had seen and normally never mentioned the quiet boy. This led to a discussion about what is necessary to observe, and the fact that what has attracted our least attention could be the most important point. The activity also made the pupils argue among themselves what was the importance of noticing certain events and arriving to conclusions based on them.

Another approach involved a game where on the top of a table there were a number of small pieces of paper with a very small figure (each one with a different part of the human body) and the corresponding name written on it. The child needed to be able to understand what was in the paper and stick the piece of paper in the proper place of a model of a human body. They could do this alone, or they could seek for help from a classmate. Furthermore, although we did not bring attention to the fact, there were some magnifying glasses that would help them in their task if they decided to use them. Soon, the majority of the children found out that if they did it together with a classmate the task became easier, some of them also tried the magnifying glasses and discovered the advantages of it, and commented about it with the other children. After the game (the winner would be the individual or the group that completed their task faster) there was a moment when the pupils discussed with the teachers the importance of collaborative work and also the discovery of instruments to help solve the problems.

The need for a proper registry was performed by asking the children to go out in the garden and for each one to bring a leaf of the same plant. Uponarrival, they should observe their leaf and take notes freely in such a way

that they could recognize their leaf. They were free to register as they preferred. They could take notes, measure, take photos, but could not mark the leaf in any special way. After this was done they were asked to put all the leaves together and then they needed to find out their own leaf. This was usually accomplished, and when this was done pupils were asked to exchange their notes, the leaves were all mixed together again and with the registry made by another child they needed to find the proper leaf. After this activity, the children were asked to discuss the importance of recording the data not only for oneself but also for other people in order to be able to recognize what one had found.

Another group of experiments were designed to indicate that even without the "complete picture" they could formulate a hypothesis. This time, different groups had to complete different jig-saw puzzles. All of them had missing pieces and the point was to guess what the picture was, even if they could not have it completed. This game brought about a discussion about how a hypothesis is formulated even in the absence of all the clues.

Similar activities were organized to teach them the need to ask questions in order to find a hidden object where the answers could only be yes or no, and the importance of formulating the question correctly so as not to obtain dubious answers.

Some activities were based on facts occurring at the time, such as the Dengue epidemic. The children were asked to go and find out everything they could about the epidemic, collect the data, discuss with the teachers at EspCie1 and transform it into information they could present to other children of lower grades.

Like the examples above, may others were conducted in this initial stage.

3.2. Group II—Experimental Short Courses

When the pupils arrived to carry out the Group II experimental activities, they had been already through the Group I activities and were less shy, more confident in asking questions and proposing solutions. At this stage 5th grade pupils were quite eager to behave as "scientists".

During these five years different topics were presented to the pupils to develop their research as part of the experimental courses: cells, microbes, embryogenesis, circulatory system, respiratory system, food. Usually the experimental course took place at least twice a year, each time with a different topic. The children seemed to be interested and to have questions about all of them. No particular course seemed to produce a greater impact compared to the others. The 5th grade pupils were all capable of relating these topics to their everyday life.

Similar to what had been described before for secondary school Deaf students (Pinto-Silva, Martins, & Rumjanek, 2013), on the last day of the course the children must prepare a presentation contextualizing everything they had learned. Along with the gain in scientific knowledge, it was possible to observe that there is also a linguistic learning of specific scientific terms. It was interesting that some signs were unknown by the elementary school interpreters. As a result, there were complaints from pupils indicating the need of specialized interpreters.

3.3. Group III—Other Learning Environments

Science can be learned outside the classroom or laboratory environment. In the present work a number of spaces were used to raise pupils' interest in science. These activities, in other learning environments, were also important to develop their autonomy and self-esteem as 5th grade children were asked to act as monitors for younger Deaf children. During this period the different classes went to a Planetarium, a Geological Museum, a Physics Museum, a conservation area for different specimens of butterflies, a rain forest National park, an exhibition in a park on biodiversity, and a number of activities related to the human body (an exhibition named The Human Body, a course to learn how to draw a human body, a workshop at the university of the various functions of the human body, and they ended by preparing a film on the various parts of the human body).

These pupils were also involved into preparing, for younger children in the Deaf Institute, science shows and workshops, during the National Week for Science and Technology.

3.4. Questionnaires

Seeking to understand whether or not the work at the EspCie1 found acceptance within the school community, questionnaires were given for parents/guardians of the 5th grade pupils that participated in the project. This group is representative, and even has a committee elected by them that participates in the school's resolutions, to the point of having voting power at meetings of the institution's Board of Directors.

