EE in Italy: Mantova's Water Analysis Project (WAP)

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Abstract
The Water Analysis Project (WAP) is an environmental research project conceived in the 70s in Mantova, Italy, as a result of a syllabus revision in the chemistry courses of the Istituto Tecnico Industriale "E. Fermi". Being restricted only to that school at the beginning, the experience, which was run under the sponsorship of Local Authorities, through improvement and expansion, involved four different schools in a pluri- and interdisciplinary investigation.

This report presents an account of a significant example of an Italian E.E. experience, examining the historical and socioeconomic context in which it grew and developed, its objectives, its processes, and its results.

Background and Context

The Water Analysis Project (WAP) is a research project studying surface and ground waters in Mantova province, carried out by five Mantova High Schools, under the sponsorship of Mantova Communal Administration, Provincial Administration and Municipal Administrations in Mantova territory.

The schools involved are as follows:

- Istituto Tecnico Industriale "E. Fermi" (ITIS) - a technical industrial school (15-19 year old studen.s)
- Istituto Magistrale "I. D'Este" - a normal school for primary school teachers (15-18 years)
- Istituto Professionale Femminile "Don Mazzolari" (IPF) - a vocational school for girls (15-19 years)
- Istituto Tecnico Femminile "A. Mantegna" (ITF) - a technical school for girls (15-19 years)
- Istituto Statale d'Arte - a state art school (15-19 years)

Mantova is a city of 60,000 inhabitants, situated in Northern Italy, in the centre of the Po valley, consisting of a large, quite flat area. The Po is the longest river in Italy.

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Mantova is an art town. Artists such as A. Mantegna, L.B. Alberti, G. Romano, P.P. Rubens worked there and created artistic masterpieces.

Influential in Mantova's artistic development was the Gonzaga family, the Signoria who ruled the town for over four centuries, from 1300 up to 1700, and changed it from a rural centre into one of the most famous European artistic shrines, without, however, being able to perceive the developing ferments of the forthcoming Industrial Revolution, being so deeply absorbed in the arts.

The Gonzagas' short-sightedness as regards industrial phenomena had long-lasting effects as, up to 1955, town and provincial economies relied mainly on agriculture, with its implied social consequences of resistance to innovations, particularly of the technological kind.

The process of industrialisation was started in the middle of 1950's. At first, there was the settling of large productive units (petro-chemical factories and oil refineries), then, in the sixties and seventies, a number of small and medium sized industries followed suit in the fields of mechanics, clothing and paper.

Also the agricultural world was affected by such a process of industrialisation, starting large scale stock raising of pigs and cattle and developing large farms with more and more automated work cycles.

These developments lay and are still lying heavy on the environment with water resources paying the highest bill for such "progress". In the 1970's, the industries located on the lakes around Mantova caused extensive and systematic pollution through the discharge of organic solvents and mercury, still to be found in the lake sediments. Though in recent years industrial pollution itself could be significantly reduced, a veritable scourge of grave proportions has broken out due to pig raising. Not to be forgotten are the various episodes of pollution of ground water due to trichloroethylene, nitrates and atrazine, which have brought to the attention of the public opinion in Mantova the fact that the pollution problem is much more complex than it was previously thought to be.

Therefore the issue is becoming progressively worse as the life of the town is largely dependent on water, which plays a strategic role in the town economy. In fact, Mantova is surrounded by three lakes, has three natural rivers and hundreds of artificial canals whose waters are exploited by agriculture, industries, and, in bygone times, used even for leisure time activities.

When we started the project, we thought it logical to investigate into the most important and, at the same time, most polluted element – the water of Mantova.

The WAP began in 1976, the year of the Seveso disaster, and the year of the passing of Merli act, three events strictly linked together, as we shall see.

The WAP started in the context of an experimental course set up in Course "C" in Industrial Chemistry at the ITIS with the aim of re-organising the curriculum by introducing an inductive method for teaching chemistry, putting team teaching into practice in the planning of activities, unifying the assessment

system, actively searching out and establishing cultural, social, economic, and environmental contacts with the local community and surrounding area.

The study of the water resources was thus located in a wider design which aimed to revitalise the curriculum structure and overcome the rigid guidelines set down fifty years ago for our secondary school with a new dynamic interaction among its subjects and with the opening of new channels of communication and cooperation with the world outside the school.

