SCIENCE FOR STREET CHILDREN
- RESULTS OF A LONGTERM DEVELOPMENTAL PROJECT IN SCIENCE EDUCATION -

Manuela Welzel-Breuer¹ and Elmar Breuer²
¹ University of Education Heidelberg, Germany
² Gymnasium Englisches Institut Heidelberg, Germany

Abstract: Since 2002 we are part of an international collaboration project called “Patio 13-school for street children” in Colombia. The aim of this project is to find ways to educate children who are used to live in the street, disconnected from the official school system and without any regular life and future. The existence of so called “street children” is an increasing problem, worldwide. According to the UN Convention of 1989 on the Rights of the Child the society has the responsibility to find ways to offer them adequate contexts and possibilities for learning – also in science. Within our project, we are co-operating with a teacher education institution in Colombia and linking cultural aspects of education with previous experiences in pedagogy for street children and modern ways of teaching science. Together with advanced pre-service teacher students we could develop, implement and investigate different ways to teach science issues as part of a curriculum for street children using an inquiry based science education (IBSE) approach, simple experiments and material. One major challenge was to enable the Colombian teacher students to apply the methods of inquiry based learning. The whole project was evaluated using design based research methods (DBR) and specific analyses of video-recordings. The main research question has been: How to enable advanced teacher students to motivate street children to do science learning activities? Within this paper we will report on three different approaches we developed, the results we could achieve and the conclusions we could draw.

Keywords: science, street children, IBSE, authentic learning environments, pre-service teacher education

OBJECTIVES
Since 2002 we are part of a German-Colombian collaboration project called “Patio 13-school for street children”. The aim of this project is to develop ways of enabling Colombian pre-service teacher students to educate children who are used to live in the street, disconnected from the official school system and without any regular life within families. Together with pre-service teacher students in Colombia we developed, implemented and investigated different strategies using an inquiry based science education (IBSE) approach, simple experiments and material (Rocard et al. 2007). The problem we wanted to solve is: How to enable advanced teacher students in motivating street children to do science learning activities?

SIGNIFICANCE
The existence of street children is an increasing problem, worldwide (Weber & Jaramillo 2005, Strassenkinderrreferat 2013). According to the UN Convention on the Rights of the
Child (UN 1989) the society has the responsibility to find ways in order to offer them adequate possibilities for learning – also in science. Especially in Colombia there are plenty of children living without parents, home and education. They often live in the vicinity of large cities like Medellín, Baranquilla or Cartagena. Social institutions (so called “patios”), engage in taking care of these children and offer them food, shelter and health services. But, mostly there are no educational offers. The project “Patio 13” focuses on that: For the last eleven years, a group of social and educational scientists from Colombia (Escuela Normal Superior María Auxiliadora, Universidad de Antioquia) and Germany (University of Education Heidelberg, University of Education Freiburg, Heidelberg University) has been working together in order to implement a program of instruction in different subjects to be applied in a patio in Medellín and in other institutions for children in difficult living situations (in a state of “vulnerability” (see Herrera Casilimas et al. 2012, 11ff.)). The idea is to improve the situation of those children through education. The offers need to be special in a way that the children are free to participate. The learning units need to be highly individualized; they have to be oriented towards the interests of street children and organized interactively.

THEORETICAL BACKGROUND

Authentic environments are necessary for an effective learning context (Roth 1995). School science needs authentic learning environments for school children with their specific experiences and social habitus (Bourdieu 1993, 98ff). Thus, street children, too, need a specific science education, which is based on their social habitus: their living conditions, experiences, motivations and interests. They do live a life fundamentally different from that of children with a family and school background (Weber & Jaramillo 2003, Herrera Casilimas et al. 2012). They behave in a specific way related to their individual street life experiences. Their capabilities with respect to teaching-learning interactions are different from those of children who experience conventional school socialization (see Herrera Casilimas et al. 2012, 67-68).

