## Preface State Secretary Dr. Uwe Thomas

Dear Readers,

"What helps girls is also good for boys; unfortunately, the converse does not apply". This basic principle for teaching physics formulated by the lecturer in physics teaching methods, Martin Wagenschein, 30 years ago still continues to have effect today.

When we consider today how we can increase the proportion of women in computer science, engineering and science, we find that: the more attractive courses are made for women, the more women opt to study them. Numerous model trials nationally and regionally show that with innovative forms of teaching and learning in schools and universities we can appeal to women in respect of science and technology and win them over to appropriate courses. This then also benefits those men for whom science and technology – contrary to all prejudgement on the grounds of gender – are not automatically an open book. Applied in this way, gender mainstreaming becomes an impetus and driving force behind course reforms in computer science, engineering and the sciences. How these driving forces can be utilised and "opportunities generated by a new diversity in higher education and training" can be progressed was demonstrated at the conference organised jointly by the Federal Ministry for Education and Research and the Bund-Länder Commission for Educational Planning and Research Promotion (BLK) at the Deutsche Museum at the beginning of February 2002.

There, specialists, both male and female, stressed that the differences between boys and girls regarding choice of school-leaving exam subjects – differences which are already detectable at school – and also handling computers and the internet have an effect on choice of subjects to study. Many young women restrict themselves to quite a small number when considering their choice of career, i.e. to just 13 of over 300 possible occupations. The majority of women continue to study German, languages or education, whereas men enrol for mechanical engineering, electrical engineering or physics. As a physicist, the subject of physics is of particular concern to me. Here in Germany, we have a particular shortage of women interested in the subject. In the year 2000, for example, only 4% of girls qualified for higher education chose physics as a subject in the school-leaving examinations and unfortunately physics is still one of the subjects in higher education with only a small proportion of women students. Whereas the proportion of first-year female students in mathematics is already over 50%, their numbers in physics represent only 21% of total student numbers. The percentage of those women dropping out of first degree study or changing to other courses is twice as high as that of men. In other disciplines, too, for example in computer science, more female students than male ones drop out from their studies. Here we have to look for the reasons and, above all, draw conclusions from the situation. Our society must seriously consider the question as to whether it can afford not to utilise the potential talents of qualified women.



Here, the universities above all come into question. In the framework of the Bund-Länder Commission for Educational Planning and Research Promotion, the Federal Government supports the universities in numerous model trials in creating appropriate new courses. I think, however, that in spite of all the effort made we are far away from the objective of rapidly achieving a "critical" mass of women students in the classic science and technology subjects. I would therefore encourage the universities and the colleges for applied science to offer specific courses for

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a few years, for example women's courses or courses with mono-educational units. I would be more than pleased to support higher education establishments which are interested in getting active along these lines on their own initiative.

It is gratifying too that more and more companies are adopting the idea of smoothing the path for women into technological and scientific fields of work. This is increasingly being reflected in corporate policy, when equality of opportunity is viewed as a central management duty. In practice, that may mean, for example, supporting the partner of a woman graduate in seeking work or offering appropriate child care facilities.

Many projects initiated by the Federal Ministry for Education and Research show that it is possible to arouse the interest of girls and young women in the sciences, technology and computer science. A few examples: The multimedia planning game "Job seeks me" enables exciting job information to be called up with the greatest of ease. A great number of contacts with companies and with young women in the field of IT can be made by means of the campaigns "Be.ing – in future with women" and "Be.it – be a computer scientist".

The "Join-In Projects", such as the nation-wide "Girls' Day, Future Day for Girls", which was initially held as a pilot project in April 2001 in the field of IT and this year has been extended to other areas of activity throughout the country, represent a special presentation. On May 8th 2003 girls will again be able to visit companies for a whole day, where staff will provide information on jobs and training opportunities, job prospects and salary ranges.