The WAP thus is to be understood as one of the results that grew from the demands for innovation that shook the national school system in those years. But, in the same year, industry and local boards were hard pressed after the "Merli Law" passed in Parliament. With several years of delay in respect to the other European countries, Italy has in the Merli Law the first set of regulations regarding water pollution. Opposed and hindered by industry on the one hand, and supported by environmentalists on the other, the law sets down norms for the regulation of waste disposal in water, stipulates maximum concentration levels of primary pollutants, establishes timetables for conforming to the new limits for waste disposal, and entrusts water control to the local boards.

At the time, the local communities found themselves unprepared in the battle plan against pollution; the environment had not yet been considered an important resource, the word "ecology" still had fuzzy connotations, data banks on possible pollution sources were lacking, and there was no skilled personnel available for sampling. Lastly, there was the problem of carrying out the actual analysis of water quality.

The situation seemed without any viable solution. But one was found in the Municipal Administration in Bagnolo S. Vito, a large town south of Mantova. One of the schools, the ITIS, was called to examine the feasibility of entrusting the analysis of the surface water of the local area to students and staff in their Experimental Course in Chemistry. The school had qualified personnel, excellent facilities and a highly motivated work force at zero cost, not to mention the great desire to verify experience in the world outside the school.

In this way, the WAP was started, spontaneously, to join school reform with environmental protection, combining the considerable human, professional and instrumental potential of the school with the availability of the services provided by the local boards.

As stated earlier, a third relevant factor was the Seveso disaster. On July 10th 1976, the explosion of a reactor for the production of a herbicide intermediate caused a heavy leak of poisonous gas into the atmosphere at Seveso, a town 20 kilometres north of Milan. The toxic cloud spread its poisons on a wide area; among them there was the infamous dioxin. In a few days 3134 animals died and another 72,000 were killed by order of the Sanitary Authorities. Hundreds of members from the local community were hospitalised because of eye inflammation, skin lesions, and chloracne and thousands of others had to leave their houses without knowing if they would return one day, since the international

scientific community did not know how to reclaim the contaminated terrain. Italian public opinion was shocked by that tragedy and, most likely for the first time, seemed to fully realise the problem of pollution and its consequences. Therefore Seveso acted as a powerful catalyst on the targets of pollution study and, consequently, also on the agreement between ITIS and Bagnolo Municipal Administration.

The Story of the WAP Study

The study has resonated with the community at local and provincial level and has attracted attention from the local health board (Consorzio Sanitario Mantova 3 Esterno Sud-Ovest), to which the town of Bagnolo belongs. The health board entrusted the water analysis of the other communities within its jurisdictional boundaries to the school.

The analyses of Borgoforte (1978) and Curtatone (1979) follow upon the original ones of Bagnolo (1977); in the meantime, the operative structure has been expanded within the Course "C" Chemistry, comprising now the whole course (three classes). The result has been represented as a Model for Environmental Study (OECD, 1989).

After this achievement was recognised in a national competition and articles in several weekly Italian newspapers, the project faced an important task in 1980. The Provincial Administration of Mantova entrusted the analysis of 130 canals in Central and Upper Mantova region to the Course "C" at ITIS, to be done in conjunction with the Laboratory of the provincial health board, with the results contributing to the construction of a hydrographic atlas of the province.

The vastness of the territory under study forced the ITIS team to revise its organisational structure started in the preceding three-year period. The territory was divided into five zones of some hundreds of square kilometres each.

To minimise the time necessary between sampling and analysis, an operative base was set up in each zone. It took a week to prepare the operative base and to execute the water analyses in each zone.

The operative base made weekly shifts. The study was carried out in the months of March and April 1980 and constituted a difficult bench test for the project; the difficulties were overcome by a mobilisation of the forces in the field. Once the WAP has passed this "test", the originators could start setting up the second phase of the project.

It soon became apparent that a chemical test alone was not sufficient to furnish complete information on the state of health of a watercourse: a sampling could be chemically pure, but bacteriologically polluted. Hence, there grew the necessity to extend the range of the survey to include other parameters.

The students of the chemistry course at ITIS were not able to conduct other kinds of analysis. As skills cannot be invented, but must be developed, it was necessary to find them elsewhere, for example at other schools. At the normal school for primary school teachers, Prof. Giorgio Persico, professor of natural

science and expert in field work, launched the idea of the study of microplankton, microscope-based work which could be done by the student teachers in their first and second years.

At the IPF, Professor Nidia Bernardi, teacher of microbiology, enthusiastically received the idea of involving the students of the technical classes of the chemistry and biology laboratory in the specific task of bacteriological analysis.