Usually, pre-service teacher students are not familiar with street children’s life. They themselves typically have practiced a regular school career and, on that basis, they study at Universities in order to teach at regular schools in the future. Because of that, for being able to educate street children, the teacher students have to become familiar with street children and to adapt their pedagogy to the street childrens’ specific experiences and needs.

Thus, we had to think about an adequate way of introducing science to street children and about how to prepare teacher students for this job. We decided to apply methods of IBSE (see Rocard et al. 2007) both for instructing street children and training (educating) teacher students, because:

- Typically, street children are trained and specifically interested in practical, useful and exploitable things (see Herrera Casilimas et al. 2012, Strassenkinderreport 2013) and in constructing handicrafts they use to sell in the streets. These are ideal conditions for an IBSE approach.
- Their verbal communication skills (description, argumentation, discussion) are only poorly developed (see Herrera Casilimas et al. 2012, Strassenkinderreport 2013); on the one hand highly developed communication skills are not mandatory pre-conditions for learning science through IBSE, on the other hand, communication
skills can be trained and developed while manipulating material within groups, experiencing surprising phenomena and initiating thinking about them, or working on the solvation of problems.

- The street children typically are not able to read and write very well (see Herrera Casilimas et al. 2012, Strassenkinderreport 2013), using IBSE the need of documenting observations and findings gets visible for them.
- The teacher students we are working with are only educated in theoretical approaches to science like treating formulas and calculating values. Investigating phenomena empirically is not in the focus of their science curriculum. In order to enable them to realize IBSE with street children they have to become familiar with IBSE. We are convinced that this requires that the teacher students themselves have to learn science within IBSE contexts.

**RESEARCH QUESTIONS**

Because our stays in Colombia have been short term stays and the teacher students were not prepared for IBSE we were faced with several logistic and scientific problems. The main questions that occurred are the following:

1. How far is it possible to enable and motivate teacher students in teaching street children in science using IBSE - within a couple of weeks?
2. How do the students realize their instructional environments for street children concerning methods and content?
3. How do the street children react on the teaching offers in terms of participation and interest?

**DESIGN AND PROCEDURE**

Co-operating with a teacher training institution in Colombia we are linking cultural aspects of education with existing experiences in education for street children and modern ways of teaching science (IBSE). Pre-service teacher students at this institution are used to study the life of street children and thus are prepared to interact with them. Twice a week, they have to offer lessons in a patio e.g. in mathematics, mother tongue, arts. In an accompanying seminar they reflect on their teaching experiences.

This practice can be seen as a fulfilled pre-condition and has been continued for the project presented here: In our project, the students realized science and physics lessons with street children of a patio in Medellín and of other kids in the state of vulnerability and reflected the teaching-learning situations together with us afterwards. The major challenge for us was to enable the pre-service teacher students in applying IBSE. Neither from their own science classroom experience nor from their teacher training practices they are equipped with adequate skills.

Through seven visits – between 2002 and 2012 - we generally developed three different strategies of working with teacher students and street children:
Strategy 1: Science Course – Lesson Preparation – Teaching – Reflection

Applying Strategy 1 we started with a science course for the students. This course concentrated on a specific content like electricity (circuits, electromagnetism) and lasted about 6 to 12 hours. Here the students could deepen their physics and methodological knowledge in an IBSE environment. On that basis and within small groups they developed their own units to be taught to street children. The ideas have been discussed internally on the basis of the pedagogical content knowledge the teacher students and we had. This phase lasted about 2 to 4 hours. The units developed by the teacher students have then been offered to street children. Each lesson taught by the teacher students has been observed carefully by fellow students and by us; additionally all lessons have been videographed. After each lesson taught the group met in order to reflect jointly the teaching and learning activities analysing the videos. Ideas for improvement where gathered and discussed.

