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ABSTRACT

"Schools Ethics Technology" was a German interdisciplinary research project with the Centre of Ethics in the Sciences at the University of Tubingen. The project highlighted the new topic of biotechnology and genetic engineering, involving the formation of active project groups within schools. This study examined teaching activities within 10 project schools over 1 year. Researchers evaluated the role of project work in school development. Students in grades 5-8 and in grades 9-13 completed surveys. Researchers examined teacher portfolios and conducted participant observations. Results indicated that most students felt ill-prepared by the schools for responsible citizenship. Facts from the sciences were only made central in classroom work when they had gained specific significance with regard to a question or when they could be used to show the difference between empirical knowledge and ethical considerations. Verification experiments were only conducted in the classroom if students had discussed their worth and implicit meaning. The role of teachers changed in an analogous way during project work. All schools had difficulties planning and converting the ideas of developed understanding of science and technology into real classroom work. The main cause was the prevalent school culture. The researchers note the need to change school culture at all levels. (Contains 3 figures and 13 references.) (SM)

The Role of Research in School Project Work and Teacher Development: Results from Project „Schools Ethics Technology"

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1. INTRODUCTION

The general theoretical framework of our project „schools ethics technology" has been outlined previously (Schallies, Wellensiek & Lembens, this Journal). It represents an interdisciplinary research project with the Centre of Ethics in the Sciences, University of Tübingen as a partner. In this paper the focus of interest specifically is turned to teaching activities having taken place within the 10 project schools in the course of one year. The role of project work for school development was evaluated and will be discussed with regard to „appropriate understanding" of science and „school culture".

The project „schools ethics technology" is designed as a „mode of intervention": a pedagogic experiment which is programme and method at the same time. Programme in so far as from the very beginning the project itself is used as a source of authentic problems. Solving these problems for schools requires deeper levels of communication for all persons involved, across grades and subject borders, with external experts from research institutions, industry, organisations and parents that normally do not take place in routine school life. Participation in the project „schools ethics technology" was voluntary for schools. The decision of a school to write up an application for participation, the dealing with the special and new topic „biotechnology and genetic engineering" for school work, the formation of active project groups within schools, the mutual discussions of attainment targets with the school authorities, teachers and students, are all problems that require co-ordination. For students active participation was asked for and possibilities to put this into reality at different grades and different school types had to be considered (Wellensiek 1998). From the point of view of research it would be necessary to investigate which specific themes were finally chosen for teaching, which aspects of the theme were considered first in importance, which least and why?