A few meetings were necessary to define the objectives, tasks and time schedules to enable the creation of the integrated WAP Research Group, which proposed an as yet untried formula and a fascinating challenge on the level of cooperation between different types of schools.

The initial action by the expanded project took place in 1981 with a study of surface and ground waters in the town of Roverbella; then the research team was consolidated during the studies of 1982 (Castellucchio) and 1983 (S. Giorgio), expanded with the contributions from the ITF and some classes from the ITIS who combined with the primary teachers' school in the study of microplankton.

In the light of its pedagogic and curriculum implications, the collaborative model manifested in WAP merits public attention. The Provincial Administration, which had always been sympathetic to environmental work, took upon itself just this responsibility and commissioned the state art school of Mantova to set up an exhibition on the first five years of WAP as its theme in September 1982.

The exhibition required two years' preparation and was finally set up in the rooms of the Casa del Mantegna in spring of 1984; the overall harmonious impression of the work done by motivated students enhanced the essential aspects of this project.

The most recent commission arrived on the wave of success of the exhibition: a study on the lakes around Mantova to be conducted over a period of several years was commissioned by the municipal administration of Mantova, which unanimously approved a budget estimated at 18 million Lire (sixteen thousand dollars).

The research group members agreed that the task would bring prestige as well as risks. The structure of sampling would literally have to be reinvented, and above all, the statistical data would have to be handled at a high level of perfection in order to obtain trend projections and to suggest means of restoring the environment.

Started in spring 1985, the study of the lakes is still in progress.

Objectives of the Project

The Communal Administration asked for a precise investigation into water quality, data on pollution, developing trends and antipollution proposals. In addition to these "external" requirements, the participating schools have certain specific environmental, pedagogical and professional aims.

It is intended that the classes progress from being an occasional gathering of students to becoming a team whose members carry out a common, concrete and useful project. One class works with other classes and one institute collaborates with other institutes. More subjects (organic chemistry, analytical chemistry, physical chemistry, industrial chemistry, mathematics, electronics, statistics, biology, etc.), are to be involved in the project to give the opportunity for interdisciplinary research.

The dynamic interaction among classes and subjects is devised to change the established idea of "school" and trigger new kinds of cooperation among the differently specialised courses in the same technical school (chemistry, electronics, mechanics, electrotechnics) with a view to building apparatuses and instruments or carrying out particular studies (data treatment, model building). Moreover, besides extending teachers' and students' cognitive horizons, the cooperation among different schools enables them to realise things that a single school cannot accomplish.

The schools usually plan frequent contacts with the community (sampling and analysis operations, results presentation) in order to repeatedly inform the population and lead them to reflect and debate. Owing to this reciprocal interaction both school and community are bound to change; in fact each component is influenced as the overall project develops.

Benefits for the Students

Students feel gratified as they work at a useful project from which they obtain cultural and professional advantages.

In a few stages of the project learners enjoy many degrees of freedom: they are supposed to change a procedure, should they find a better one, can and must decide when selecting either a polluting source or a concentration interval, taking upon themselves the responsibility for the choice. During all of the project stages the learner is free to make use of the right of criticism and to suggest proposals for improvement.

On many occasions, students have to learn how to refine their communicative abilities when they are interviewing representatives from local institutions or when they are talking to the members of the community, during analyses or presentation of results.

Under other circumstances, the research stimulates the students' creativity (in sample or support projecting, in mapping, sign, film or poster making etc.) or their executive qualities (carefulness and precision in sampling or in analytical operations) or intellectual qualities (in correlating different data or in explaining anomalies).

The research is supposed to take students from an "environmental discovery" phase (through the hydrography study, territory investigation, sampling operations, results breakdown and presentation) through a phase of

awareness of environmental exploitation, and study of possible remedies, to the mastering of an environmentalist's attitude.

Taking all above into account, it is unavoidable for students to identify themselves with the research, which enables them to start learning programming and planning methodologies and, above all, team work. Students have to fully realise they are an active subject, capable of modifying themselves, their inner environment (their school) and the outer one (their territory).

Benefits for Teachers

With experience, there is the opportunity for teachers to expand their own abilities to plan, organise, manage groups, work out models and try them in the field. There is also the intention to gain from this experience a privileged observation point from which a holographic evaluation of the student can be made. Being able to take advantage of greater liberty than that in the traditional school, students offer differentiated elements for judgment. Beyond this, teachers can widen and deepen their knowledge in their own disciplinary field and finally expand it in interdisciplinary discussions between teachers of various subjects in different schools.

