

Physics for Street Children:

An international, scientifically directed project

Manuela Welzel and Elmar Breuer, University of Education Heidelberg, Germany

Physics for street children? Does that make sense? Don't street children need something else, something more fundamental? We also asked ourselves these questions when we were asked to take part in the project "Patio 13: School for Street Children" in Colombia. And whether that makes sense! Probably even much more so than we think in the meantime. The background of our project, "Physics for Street Children," is the interdisciplinary and international cooperation that has existed for several years within the framework of the project "Patio 13: School for Street Children" between the University of Education in Heidelberg and the Escuela Normal Superior María Auxiliadora in Copacabana near Medellín, Colombia. One goal of this project is to develop, together with student teachers in Colombia, teaching and learning units appropriate for street children that the students can then themselves utilize in projects for street children. The development and implementation of these units are scientifically directed using qualitative methods.

1. The situation of street children in Colombia

The number of street children worldwide is increasing rapidly. Especially in Colombia, where civil war has prevailed for over forty years, many children live without their parents, without a home, and without education. These street children live primarily in large cities. Here there are social institutions, called "Patios," that take in these children and give them shelter, clothing, food, and health care. Most of these institutions, however, do not offer much more than this [1]. The project "Patio 13: School for Street Children" attempts to do just that. Social scientists, educationalists, and didactics experts from Colombia and Germany decided to develop, together within the framework of teacher education and training in both countries, a program for street children including educational opportunities in various subject areas that they can regularly take advantage of while living in the Patio. These offerings must be specially tailored to the needs and requirements of the street children; they must be appealing so that the street children voluntarily and gladly accept them.

2. Learning environments for street children

Roth [2] has shown that particularly authentic learning environments are necessary for effective learning and teaching contexts. That means, for example, that for school instruction, authentic school learning environments are to be created that are well suited to street children and that encompass their curricular and extra-curricular experiences and habits, as well as their interests and potential. Street children also need special learning contexts that take into account their 'particular' experiences, motivations, and interests. Street children live a completely different life than normal school children who have a home and family.

Student teachers and teachers in Colombia and elsewhere in the world generally have no substantial experience with street children. They have had a normal school career themselves and follow studies at a university or college that enable them to teach "normal" children at "normal" schools. As in many places in the world, the educational system in Colombia is a traditional system that dooms children who are once outsiders to remain that way. But in order to teach or to educate street children, and to be able to develop appropriate learning and

teaching environments for them, however, their future teachers must know more about their life and behavior, their thoughts, feelings, and learning style.

We would like to contribute to this cause with our project. On the one hand, the project “Patio 13” investigates the living habits, personal stories, experiences, and interests of street children; on the other hand it develops and tests “out in the field” educational opportunities in the areas of language, mathematics, art, and other subjects [3, 4]. The student teachers are included in this work at an early stage. Insofar we also had to create an authentic learning situation for the Colombian student teachers. In our part of the project, we had to develop a learning environment for the natural sciences not only geared toward the habits of street children, but also one in which the Colombian student teachers could teach in the Patio. While trying out these learning contexts, the learning behavior of the street children is more closely examined.

3. Learning processes and the creation of learning environments

Recent studies on learning processes in the natural sciences at schools [e.g., 5, 6, 7, 8] have shown that learning always occurs in individual processes and is bound to a particular situational context. The meaningful developmental processes are determined by the particular (subjective) areas of experience—from concrete, experimental experiences with material to theoretical discussions. More and more levels of complexity, therefore, are achieved depending on how one deals with concrete phenomena. In order to create learning environments adequate for the learning process, one has to take this into account. In relation to our project on developing appropriate physics lessons for street children that fits in with their learning process patterns, this means that we have to create learning contexts that first allow the children to gain meaning from less complex tasks and then to build up to more complex levels. Which means in effect that, in the new learning context, the street children must have the chance first to gather some concrete, solid experience with very elementary experiment material and also to be able to communicate their observations. Only on this basis will they then be able to further differentiate physical objects and their properties, to explore them step by step experimentally, and finally to discover and comprehend principles of physics.

4. Physics instruction in Colombia and physics for street children

“Our” Colombian student teachers learned physics exclusively in theory and through teacher-centered instruction (traditional classroom style). In other words, they were never able to make any experiences themselves with experimenting. They are therefore not very well prepared to teach physics by doing actual experiments. We thus had to make learning contexts available for them in which they could—in small groups—practice experimenting with concrete materials. That is how we decided to implement the essentially same learning contexts—the experimental approach to physics—for the students and the street children, and to compare the learning behavior of the students with that of the street children.