Despite the fact that more children participated in the EspCie1 activities from 2010 to 2014, some pupils had been transferred, some lost all kinds of connection and only 51 questionnaires could be sent. Of the 51 questionnaires delivered to this group, 29 returned, two of which were incomplete and two had erasures.

The first observation was that the children were interested in science even before starting at EspCie1. There were seven pupils very interested, 13 interested, four indifferent. The main change observed after participation was that the four indifferent became interested, and the number of very interested doubled to fourteen. This was during the activities and remained even after the activities in EspCie1 finished.

Another questionnaire was conducted with teachers of the 5th grade pupils who participated in the EspCie1 and teachers of other classes of the 1st segment of elementary school that had been monitoring the 5th grade pupils. A total of ten questionnaires were distributed and analysed.

Teachers were unanimous in marking "very interested" with regard to the question related to the interest shown by the students. Furthermore, they were unanimous in classifying the work at EspCie as very good.

Among the remarks made by the teachers the majority (eight teachers) mentioned the activities, seen as well planed, as important in active learning and able to develop reasoning and the scientific spirit of the child. Six of them mentioned as well the interest and the degree of autonomy that the pupils developed and only three mentioned the role of the teacher, but it was not clear if they thought their own approach should incorporate some of the strategies observed.

The graduates of the Faculty of Bilingual Education, both Deaf and hearing, were exposed to two different models of activities carried out in EspCie1 for pupils of the 5th grade. The first model was one of the introdutory activities that aimed to provide the experience of formulating hypotheses from deductive observation and to discuss the importance of observation and hypothesis in scientific work. The second model was an experimental course lasting several days.

In the first part fourteen undergraduate students participated and all the evaluations and comments were positive. There only negative comments were related to the size and physical organization of the classroom and to the fact that they thought this kind of activities should be extended to other classes of the second segment of elementary school. However, none of them seemed to propose to use similar approaches in their teaching activities.

In the second part thirteen undergraduate students(one missed class that day), were invited to participate in the Experimental Activity involving the respiratory system, with the pupils of the elementary school that were engaged in EspCie1. This activity was evaluated by undergraduate students (future teachers) as excellent or good. They were also told that they were free to add comments if they thought it were necessary.

A group of questionnaires were given to seven members of the Institute administration. There are, however, eight replies because during the five years of the development of this research, one person acted in two different departments, being the representative of different management positions directly related to the work proposed in the institution.

In relation to the interest of the institution regarding the project, there were five positive answers "very interested", but the other three answers were "indifferent", "very little concern" and "disinterested". In the space for additional comments it was mentioned that the Institute did not support that kind of work accordingly, did not understand the pedagogic process, and thus the work represented an individual effort and did not count with institutional backing, as the institution did not understand the advantages of collaboration with the university team. Among the positive aspect it was mentioned the possibility given to the undergraduate students from the Bilingual Pedagogy Course to be involved in a different way of teaching science.

With regard to the second question: How would you rate the science work done by EspCie1? there was no disagreement, it was always marked as very good.

4. Discussion

The challenge of introducing, in a special school for the deaf, a new approach for educating the students was not an easy task to implement. It was necessary to introduce new activities without disrupting the school curriculum, in addition it was necessary to transform an ordinary classroom into a small laboratory and it was required that the teaching staff were prepared to change their attitudes and start to regard science education as something feasible. More importantly, it should motivate elementary school children to seek for information and to appreciate science.

When members of the school administration of the institute were questioned regarding the support given to the project, it was mentioned by one of them that not enough backing was given. Donovan (2013) mentions that despite the enthusiasm shown by people when given access to new technology, this is less so when innovation requires them to change their behavior. This is clearly seen in an institution established for a long time. However, the methodology described in this work was tested for five consecutive years with considerable success. It was possible to track the interests of the 5th grade children that had been part this project, as they kept returning after leaving the 5th grade and asking if they could help in the activities even if they were now in higher grades. Similarly, the younger pupils kept stopping at the door of the EspCie1 asking when they would be old enough to participate in the project.