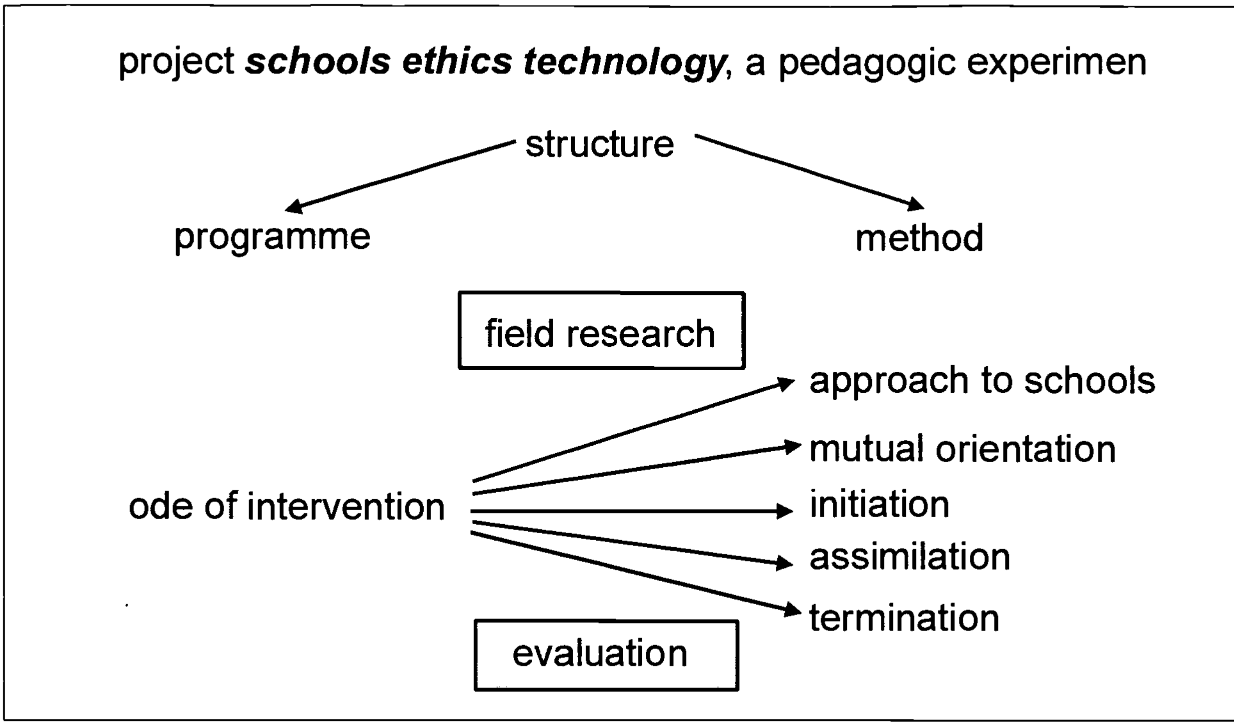

Figure 1: general organisation of school projects

Project SET can be looked upon as „method" also, since research into individual processes of construction of knowledge and development of understanding require the analysis of interaction in a „natural" environment. The applied mixture of research instruments, e.g. participant observation, questionnaires and interviews as well as the use of different sources of data will counterbalance the specific shortcomings that one method might have, and also give a new research focus, since the empirical verification of stages of development has become less important in research recently. Instead, the analysis of the processes that initiate developmental steps and explain them have become more important in research (Brumlik & Sutter 1996).

Approach to the schools (N=255) is the first phase of field research (Friebertshäuser 1997, p. 513) and was in all cases accomplished by the same letter of contact, which gave general information about the project and asked schools for a formal application if they were interested in taking part in the project work to come. In order to avoid preaffirmative responses and for methodological reasons, only the official ways of communication with schools via the respective directorates were taken, and not the presently used informal contacts to teachers. In the application form schools were asked, besides other more factual data, if they had any specific guiding maxim or ideal for their educational programme. A total of 45 schools responded initially. There was only one school which had maxim, giving itself the name „Friedensschule".

After the process of application and selection was concluded, it resulted in a group of 10 project schools, **orientation** was the next step. The most important aspect in this phase was the build-up of confidence between researchers and schools. In this phase there is uncertainty by all persons involved about the new roles that have to be taken. In order to make it easier for all, in-service training activities were organised, either at the university of education at Heidelberg, or in-house in different schools organised by Tübingen centre for ethics in the sciences. Special care was taken to outline the main aspects of the project: problem-orientated approach, interdisciplinary approach, preparation of science as a social system for acting, bring into consciousness the fact that ethical reflection is necessary and should be used purposefully for decision-making.

In the phase of **initiation** the researchers are taken to a test by active participants in the project work from the schools. Usually this is also a period which is decisive for progress or failure of project activities. During this phase the schools were approached by the research team to allow an investigation of students and teachers by questionnaire. This did not go unnoticed in the general public, and the Greens in Rheinland-Pfalz suspected some manipulative and suggestive activities by the research team in order to promote biotechnology / genetic engineering.

Assimilation is the phase, when the researchers are best integrated into the field. During this phase, work inside schools is greatest, it is also a period with intensive mutual work, conceptualisation and realisation of ideas and occasions for participant observation.

Termination is the last phase. Finishing project activities and evaluation of results are key issues. For the acceptance of results and considerations of further action to be taken in schools all results have to be presented and discussed with all the school conference. In order to do this, the research team prepared all data for presentation, triangulated in the interdisciplinary team from Tübingen and Heidelberg. For each school a final report was prepared, mailed in advance to the school and then discussed openly in a school conference.

2. GENERAL FRAME FOR PROJECT SCHOOLS

Each school had a definite contact partner from the interdisciplinary research team of SET responsible for all questions as regard to organisation, content dependant or methodical questions, co-ordination of activities, and as adviser for choice of external learning locations or other activities.

Each school was offered help with basic literature and publications on every theme relevant for the project work. Many of the materials were offered via internet to the schools. For those five schools taking part in the project work that did not have an access to internet, the research team gave support to obtain internet access by means of the special activities of the German Telekom Services.