The WAP Model in More Detail

As has been mentioned, the WAP is a model for the study of surface and ground waters of a particular territory. The study, of which the culminating moment is the execution of a cycle of chemical, bacteriological and microplankton analyses, proceeds through the following stages:

1. preliminary contacts and agreement between school and local board
2. study of the subterranean and surface hydrography
3. territorial survey
4. location of the sampling sites and sampling plan preparation
5. training and practice at water sampling, analysis gathering and elaboration of the data
6 setting up operative bases in the field
7. analysis cycle
8. data re-elaboration
9. publication of the results

The *preliminary contacts* follow up the written requests sent out by the municipal administration to the school; they serve to identify the scope and aims of the work, the necessary facilities and services (meeting rooms, canteens, transportation, etc.). In a more advanced phase, the school presents a budget, which is elaborated on the basis of previous experiences and the availability of services offered by the local boards, to the local administration.

The approach to the *hydrography* of the territory is made on a theoretical basis: for the study of the hydrography of surface water, reference can be made to material furnished by the land reclaim authorities or the civil engineering corps. The information furnished by these boards is essential for understanding the seasonal conditions of water flow and the level of the drainage and irrigation canals. Relevant information is also material furnished by the rain gauge station. The ground water survey requires precise indications on the direction of deep currents, but experimental studies are rare. In absence of them, relative data can be obtained by approximation: given that the slope of the natural clay strata support the waterways, it retraces that of the level terrain inferred from relief maps.

In this work, the students can take advantage of the advice from two expert hydrogeologists from Mantova.

To locate the wells and the sources of pollution, a general *expedition into the territory* is organised. The territory is divided into 10-12 zones of 3-5 square kilometres each, each zone is assigned to a squad of three to five students who comb it thoroughly to register possible sources of pollution, dumpings, and wells for drinking and irrigation water.

Finally, on the basis of the indications gathered during the field inspection, the map of *water sampling sites and the sampling plan* are prepared.

To achieve precision and efficient use of time, all students undergo strict *training*, both those involved in water sampling (three motorised sampling teams, two students each) and those operating in the various analysis laboratories.

Among the chemical labs, the *mobile* one is worth mentioning, set up in the territory under examination during the *analysis cycle*. A lot of energy is committed to training the data centre team (five students and two teachers), which is the focal point of the organisation, co-ordinating the various units and collecting analysis data during the study.

After the analysis cycle, generally accomplished in spring, the *data processing and elaboration* phase can begin. The results of the chemical, bacteriological and microplankton analyses are compared for an eventual interdisciplinary study. The work is concluded with a presentation of the results to the local administration, in a public lecture. Proper coverage is given by radio, TV, and the press to ensure adequate *publication of results.*

In the current WAP, the four schools mentioned previously participate each with its specific functions and a defined number of classes and teachers.

In total, for each analysis cycle thirteen teachers and twenty classes are involved for an approximate total of students varying between 300 and 350.

In the present version, in a day, the structure can gather and examine 45-60 samples for chemical analysis, 20 for bacteriological analysis, and 15 for microplankton analysis.

Results & Effects

In the panorama of results obtained in a study such as this, those which can be evaluated with the greatest precision must be distinguished from the others: the former more concrete, the latter more difficult to evaluate because they are connected with the maturation process of the students.

Among the objective results, the structure can reveal tens of thousands of analytical data, gathered over a ten-year period. Many reports connected with the interpretation of the increasing analytical outlines have ensued from the examination of the results, including some publications financed by various administrative bodies. The structure has furthermore produced a considerable number of documents, maps, charts, graphs, demonstrative materials such as photographs, slides, Super-8 films, video cassettes, etc. Particularly in its first years, the structure made frequent use of the mass media. Illustrated monographs pertaining to analytical interventions in the single communities were also produced.

Running down the list of the concrete outcomes, the following material constructed by the students and teachers of the Mechanics Course of ITIS can be mentioned: racks for deep and surface sampling, disks for measuring transparency, containers for microplankton, protective cages for thermometers, sample racks and protective covering for probes for measuring dissolved oxygen in water.

Qualitatively speaking, the most meaningful visual materials were produced by the students of the State Art School, the fifth school involved in the project. After setting up the great WAP exhibition at Mantova Mantegna's House in 1984, this school was charged with the production of the static iconographic materials (posters, brochures, etc.) as well as with the supervision of all the audio-visual material of the WAP.