A number of aspects should be highlighted in this experience. It did not rely on a sole educational approach. It made children interact with science in a playful way. It started by showing children the importance of observation, of simulating a situation and making a hypothesis, of the advantages of cooperating and how crucial it is to keep a good registry of what is observed. These are, of course, important attitudes not just for science but for daily life. This kind of course puts also relevance on experimental work following the steps of the scientific method. However, the questions, the hands-on experiments, the analysis of the results, the final conclusion were all elaborated by the Deaf pupils themselves. The children identified the problem they wanted to solve and integrated the information generated. During these scientific experimental activities they had tutors that are students or Deaf teachers working in a scientific lab at the Federal University under the supervision of two scientists. These Deaf tutors were extremely important as role models, the children wanted to become like them. Furthermore, the Deaf tutors introduced in a very natural way specific scientific signs developed at the University to supply the need to communicate science in Brazilian Sign Language. In addition to laboratory work, multiple strategies were developed to raise the interest in science for those children that might not be particularly keen in experimentation. These strategies involved going to museums, organizing and participating of Science fairs, visiting natural parks etc. providing that each space became a motive for the pupils to develop in a natural way their interest for science (Feinstein, Allen, & Jenkins, 2013).

A well succeeded experience is seen at the National Technical Institute for the Deaf in the Rochester Institute of Technology, where secondary school and undergraduate Deaf students are trained to follow the areas of science and technology (Pagano, Ross, & O'Neill, 2012). What our experience shows is that more Deaf youngsters would probably follow the scientific field if their interest was raised during the period of their childhood and this was our intention with this project.

This project also focused the teacher, mainly future teachers for the Deaf.

In addition to the difficulty found in teaching science to small children (Tilgner, 1990) it has been reported that there is a need for more science teachers in secondary schools and that this is more severe when it involves science teachers in deaf schools (Seal, Wynne, & MacDonald, 2002; Mangrubang, 2005). The Gallaudet University also sought to create a training course for science teachers for the Deaf using an inquiry-based course (Mangrubang, 2004). This shows that this method could be used in schools with Deaf students considering the teaching staff was prepared to use it. In the present work, despite the interest in the strategies used and the recognition that the pupils were interested and excited about the activities, neither the teachers of the 5th grade nor the undergraduate students of the Pedagogy course manifested interest in using this method. Probably the lack of control of the development of the process and their lack of scientific knowledge inhibited their choice. However, both administrators and teachers recognized the importance of a strategy that involved collaboration with scientists from the university and Deaf trained at the university.

In the present project the teachers' team at EspCie1 was composed by one Deaf and two hearing teachers, one of them the author of this work. None of them had been directly involved with science before. To compensate this lack of specific training, they received support from university scientists as well as the collaboration of Deaf tutors as described above. For the two teachers, responsible to undertake the activities developed in the EspCie1, this was a first experience. For Flores this was part of a PhD project and, despite being responsible for the organization and suggestion of the activities, did not directly take part in them. When this work was assessed from the EspCie1 team point of view, they mentioned the development of the pupils' capacity of reasoning. They could manage to be critical and to argue in favor of their ideas; furthermore, they also improved their vocabulary. The EspCie1 staff commented, on the other hand, that the teachers accompanying their pupils felt uncomfortable by the fact that they could not give the answers to the children. They were used to be the ones with the knowledge. Furthermore, because, the activities are planned for students to answer their own questions, they often

follow a different path than that originally organized. Therefore, despite the activities not being at random, the subsequent development of each one is not entirely predictable and takes the teacher out of their comfort zone.

When the EspCie1 team was interviewed, an important point mentioned by both hearing and Deaf teachers alike was the advantageous situation of having a real Bilingual situation where they could help each other when the situation aroused. They also mentioned the model of a Deaf teacher that functions as a mentor and encourages the Deaf pupils to achieve that level of knowledge (Foster & MacLeod, 2004). This was a similar situation as that seen with the Deaf tutors, but with the advantage that the teacher belonged to a permanent staff and could be always present. There was also an awareness of the importance of different looks towards the same event as neither of them was quite prepared to face the dynamic aspects of this kind of approach.

5. Conclusion

The analysis of different learning strategies indicates that different approaches have been and are being used for teaching the Deaf but are mostly focused on older students (Easterbrooks & Stephenson, 2006). The guiding idea of the present work was to use different strategies for teaching science for children at the first segment of elementary school. In addition to acquiring autonomy, the pupils' interest in studying school science was raised, and the scientific subjects addressed during the five years of this research far exceeded the proposed curriculum content for this age group. It is possible that this early intervention is capable of modifying the position of those individuals in their pursuit of knowledge.

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