In all schools the general aims of the evaluation by the research group and the legal aspects of data acquisition in schools were explained to school conferences. Also, different activities of in-service education in the course of project work were offered to schools: e.g. a choice of general lectures at the University of Education Heidelberg from experts for various disciplines, jointly organised with the academy for technology assessment of the state of Baden-Württemberg for one whole semester (Schallies & Wachlin 1999), range of in-house lectures, discussions and seminars from experts in the fields of biotechnology / genetic engineering and ethics that could be chosen from Tübingen according to school needs, special courses on the instrument „portfolio“ as well as roundtable discussions with one another and officials from the Ministry of Education of the State of Rheinland-Pfalz.

3. RESEARCH METHODOLOGY

Quantitative data obtained from 2 questionnaires for students (grades 5 to 8; grades 9 to 13) have been discussed in a preceding paper (Schallies, Wellensiek & Lembens, this Journal). Here we shall concentrate on qualitative data mainly, since the process of school development was in the centre of interest.

With regard to a qualitative research approach, we consider „portfolio“ to be a suitable instrument for the study of individual learning processes in a naturalistic context (Melograno 1994). In Germany, portfolio as a research tool is practically unknown. For the teachers taking part in project SET a special seminar was therefore offered to get them acquainted with "portfolios". Following the seminar, 15 teachers decided to prepare a portfolio for themselves.

Also, students of grade 12 of a gymnasium decided – after having studied a publication by Adamchik (1996) as an interdisciplinary classroom work with the English and biology teachers - to deliver individual portfolios on genetic engineering instead of having a written test at the end of the project work and the end of term. For this purpose, time allowed (five months) and criteria for assessment of the individual portfolios were agreed upon by students and teachers.

A total of 156 participant observations were carried out in the course of the project. Of these, 88 were obtained from a tandem of observers (pedagogy / ethics) and 62 / 6 from single observers (pedagogy / ethics) respectively. Also, 7 settings of class room activities were videotaped. All contacts by phone, all exchange of written materials and letters have been documented. Before starting on the evaluation process of the project, every researcher had to draw up an overview of all documents and research materials in tabular form. From these tables completeness of documents was checked by both work groups from Tübingen and Heidelberg. Missing documents were added reciprocally, before evaluation was continued.

Stages of qualitative analysis of content were as follows (Mayring 1996, Lamnek 1995a and b): First the material was looked through exploratory, not guided by any specific theory. This will give a first overview and point out categories for characterisation of individual cases. Second, specific materials are extracted for detailed analysis. These could be i.e. memos taken from a telephone call, photographs documenting classroom work, portfolios, transcribed interviews, specific sequences taken from video documentation, protocols of participant observation. This stage of evaluation aims at condensing the materials that are to be examined more deeply. For this aspect, the situation that led to the formation of the material has to be analysed. This can be done by including the information about the context of origin. The next steps would be to bring all observations and statements in chronological order, draw up an excerpt of content and classify and assess all the materials obtained by different investigation methods about a single school. This so far is done in each work group of researchers separately ("triangulation of methods").

In the following phase the results from both work groups are compared in a joint meeting and discussed until there is an agreement on the evaluation of the data ("triangulation of investigators"). The results will be summarised in a school profile, and are the basis for a final presentation and discussion with the school community concerned at the end of the project.

4. RESULTS

Participation patterns

Generally, it was difficult for teachers in project schools to work together interdisciplinary for a longer period of time. Rather small project groups resulted, and narrow interdisciplinary efforts were preferred to wide interdisciplinary efforts. The lowest rates of project activity were found in the classical German Gymnasium and in the comprehensive schools. Whereas the first finding could be attributed to rigid time tables and prevalent orientation towards final central examinations, the second finding is attributed to the sheer size of the comprehensive schools with up to 1700 students. Also, the classical orientation of schools as a collection of classes structured according to subjects and having a definite allocation of time from the overall timetable, has the effect that project work is seen as a disturbance of the normal course of work and an extra activity which requires extra work from the teachers. Hauptschulen and Realschulen are more used to project work and thus had less difficulty to integrate project „schools ethics technology“ into the normal school life.