Figures 1 and 2. Science course for pre-service teacher students on electrical circuits

Figures 3 and 4. Teacher students prepare science lessons and plan the agenda for their course
Strategy 2: Lesson Preparation – Teaching – Reflection

Applying Strategy 2 prior to our visit we had intense contacts via Email with our students in Colombia. When we arrived in Colombia the teacher students started immediately with the preparation of their own teaching units. This was possible in those years we could work with experienced students who already learned with us during former visits. Thus, the teacher students could apply their prior science and teaching knowledge. In addition, the teacher students could make their own choices of contents or topics they were interested in and which they liked to teach. Our task was to support them with material, methodological ideas and scientific explanations.

The teaching units prepared within a course of about 6 hours then have been realized with street children of a Colombian patio.

The lessons taught by the teacher students, have been observed by fellow students and by us. Again all lessons have been videographed. After each lesson the group met in order to reflect jointly the teaching and learning activities. Ideas for improvement where gathered and discussed. The group which had to teach the following lesson tried to include these ideas into their plans and practice.
Strategy 3: Exhibition Preparation – Exhibition – Reflection

To plan and organize an interactive science exhibition for school children as well as for street children was the purpose of two other visits. Thus, we prepared and offered a list of possible experimental exhibits on different science phenomena. About 20 groups of teacher students could choose from this list or bring in additional ideas. Within the first days of our visit (about 4 - 8 lessons) the teacher students could try out the selected experiments, become familiar with the phenomena and arrange their own interactive exhibits. The ideas for the exhibits were presented to the whole group of teacher students and intensely discussed in order to make them a sustainable experience for the expected visitors.

For a whole day the exhibition was realized in the school area inside of several classrooms and outside in the school yard. The teacher students initiated and supported science activities for about 1000 visitors including different groups of street children, which have been invited and accompanied to the school. The activities during the day of the exhibition have been observed by the teacher students and by us. Reports and photographs have been produced. The exhibition was followed by a group discussion and pedagogical reflection.

Figures 9 and 10. The teacher students prepare science exhibits

Figures 11 and 12. Street children while exploring mirrors and solutions
DATA ACQUISITION AND DATA ANALYSES

Applying a field study strategy the data to be used for analyses are field notes. All teaching activities of the teacher students have been observed by fellow students and by us; written reflections have been initiated and gathered. The activities of students and street children have been videotaped and photographed. We recorded observations concerning the application of our strategy and the reactions of teacher students and street children at the end of each day.

The data have been analysed qualitatively and mainly validated communicatively during our reflection seminars with the Colombian teacher students. According to the principles of design based research (Kelly 2006) the development of the teacher students’ skills and the street children’s motivation have been analyzed.

RESULTS

1. How far is it possible to enable and motivate teacher students in teaching street children in science using IBSE - within a couple of weeks?

For all strategies using the IBSE approach, the teacher students themselves have been extremely motivated in learning science topics. They have been surprised about this approach, they told us about their prior experiences and the difference between our IBSE oriented courses and the traditional science lessons at school. They enjoyed to explore material and phenomena empirically and started to pose and follow own questions concerning the phenomena they experienced. After first experiences they started to search for further information on the phenomena and explanations for their observations. They searched within their school booklets for hints and links. They discovered the usefulness of the library and the internet for gaining scientific background information. We could observe that they began to vary the experiments initiated by us, to add material and devices.

Figures 13 and 14: Teacher students explore phenomena preparing lessons

On this basis the teacher students became able to motivate street children to do science activities. We could observe that the teacher students started to work on the improvement of their actions and interactions. They understood that IBSE is a good way to motivate street children. Through developing the instructional design and reflecting the teaching-learning situations the teacher students improved their own teaching practice and PCK – progresses became visible.
Otherwise, even using Strategy 1, in many cases we could observe that the teacher students suffered from a lack of sufficient knowledge regarding the physical content and experimental skills. For example we observed several situations in which the teacher students showed difficulties to solve problems that occurred in simple electrical circuits constructed by the street children. Short cuts weren’t identified, batteries have been heated, and errors have not been detected. It is obvious that for most of the teacher students involved in our project such a small number of science lessons are not really sufficient to develop experimental and scientific expertise even within a limited subject area. Nevertheless, on the side of the teacher students we could realize an engagement in scientific activities and a promising motivation to learn more within this field.