We began our project in the summer of 2003 with a two-week physics course for a group of fifteen students at the Escuela Normal Superior. In this course the students had not only to learn about physics themselves, but also to develop one teaching unit for the street children. We provided them with experiment materials for teaching topics on electricity, which they could, guided by sets of instructions and questions, experiment with independently and freely.



Fig. 1 Experiments with electromagnets



Fig. 2 Searching for explanations

Through these experiments, the students learned about laws of simple electric circuits and about electromagnetic phenomena. They discussed their experiments and observations (Fig. 1) and tried to find theoretical explanations for them (Fig. 2). Then we dealt with the lessons for street children. Together with us, the students discussed the experiences they had just made with the experiments and their experiences with street children. The students at the Escuela Normal have classes in education beginning already in the eighth grade and regularly do internships working with street children. They could therefore tie in their own observations on the abilities and behavior of street children. They designed examples for instruction in the Patio. Four of our students could put their lessons to the test afterwards. We allowed them to try out their ideas without directly interfering and were anxious to see what would come of them.

5. Observations and results

Our observations (video recordings and observations during participation) showed that both groups profited from the interactive experiments that were offered. The material provided motivated the students as well as the street children to experiment and to articulate their observations. All of them used the experiment material extensively and for extended periods of time. They constructed electrical circuits with several bulbs, switches, and batteries; they designed their own electromagnets and tested them. They varied the tasks independently and realized their own experimental ideas. All demonstrated excitement and pride over their achievements. Nonetheless we did observe differences between the learning behavior of the street children and that of our “normal” Colombian students, particularly with regard to the social behavior, the organization of group work in a small group, the communication within the small group about the physics facts, the creativity, and the diversity of experiments.

The student teachers, our “normal” students, never had problems with teacher-centered learning-teaching situations and group work. They were always focused and attentive. While dividing up into small groups, first there were discussions about who would like to work with whom in a group. Then the tasks were quickly assigned within each group and different roles assumed. All of the small groups worked very closely on the problems we assigned. Once they had mastered a problem, all activity stopped and the students waited “patiently” for further instructions. Just as we had assumed on the basis of our learning theory and the lack of knowledge about experiments, the observed learning processes began with a very low level of complexity. Theoretical knowledge from earlier (teacher-centered and theoretically oriented) physics classes rarely came into play during experimentation. We could nonetheless observe

in some groups intensive discussions about the theoretical background of their experiments. We were asked for textbooks so that the students could look up more in-depth explanations. The explanations were then communicated within the group and agreed upon by the individual group members.

Through the interactive situations and the joint reflection on the learning-teaching context, the students learned how one can arrive at theoretical explanations through concrete experimental practice. They brought in their own experiences from working with street children whom they had gotten to know from the Patio and thought about how they could design effective learning-teaching contexts. Thus the students began to reflect on how to deal with learning-teaching situations.

However, the first teaching attempts in the Patio were for them surprisingly unsatisfactory. Just as they had themselves experienced it in school, they began their lessons with the street children with a teacher-centered approach—despite the fact that they had experienced a different approach with us (Fig. 3).



Figs. 3 and 4 Students teach street children first in a lecture format, then interactively

But it immediately became apparent that this approach stood no chance. The street children were not capable of concentrating and listening for extended periods of time in such a situation. The students therefore had to change over to an interactive strategy. Once they placed the material on the ground, demonstrated an example, and allowed them much freedom to explore their own ideas, they attained satisfactory results (Fig. 4).

The street children are used to living and functioning in small groups. That affords them protection on the street and helps them survive. During the experiments, however, rivalries between the individual members of the group arose quickly: they all wanted all the material and to do everything by themselves. We could hardly observe any communication or discussion about the theoretical background of the experiments among the street children during these experiment situations. But some of them cooperated throughout the practical work. We could see that some of the children were intensely occupied with the material.



Fig. 5 to 7 Street children in the Patio engaged in experimenting

The street children worked extremely focused for long periods of time (up to thirty minutes) with the given material, quickly varied the given assignments, and demonstrated enthusiasm over their success with the experiments. Time and again, they proudly showed the other street children and us the circuits and the electromagnets they made (Fig. 8).