Subject matter chosen by teachers

From the broad spectrum of specific subject matter inherent to biotechnology / genetic engineering schools have mainly concentrated on two topics for classroom work: „nutrition / gene food“ and „prenatal diagnostic / cloning“, i.e. „green“ (plants) and „red“ (man) applications of biotechnology / genetic engineering. Both choices are relevant to students themselves, are being critically discussed in public, but are also explicitly mentioned as possible topics for classroom work in the open curricula of the different Länder. From the orientation of students towards „biotechnology“ (see Q 9, Schallies, Wellensiek & Lembens, this Journal) and the sources of information (see Q 11, paper Schallies, Wellensiek & Lembens, this Journal) presently used by both teachers and students, these choices are obvious. Mostly, only students of higher grades had a say in making the choice for project work. Also, in most cases a leading role in project work was „naturally“ taken up by biology teachers, who generally had no difficulties in handling the factual aspects of the topics. The higher the degree in the education system, the more openly the concept of science being a system for production of factual statements and empirical knowledge was recognisable in classroom work, i.e. in ascending order Hauptschule – Realschule – Gymnasium. Corresponding to this unspoken but underlying “reduced concept of science” (Dietrich 1998), „education“ was seen as a product by the majority of the teachers from Gymnasium.

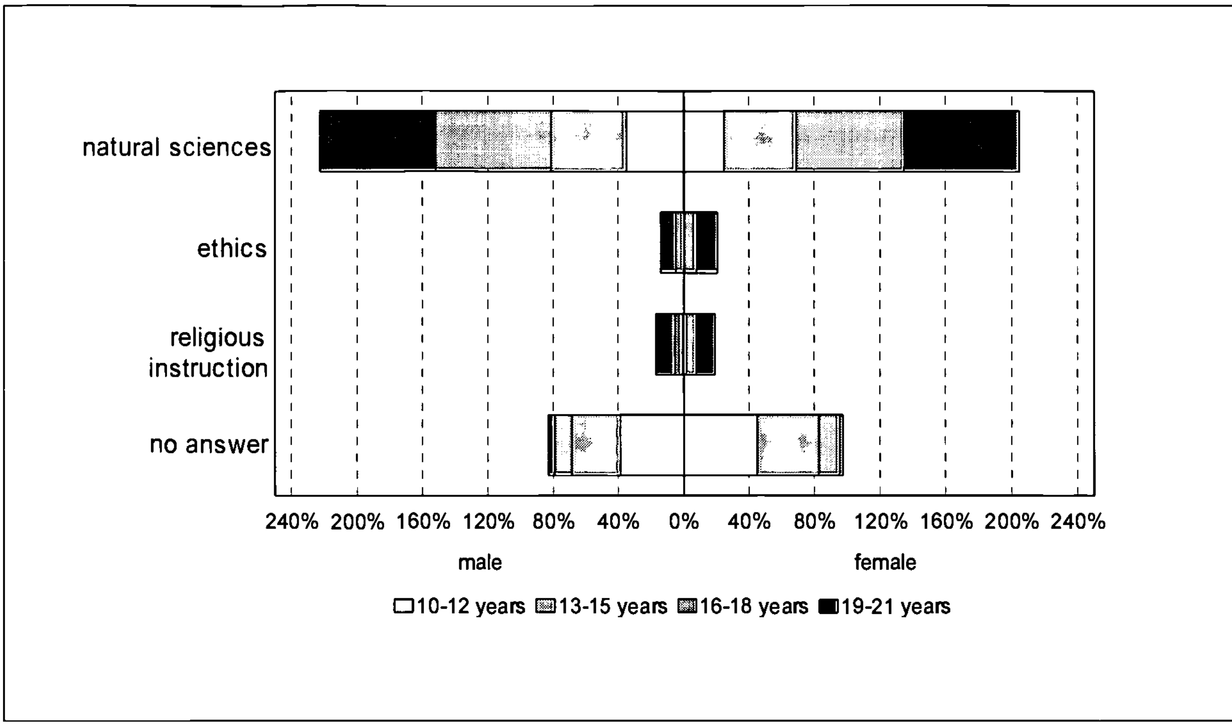

Figure 2: In which school subjects have you got information about biotechnology / genetic engineering already? (Q 12)