In addition, the project “science for street children” led to several changes in our partner institution in Colombia: The vivid interest of the participating teacher students in science and science education resulted in a transfer of knowledge and skills. Supplementary science offers at the teacher training institution in Colombia have been introduced. Because of the engagement in the international project and the positive experiences with the interactive science exhibitions the institution started to implement a science profile. This science profile starts at the kindergarten level and leads through primary and secondary education. The science profile currently comprises IBSE peer teaching science activities for the practicals to be realized with street children, but also in a Science Club weekly offered by teacher students for school children of grade 7 and 8. Here the 7 and 8 graders explore phenomena and prepare science activities for primary education at their school. Specific classrooms are equipped with proved experimental material and literature. The construction of a special building for science education at elementary and primary level was recently planned and goes through the administration. The institution aims at becoming a regional Teacher Training Center for science education.

Since about ten years Colombian and German science teacher students increasingly participate in an international University exchange program in order to proceed studying at the other institution. It appears that the people involved in the project feel more and more independent and well prepared to improve science education for future science teachers, for students and for street children.

2. How do the students realize their instructional environments for street children concerning methods and content?

Developing the instructional design and reflecting the teaching-learning situations the teacher students enriched their own teaching practice. They started their lessons tradition-
ally with socializing activities and formal introduction, but then they included experimental activities to be done by the street children for their first time. They let the street children explore phenomena individually or in groups. They supported observations and problem solving processes.

In order to prepare their own instruction the teacher students used the experimental approach, material offered by us and experiments we proposed. It was interesting to see, how the Colombian teacher students combined the new IBSE ideas with elements of their “traditional” teaching practice like telling stories or playing games which they adapted to the current content. The interaction they performed and the learning material they prepared was a colourful demonstration of a child-friendly culture.

Especially when using Strategy 2 and 3 the students introduced a lot of own ideas concerning scientific topics, experiments and handicrafts, adequate for the street children. For instance they introduced the construction of kaleidoscopes and periscopes; they used motorbike batteries in order to achieve high electrical currents. They realized new topics like measurement of time, magnetism, function and capacity of the human lungs and others.

However, also concerning an adequate use of the IBSE approach the time we had to educate and prepare the teacher students appeared to be very short. Since the students often tended to interrupt, to correct and to explain too early, they did not show enough professional patience and expertise in order to support the self-directed individual learning processes of the street children adequately. It became visible that the traditional habitus of the teacher students concerning a “direct knowledge transfer” is very durable.

3. How do the street children react on the teaching offers in terms of participation and interest?

In general, the teacher students could motivate the majority of street children to do science activities.

Especially applying Strategy 1 and 2 the street children have been experimenting individually for periods of up to 30-60 minutes. While engaging in the given topics the street children used the material extensively and repeated experiments several times. They have been surprised about visible effects and phenomena, and showed to be proud about successful actions (e.g. constructing an electromagnet or a complex electrical circuit; measuring the volume of their lungs or time using the sun light). Especially “take-away-results” like kaleidoscopes, periscopes and sundials have been of high interest. The street children treated their products carefully, kept them like little treasures and took them “home”.

Figures 17 and 18. Science phenomena are interesting and worthy to be explored
In addition we could observe that the street children have been dedicated to “paper and pencil work” following the experimenting phases. Often, at the end of lessons, some of them asked for more offers. Applying Strategy 1, street children showed a sustaining motivation in terms of participation in science activities over a period of five weeks.