Involving a highly professional artistic school allows us to obtain sure promotional and pedagogic results: in fact, aesthetically valuable images facilitate advertisement of the project and induces students to value harmony with the environment.

Among the results difficult to assess, we include the professional and pedagogical ones and also those which are related to environment defence.

Professional Results

At the end of the investigation, students master the planning and management systems of complex environmental research, analytical techniques, specific competence in aquatic analysis, and a fairly good ability to elaborate analysis data. Teachers acquire a remarkable managerial competence, deep knowledge about water systems, and, seeing their social role expand, they appear to gain great personal gratification.

Pedagogical Results

We acknowledge a lack of scientific indices to evaluate our students' pedagogical progress; however, a few details seem to be quite clear. First of all, the enthusiasm with which the research is prepared and carried out is demonstrated by the fact that:

- during analysis days at the end of sampling operations, the students in charge are allowed to go home, but it often happens that they stay on to help their fellow analysts carrying out longer analyses;
- on many occasions students work extra school time, for example at night or on holidays, to elaborate data or to prepare the final report;
- a good many former WAP graduates are still in touch with us, ready to actively collaborate in case of need.

The judgements that students express about the research are another reliable element for evaluation. They are positive or extremely positive, unanimously considering the research quite useful to their own development.

The WAP cannot boast of any miracle but can maintain that a great number of students have remarkably improved their communicative abilities and their self-confidence. Some of them have even discovered unexpected resources in themselves and have reached the conclusion that "When you work harmoniously you can obtain unhoped for results".

In any case all the students consider field work stages particularly gratifying, as they can act autonomously and responsibly, exploring the territory, interviewing the population, sampling or measuring.

Consequences on the Inner Environment (School)

As a consequence of the project, many barriers between specialisations have been lifted. Students, teaching and non-teaching staff work in an atmosphere of great cooperation, ideas are constantly flowing, catalised by the ongoing project, which enables us to use human and technological resources to the best advantage. The frequent contacts with outside institutions make the teachers' profession more varied and seemingly more exciting.

Consequences on the Outside Environment (Territory)

Unfortunately, and perhaps unexpectedly, we cannot report of any extraordinary results in the form of environment protection. After our analyses, no detectable improvement has been noticed on the water quality of the investigated communes. Only Bagnolo and Curtatone of the investigated communities have given the research due attention, successively installing sewers linked to water conditioners; the others have either buried the report out of short-sightedness or because they were scared of the serious findings (Roverbella) or discarded it owing to political crises (Castellucchio and S. Giorgio).

So the relationship with the local authorities develops in a linear way till the penultimate stage of the enquiry, when it reaches a standstill. The main cause of trouble is to be found in recurring political crises in communal administrations. Where that does not happen, fears and insecurities combine with the determination not to damage specific interests or to upset existing hegemonies.

In conclusion only a restricted minority of administrations seems to be able or willing to deal seriously with the data we supply in a socially useful way.

And yet, as regards environmental protection ours is not a bankrupt budget. By taking young people into the territory, we make them environmentally aware, more active, self-confident and open to communication and we teach them that humankind can modify itself and its environment (at least the inner one).

We feel sure that our students will take their new attitude into their working places or into universities and, should they have to make choices that affect the environment, we hope they will make environmentally-positive ones.

Conclusions

Reports about the conditions of social and natural balances are becoming more and more alarming; despite that, governments seem to be unable to elaborate a common strategy against pollution, and rather tend to allocate ridiculous fractions from national budgets to environmental protection.

Therefore schools are charged with a great responsibility, liable to produce anxiety and anguish. And one thing that students do not need is anguish. School teachers should never forget they address young people, teenagers full of fancy, energy and creativity, fond of play and amusement, but emotionally susceptible and easily influenced.

Environment protection is not to be considered a sort of war full of threat, but an adventure likely to give great intellectual stimulation to those who are involved, besides being useful in a pragmatic sense.

Then let us publicise E.E. In mass media, society slogans are used to lead ideas. The WAP slogan for the 1990s might well be: "Come on, folks, let's save the world; there's fun in it!"

Reference

OECD (1989) "Environment and School Initiatives - The Environmental Perspective", in OECD/CERI (eds.), *Environmental Education and Citizens of the Future*, OECD, Paris, in preparation.

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