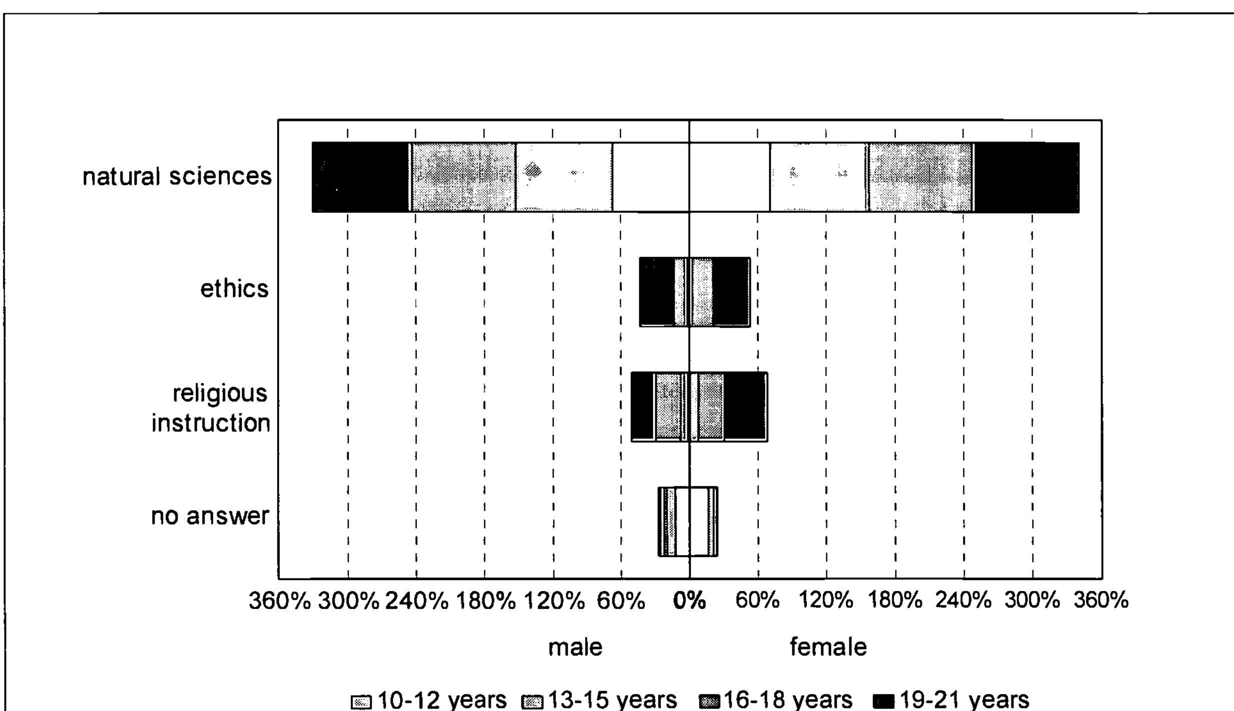

Figure 3: In which school subject should „biotechnology / genetic engineering" be taught? (Q 14)

Examples of project work

In order to give some insight into definite project work, one example of each school type of the differentiated school system is given below.

Hauptschule: Interestingly a Hauptschule, situated in a more rural area of the BioRegion, at first had declined to take part in the project. However, since the ministry of education was particularly interested that a Hauptschule should get involved, a small group of teachers finally decided to join in with grades 9 after an intervention of the headmaster. Preparation for project work took several months, filled with intense reflection before teaching was realised in well-suited and co-ordinated efforts across subject borders. Problems were accurately pointed out in teamteaching at the start of the project, worked out by students in project days, finally presented to the school community and evaluated. The topic "application of genetic engineering to the production of foodstuffs" was worked out with the help of discussions with external experts, visits to locations where foodstuffs were being produced (conventional and "bio"-farmers) as well as opinion polls carried out by the students in front of consumer markets in the vicinity. The topic "application of genetic engineering to man" was worked out by a small group of students, who visited a local company producing drugs for therapy and diagnosis by means of genetic engineering. In a discussion with the manager responsible for research and production the students had an opportunity to get acquainted with the views of a scientist. Finally, all the 9th grade students visited a large international pharmaceutical company nearby Mannheim. Besides getting to know strategies and aims of a company busy in a world market, students also got information about training and employment for graduates from secondary schools.

The evaluation of school project work unveiled again an interesting discrepancy between pedagogic intentions and motivation of students: teachers had arranged learning with a main focus on understanding and valuing in technology. Students however derived most pleasure from the correct reproduction of terms such as DNA, genome, anti-sense-technique. They found this to be a definite advantage in competence over their environment, e.g. parents and peers.