But also challenges for the teacher students became obvious. We noticed particular children who were not able to concentrate for longer periods of time. Those kids periodically left the actions, but came back later.

The children always reacted negatively when lessons started with lengthy explanations and introductions – a traditional habitus of the teacher students to be neglected. The street children used to disturb the course, to play with own toys, and also to argue and to brawl. Sometimes some of them left the group in order to explore the world outside the pedagogical offer.

Regarding the experimental activities, we had to take into account that every child needs own material because most of them are not used to work in groups. Teaching and learning material has to be distributed at the time it is needed, because too much on offer leads to unplanned actions.
DISCUSSION AND CONCLUSION

The aim of this project was to find ways to educate children who are used to live in the street, disconnected from the official school system. We have been working together with pre-service teacher students and linked Colombian pedagogy to IBSE. The main challenge of our long-term project of about 11 years was the repeated short term presence of ourselves in Colombia – which was a limitation caused by our own affiliations in Germany. Because our stays in Colombia have been short term stays and the teacher students in Colombia were not prepared for IBSE we were faced with several logistic and scientific problems. Thus we concentrated on the following research questions:

1. How far is it possible to enable and motivate teacher students in teaching street children in science using IBSE - within a couple of weeks?
2. How do the students realize their instructional environments for street children concerning methods and content?
3. How do the street children react on the teaching offers in terms of participation and interest?

The application of three different strategies, especially designed for short stays show promising results on the side of the teacher students and the street children. It became obvious that at first the teacher students need to be introduced carefully into science phenomena, experimenting and interactive strategies to be able to offer IBSE in a correct sense. Realizing that, already at a beginner’s level, the students are able to understand the basic scientific phenomena, to gain necessary skills for experimentation and adequate interaction with their learners. Organizing reflexive courses with alternating science seminars and teaching in authentic contexts combined with video analyses made it possible to improve the quality of the teaching practice performed by the teacher students. Nevertheless, some problems with lacking science background knowledge on the side of the teacher students remained.

We can clearly state that the street children actively participated in the lessons offered by the teacher students. They experimented eagerly, asked for more science activities, showed learning progresses. They treated their products like little treasures. The teacher students have been surprised about the long lasting patience of most of the street children.

Reflecting our experiences with respect to the different strategies of implementing science for street children within an international and intercultural educational project we come to the following conclusions:

For short project stays up to three weeks, already experienced science teachers or science teacher students at the partner institutions and intercultural experiences on both sides we can recommend the implementation of Strategies 2 and 3. These strategies allow dedicating sufficient time to work carefully on the development of adequate explorative and instructional designs and the reflection of teaching activities in the field. Here it is important to take care about the proper application of IBSE for limited science problems and the appreciation of the different cultural conditions.

For longer project stays of at minimum five weeks Strategy 1 can be recommended. This strategy leaves additional and necessary time to deepen science knowledge of less experienced teachers or teacher students. It also allows using and exploring more extensively the local conditions and opportunities.
It was impressive to see how the project initiated further science education activities at the partner institution in Colombia. This offers new possibilities for joint projects and new research fields for the future.

ACKNOWLEDGEMENT

Many people have been involved in this project. We received great support from individuals and institutions. We are grateful of having the opportunity to be part of intercultural developmental processes and to work with so many enthusiastic and creative people. Many thanks to Prof. Dr. Hartwig Weber, Henrike Schön and the University of Education Heidelberg, to Sor Sara Sierra Jaramillo, our Colombian teacher students and colleagues and the Escuela Normal Superior María Auxiliadora in Copacabana, to the Universidad de Antioquia in Medellín, to the Landesstiftung Baden Württemberg. We are grateful for a substantial support of our activities.

REFERENCES


Niedderer, H., Tiberghien A., et al. (1998). "Category Based Analysis of Videotapes from labwork (CBAV) - the method and results from four case studies."


http://www.ohchr.org/Documents/ProfessionalInterest/crc.pdf