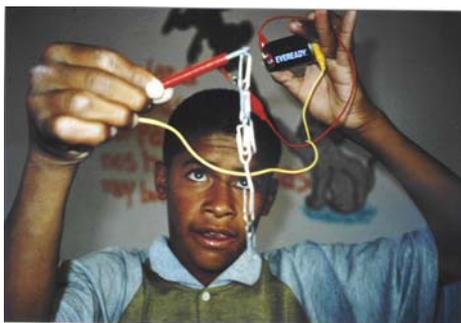


Fig. 8 The electromagnet works!

The street children were considerably more spontaneous and somewhat more creative than the “normal” students. They quickly understood the practical dimension of the experiments. Our teacher students were very impressed by this.

6. Where does it go from here?

In conclusion, we can say that the students and also we learned a great deal about the learning process of street children through this project. Street children are especially curious, interested, and enthusiastic. By observing the street children, the students gathered quickly that an experimental approach leads to an extensive engagement and enables them to solve problems of physics.

In the future, we would like to examine more closely to what extent the street children remain interested when physics is offered over a longer period of time in the project. We began this next step of investigation in the summer of 2005. Since then the Colombian students have developed interactive series of experiments relating to various topics of physics in preparation for a “Science Day” for students of the Escuela Normal and the street children (Figs. 9 and 10).



Figs. 9 and 10 Series of experiments on lessons in electricity and optics for Science Day 2005

For Science Day 2005, these series of experiments were presented and successfully tested over two days in August. The series of experiments are now being implemented in lesson sequences in order to establish a long-lasting and regular schedule of physics instruction for street children in the Patio. The implementation of these experiment series will be guided and observed by the students and the educators. Parallel to this, the previous knowledge of street children in the relevant topic areas will be examined in smaller studies by the students.

This work is currently taking place—and not only that: the attempt to integrate street children in the framework of educational studies goes so far that even the “advanced” street children visit the Escuela Normal once a week on a regular basis and study with the teacher students. We ourselves have found that the teacher students also profit enormously from the interactive approach. Especially because of the prospect of developing interesting and motivating lessons for street children, they have begun committing themselves to and enjoy dealing with the realm of physics formulations.

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References

- [1] H. Weber & S. Sierra Jaramillo: Narben auf meiner Haut. Straßenkinder fotografieren sich selbst. Frankfurt am Main: Büchergilde Gutenberg 2003.
- [2] W.-M. Roth: Authentic school science: Knowing and learning in open-inquiry laboratories. Dordrecht, Netherlands: Kluwer Academic Publishing 1995.
- [3] H. Weber, S. S. Sierra, H. Meeh, and A. Crossley: Der Himmel über mir. Überleben auf den Straßen Kolumbiens. DVD. Rosenheim: coTec Verlag 2005.
- [4] www.patio13.de (homepage of the project)
- [5] M. Welzel: Student centred instruction and learning processes in physics. Research in Science Education (1997) 27(3). 383-394.

- [6] M. Welzel: The emergence of complex cognition during a unit on static electricity. *International Journal of Science Education* (1998) Vol. 20/9, 1107-1118.
- [7] M. Welzel: Systematic analysis of instructional design: The influence of interactions on students' cognitive processes. In: Systematic analysis of and reflection on "emergent practices" of instructional design. Paper presented at the symposium "Systematic analysis of and reflection on 'emergent practices' of instructional design", EARLI Conference, August 1999, Sweden. University of Leiden. 23-36. 2000.
- [8] S. von Aufschnaiter: Development of Complexity by Dealing with Physical Qualities: One Type of Conceptual Change? In: Komorek, M. et al. (eds.). *Research in Science Education: Past, Present, and Future. Proceedings of the Second International Conference of the European Science Education Research Association (ESERA)*. Vol. 1. Kiel: IPN, 61-63. 1999.

Prof. Dr. Manuela Welzel is Professor for Physics and Physics Education at the University of Education in Heidelberg. Her research and work focuses on the teaching and learning of physics and the natural sciences in various contexts as well as on a profession-oriented program for teacher training. (welzel@ph-heidelberg.de)

Dr. Elmar Breuer is a senior teacher at the Gymnasium Englisches Institut in Heidelberg and a visiting lecturer at the University of Education in Heidelberg. He teaches physics, mathematics, and computer science. (elmarbreuer@gmx.de)