Realschule: At one Realschule there was at first only one teacher who thought to be able to teach project "schools ethics technology" - as one person - in an interdisciplinary way. After some ongoing discussions a team of four finally emerged. A concept for teaching was developed with a main focus on grades 8 and 9. A group of grade 9 students working on the topic "prenatal diagnosis" gave a lecture for the rest of the 9th graders taking on complete responsibility.

Students of grades 8 had a great interest in the topic "immunology" and formed a work group. In the course of a discussion with an expert from a company producing chemicals and apparatus for the measurement of immune activity, students decided to design and carry out an experiment in order to examine the effects of nutrition and a specific drug (echinacin) on their own immune system. An appropriate concept for teaching was agreed upon between teachers and the SET research team. In classroom work students had to work out the experiment independently, e.g. decide on the formation of test groups and control groups, draw up nutrition plans for the duration of the experiment, get permission from parents for the taking of blood samples, get expert advice on the design of experiments involving humans, get the company's support for the blood analysis etc. The experiment was finally carried out and the respective immune systems were analysed during a day-long excursion to the company. During this visit, students could execute practical labwork on genetic engineering under authentic conditions, i.e. experiencing the safety standards, work regulations and conditions for work in an industrial laboratory, where knowledge about biotechnology is being produced and applied. A few days after the visit the students received the results of the analysis from the company and had to interpret the outcome of the experiment.

Grammar school: Two special subject classes grade 13 (ethics and biology respectively) in a grammar school in a highly industrialised region decided to join the project work. The topic was dealt with in regular classes and special activities after school. Central in the project work was the decision-making on the choice of a topic itself (genetic engineering and foodstuffs), mutual reflection on appropriate arrangements for learning, and the planning, organisation, carrying-out and assessment of a panel discussion with experts.

In this school, the reflection on the use of school kits for experiments in biotechnology / genetic engineering was most remarkable, as classroom work turned into an interdisciplinary debate between students and teachers being experts in biology and laymen in ethics and vice versa. Also remarkable was the fact that some students evaluated the data obtained by a questionnaire from the plenum of the panel discussion. One of the students acquired deeper knowledge of statistics in the course of evaluation, and made use of her new skills to write an article about the evaluation of project work in the periodical "Ethik und Unterricht".

5. DISCUSSION

If one agrees that appropriate understanding of science should incorporate the different levels laid down in the definition of our work group, then project work to develop understanding of science should be organised such that students can find answers to an open question or a real problem. In modern technology assessment it is presupposed that technology can be shaped only if there is consent between the different groups in society on the aims. It is also presupposed that consent cannot be reached on a factual basis alone. Instead, the different value considerations present in individuals have to be taken into account. Therefore, in the process of decision-making one must find ways to bring into the open usually unspoken-of underlying value considerations. The way to do this is a problem-orientated approach.

From the results of questionnaires on VOSTS- statements it is also apparent, that a great majority of students see their role as future citizens exactly in this way. Results from questionnaires also point to the fact, that in this respect students feel badly prepared by schools. It is our firm conviction that the starting point for improvement cannot lie in science education alone, but has to change "school culture" as such. In project "schools ethics technology" we have looked upon schools as pedagogic units and tried to make central the following considerations:

Facts from the sciences like biology, chemistry, the theologies, ethics were only made central in classroom work when they had gained a specific significance with regard to a question (e.g. which tests and investigations are carried out in a prenatal diagnosis?), or when they could be used to show the difference between empirical knowledge and ethical considerations. This approach is necessary in our view, since traditional science teaching generally fails to achieve "realistic" views on science and technology. Also, as can be seen from the results of questionnaires, in no single case categories like "social context" or "ethical reasoning" have been mentioned in the open questions on technology, biotechnology or genetic engineering.
Verification experiments in the classroom were only carried out, if students had discussed their worth and implicit meaning (e.g. use of gene kits). We strove for "real" experiments like e.g. opinion polls on gene food, investigation of students` immune system. Such experiments are full of problems that require discussion of alternatives and informed decisions. Often, there are moral problems: e.g. how does one handle the problem with students that no longer want to take part in an experiment although the experiment is still going on and the results might be questioned if somebody terminates it prematurely? Such problems have to be solved by finding mutual consent in class, and are ideally suited to develop moral.

