Projects at school: scientific, technological and of citizen research

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Projects are an essential part of a truly educative school, a school that encourages significant, inquisitive and pertinent learning (Manning, Manning & Long, 1994; Marx *et al*., 1997). To avoid dry "scientism", it may be useful to consider three kinds of projects for the science classroom: scientific, technological and of "citizen research" (Lacueva, 2000a; Lacueva, 2000b). The combination of them offers a much more complete and balanced education for all children and youngsters. Although overlappings and mixings can occur, each kind of project is guided by different purposes, requires different methodologies and cultivates distinct attitudes and values.

Scientific projects: to describe, to explain, to predict

In the *scientific projects* the children carry out investigations similar, up to what their conditions allow, to those of the adult scientists: exploratory, descriptive or explanatory research about natural phenomena. Children pose problems, make predictions, formulate hypotheses, design experiences to obtain empirical evidence, manifest their ingenuity in the set up and use of scientific equipment, observe phenomena, register and organize data, interpret results in the light of theories, support conclusions, and reconstruct theoretical ideas on the basis of experiences and reflections.

Thanks to the collaboration of interested teachers, I have tried projects, some scientific, with venezuelan students: for example, sixth-grade students, individually, researched the characteristics, language, interactions… of a chosen baby, throughout different moments and situations of the baby's daily life (Lacueva and Viloria, 1994). The children kept a record of their observations, including some quali-quantitative ones, such as number of words said by the baby or infant, classified according to a typology proposed by the little researchers themselves. They organized their observations, complemented them with documental information and made a final report. This study generated diverse questions about mental development and characteristics of human nervous system, and motivated children to compare the babies studied with the preschool students of their institution, and to inquire with their parents about their own past as babies. A useful reference in English is the book written by the elementary school teacher Charles Pearce (1999).

Possible activities in scientific projects

- *Formulation of problems*
- *Making of predictions*
- *Hypothesizing (incipient in the first grades)*
- *Design of experiences to obtain empirical evidence: experiments, field research, surveys…*

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- *Set-up and use of scientific equipment, for example: scales, meteorological station, proof ramp for small vehicles, a "house" for earthworms…*
- *Observation and register of data*
- *Organization of data*
- *Interpretation of results, using theoretical knowledge*
- *Elaboration of conclusions*
- *Theory reconstruction based on experiences and reflection*

Technological projects: to design, to produce, to evaluate

In the *technological projects*, the children develop or evaluate a process, a product, a system or an environment of practical use, imitating in this way the work of technologists. Technological projects help develop skills and knowledges little exploited in strictly scientific inquiry: they stimulate inventiveness in the design and construction of objects, increase practical mastery over diverse materials and tools, call for the development of specific categories for the evaluation of their results, allow for the application of scientific notions, and stimulate precise knowledge about the behavior and usefulness of diverse materials, the characteristics and efficiency of different processes and the potentiality of varied tools and equipment.

In Venezuela, Bolívar *et al.* (1987) conducted a project with eight-grade students, which integrated contents of the subject Commerce with other areas. The students constituted mini-cooperatives and agreed on the item to produce: pickles. Each group of partners named their enterprise, made its rules or statutes, collected the starting capital and established responsabilities. They carried out a market study, and investigated also about the production process. In the Art class, they designed models for the label of their jars and, through a contest, chose one which was later printed. The pickles were produced at the school kitchen. A "Pickles Fair" at school helped them sell most of their merchandise. At closing, each administrator presented the accounts to the rest of the partners. For more on technological projects, see Raizen *et al.* (1995) and Eggleston (1992).

Possible activities in technological projects

When producing

- *Determination of product, process, system or environment needed or desired*
- *Design of product, process, system or environment*
- *Elaboration*
- *Trial*
- *Redesign (if needed)*

When evaluating

- *Establishment of criteria for the evaluation*
- *Trial*
- *Register of information on trial*
- *Conclusions*

Citizenship projects: to clarify, to decide, to act

In the third kind of projects, the *citizenship projects*, the students act as concerned and critical citizens, who jointly consider problems that affect them, get information, discuss and

propose solutions and, if possible, put them into practice or at least make them public, albeit at a small scale. In this kind of projects, whose methodology can be characterized mainly as of *action-research*, students learn to detect important social and socio-personal situations, to look for and to process information from different sources, to take decisions, to organize and work effectively in democratic teams, to negotiate and undertake actions of change in a rational, pertinent and prudent way.

Plonczak, Zambrano and Salcedo (1989) worked with venezuelan seventh-grade students in the project "Serviguía del barrio" (*serviguía* as a contraction of "guide of services" in spanish). The teachers knew from past experience that to study their neighborhood for its own sake was of little interest to the youngsters. So they proposed, and was accepted, to elaborate an informative guide for the general public, about services offered in the local community and its surroundings. After some classroom work on services and its kinds, and a search for information that allowed a better planning of the activity, students went out in teams to collect data. Then, they processed and organized them and, following several revisions, made a brochure using the school computers. The brochure was reproduced and distributed.