When no experiments in the classical sense were possible, specific attainment targets were agreed upon for project work. Usually, they had to be presented to the school public. In order to work on a problem, it was usually necessary to consult external experts or visit external learning locations. Since science is a system for social acting also and scientific literacy is a prerequisite for communicating knowledge, students of upper classes had to address scientists and experts on their own, e.g. in the course of preparing a panel discussion or excursion to an industrial manufacturer. Many teachers in the project were afraid that such activities took too long a time or were not carried out properly if they had to be arranged by students and not by themselves. Since the development of abilities for understanding and acting can only be acquired by working and acting independently, at least the same attention should be given to such tasks. Indeed, one should look upon them as educational processes that complement and make secure factual knowledge.

The role of teachers changed in an analogous way during the project work. The incorporation of external experts into teaching and the allowance of scope to be able to develop competencies is not in correspondence with the traditional role of teachers as a foreman / forewoman. Instead, highest professional competencies are needed, if project work is not to end in unproductive "laissez-faire". In the ongoing project work with schools the changing role of teachers was experienced as difficult and challenging for both teachers and students, but they stated also that they gained a lot from it.

All schools had difficulties in planning and converting the ideas of developed understanding of science and technology into real classroom work. Main cause is the prevalent "school culture" (Holtappels 1995): sequenced learning in a tight schedule of a 45 minutes periodicity and teachers being accustomed to teaching facts and figures from their pre-service training as experts for a specific subject. Both teachers and students are well adapted to this system, have developed coping strategies for school life, and students are especially content with marks obtained in return for learning in such an environment. This automatically has the consequence that process orientated learning across subject borders in a project is perceived as a severe disturbance. Teachers taking part in project work under such circumstances often get into a position where they have to apologise for their engagement and the „inconvenience" they cause to their colleagues. In most cases new forms of learning, incorporation of external experts into teaching, project work only have a status of being tolerated. This position is usually taken up by the headmasters also. At present, a change does not seem to be possible, since discussions on schools projects or exchange of minds on fundamental pedagogic positions rarely take place in routine school life.

From the situation outlined above, reflected by project schools of our project „schools ethics technology“, we are convinced that the educational aim „understanding and valuing new technologies“ can only be reached in an effort to rearrange school culture at all levels. The first step would have to be the realignment of „organisation culture“. Teachers must co-operate and mutually agree on general educational aims and specific attainment targets, that should be achieved with new teaching methods at the levels of grades and classes. However, the greatest problem for schools is to develop a clear perception about what this general aim could be on their own. In this respect the project "schools ethics technology" showed to have a great potential for a changeover. For most schools the public presentation of results at the end of project work was an impulse for a „pedagogic stock-taking“. This could be the starting point for a general change of internal processes to alter school culture (Steffens 1995).

Trying to change school culture without support from the outside is practically impossible. A key role can be attributed to the internal school management and the headmaster. Schools are effective in reform when reform processes initiated by individuals are combined with measures to give symbolic and practical acknowledgement by the internal school administration.

Generally, the still dominant model of teaching in secondary schools with a definite role taking as master and apprentice must be changed. Teachers also should say a goodbye to the idea that complex problems could be dealt with in class if and only if the „foreman“ has all facts and information ready-made in bits and pieces that can be swallowed easily.

We are aware that models to develop „school culture“ like the professional development school approach (Ungaretti et al. 1996) are extensively being discussed and evaluated in the English speaking community. Evolution is the preferred way to try to make teaching and learning more effective with regard to the requirements of a modern technology driven society. Project „school ethics technology“ could be looked upon as a first step in the direction of professional development school, appropriate to the traditions and structures of the German school system. We are positive that the potential to solve demanding tasks in classroom work is present. However, the impulse from the outside and the continuous support for the process of development is essential. Some schools will continue to co-operate in the work we have started with the project. To say it in the words of a student (individual portfolio, grade 12; f): ...“*one was really on ones own, also with regard to initiative and individual action, necessary prerequisites for taking up a job later or going to university. In short: it was stress and unusual, but I found it to be a very good change to routine school life. This time – not only because the subject was of pressing importance at the present time - we had not learnt for school, but for life!*“

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Sincerely,

Brinda L. Albert

Brinda L. Albert
Program Assistant