In the small town of Ramona, Argentina, the secondary school teacher Raquel Camperi and her students developed during three years what they called "a learning-in-service" project about water in their community (Gastaldi, Camperi *et. al*., 2002). Bad quality of drinking water was a problem at their town. During the first year of the project, the students made a survey research on people's knowledge about this problem, noticing lack of information. They then participated in a local TV program, and developed informative brochures and conferences. A second survey showed an increase in public awareness and more interest in participating in the solution of the problem. These results were given to the local authorities and to the Regional Service of Rural Potable Water. A comunal committee was established, and today two new plants for the potabilization of water are being installed at Ramona. During the second and third year of the classroom project, students researched the presence and possible consequences of high indexes of arsenic in the water consumed at their town. They did survey research in the community, and analyzed samples of water and of people's urine, with the help of the laboratories of a nearby university (Universidad Nacional del Litoral). The results were presentd to the public and also to the local health authorities.

It has been frequently said that the processes of scientific research are useful in the resolution of all kinds of problems, including those of personal and social life outside the laboratory. However, this is not so: the problems of the concerned, democratic citizen are not the same than the problems of the scientist, nor are equal the processes of resolution (Hurd, 1970, 1982; Howe, 1996). In the everyday world it is valuable to look for the useful knowledge and not only or mainly for the true one, and it is also indispensable to contextualize rather than to abstract (or, even better, to contextualize and also to abstract, in a swinging way). Procedures less highlighted in the scientific environment become important in the lay world: the political negotiation, the making of practical decisions, the prudent social action, the prevision of secondary consequences of action in diverse levels or circles, and the detection of possible obstacles to change. On the other hand, the interdisciplinary effort and, even more, the transdisciplinary effort become fundamental: one cannot approach social and socio-personal situations in the purity of scientific theories; it may be necessary to apply more diffuse and hybrid theories, which feed on diverse disciplines and which go beyond them.

Possible activities in citizenship projects

- *Problem recognition*
- *Characterization of the problem situation*
- *Compilation and analysis of basic documental information*
- *Decision-making, elaboration of proposals for the solution of the problem situation*
- *Development of proposals*
- *Evaluation of achievements and insufficiencies*

A flexible guideline for project-based school work

It is not easy to develop authentic project work at school. Traditional routines run against it: teachers and students are used to a different, simpler and easier kind of work, as expressed in recitation, drill and cut-and-copy library research. Another obstacle in many countries is the lack of resources: without at least a minimum amount of books and equipment, little can be done. Besides, we need to learn more from successful (and not so successful) experiences, many of them not reported or reported in a very brief way (as in this article!). Flexible orientations can be useful: it is too difficult for an educator to start from scratch and to construct by him or herself the whole skeleton of this kind of classroom work. I propose here a guideline for project work, developed from theoretical considerations, experiences reported by others and personal work with teachers.

1. *Exploratory experiences*

They enrich children's lives and are a good source of themes for projects. Among them we can mention: visits to natural and social environments, dialogs with experts, children's conferences, plants and animals at school (for a manageable period), cooking at school, free text, free drawing, free reading, songs, community action, videos…

2. *Theme selection*

From exploratory experiences, short activities, children and teacher proposals, themes for projects emerge. Different proposals can be discussed and voted on.

3. *What do we know about this theme?*

An initial general classroom discussion. It is good to write the ideas on the blackboard.

4. *What do we want to know about this theme?*

This is better done in small groups first, for more participation. Afterwards, all the questions and inquiries of the different groups are written on the blackboard.

5. *Sub-themes from questions*

Again in groups, children try to organize related questions in groups. The teacher can add some questions or sub-themes at this point.

6. *The project network*

A net is organized on the blakboard with the theme and the different subthemes generated, afterwards it is copied on a big sheet of paper and put on display at the classroom.

7. *Organization of teams*

Students organize in teams and each team chooses a sub-theme for research.

8. *New questions*

Each team adds new questions to guide their research of the topic chosen.

9. *Where can we look for information?*

Each team establishes sources of information they can use (books, videos, Internet, experts…)

10. *What research activities can we develop?*

This question helps to go beyond library research into empirical research of some kind (scientific, tecnological or citizenship oriented). Ideas for work can be found in handbooks for teachers, books with activities for children, previous projects done at the school, educative Web pages, etcetera.

11. *Project monitoring*

It is important that teacher and students assess periodically the work being done, the achievements obtained and the obstacles experienced, in order to improve processes for better final results.

12. *How can we communicate what we have done?*

Every authentic investigation ends in some kind of public report of the work done and the results obtained. Some possibilities: written reports, conferences, exhibitions, audiovisual productions, classroom books, symposia, workshops for other students, comics, time lines, dramatizations…

13. *Parallel activities*

As the project is being developed, the teacher can plan other complementary activities, more hetero-structured, like short guided experiences, workshops, work with auto-instructional materials, demonstrations, talks…

A guideline for project work

Exploratory experiences and other activities
↓
Selection of theme
↓
What do we know about theme?
↓ Short Activities
What do we want to know about theme?
↓
Where can we look for information?
↓ Workshops
What research activities can we develop?
↓
Development and monitoring of planned searchs and activities Self-instructional material
↓ Short Activities
How can we communicate what we have investigated?
↓
Communication

Conclusion

To limit inquiry to the scientific kind (or, more broadly speaking, to the strictly disciplinary-like kind, be it biological, geographical, historical…) restricts children's opportunity to learn other ways of problematization, other methodological procedures and different research goals, more relevant to their lives as citizens and to their diversified vocational interests. It also means avoiding at school themes and issues of the utmost importance for all of us: the "real life" problems not considered in a purely disciplinary approach.

Although each teacher and classroom group can develop their own way through project work, flexible guidelines and the detailed account of interesting experiences (with their shortcomings and difficulties included) can be very useful in the dissemination and reflexive improvement of this challenging and formative pedagogical strategy.

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