The presentation "Over the Horizon and Beyond – Women in Aviation and Space Travel" held by the Federal Ministry for Education and Research in Berlin at the beginning of May 2002 was very well received among young women and had over 1,300 enrolments. The participating women obtained information on and discussed the course of their education, the practical job and how it can be reconciled with the desire for children with famous female specialists in aviation and space travel.

This documentation from the international conference presents innovative models and examples of best practice from the school and university sectors. These have achieved success through appealing to the target group, through didactic measures and/or changes in the content and structure of teaching and study. Perspectives which could enhance the competitiveness of German industry and science in international terms are examined in the joint discussions between male and female delegates from industry, science and politics.

Our objective is and will remain to fill more girls and young women with enthusiasm for the sciences and technology and to motivate them to opt for education in those fields of work. This is an essential prerequisite for obtaining well qualified staff for the knowledge-intensive services and jobs of the future.

Dr.-Ing. E.h. Uwe Thomas
State Secretary



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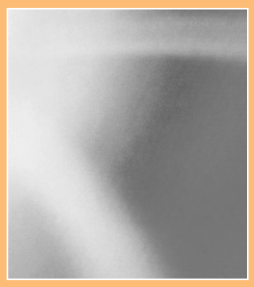
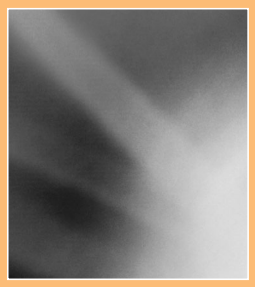
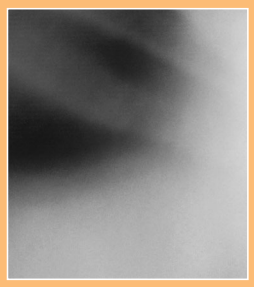
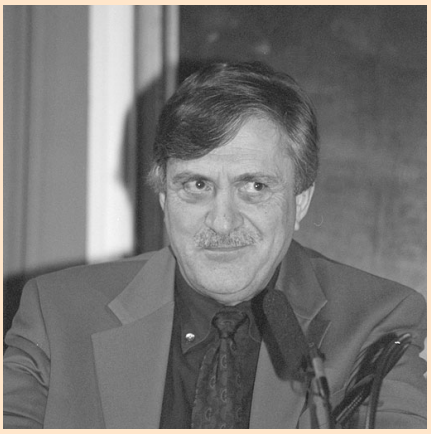




# Welcoming speeches



### *Prof. Dr. Dr. h.c. Wolf Peter Fehlhammer*

*Prof. Dr. Dr. h.c. Wolf Peter Fehlhammer is General Director of the Deutsches Museum. He is certified chemist and was appointed to a professorship at the University Erlangen-Nuremberg and the Freie Unversität of Berlin. In 1993 he was appointed honorary professor at the Ludwigs-Maximilians-University of Munich. Fehlhammer was awarded the Carl Duisburg Prize and the International Prize Primo Rovis for the propagation of the scientific culture. He is the immediate past president of the European Collaborative Science, Industry and Technology Exhibitions (ECSITE).*

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### *MinDirig Jürgen Schlegel*

*MinDirig Jürgen Schlegel, born 1945, is General Secretary of the Bund-Länder Commission for Educational Planning and Research Promotion. He has graduated in law at the University of Cologne. From 1975 to 1990 he worked in the Ministry for Science and Research of the State NRW e.g. in the spheres of university planning, research promotion and teacher further training. There he was member of the Study Reform Commission 'Economics'. Schlegel was furthermore member of the German delegation in the Committee for Education of the European Community. .*

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## Welcoming Speech by the General Director of the Deutsches Museum Prof. Dr. Dr. h.c. Wolf Peter Fehlhammer at 01.02.2002 in Munich

Welcome Ladies and Gentlemen,

It falls to me to commence proceedings and I do that by warmly welcoming you to the Deutsches Museum for this high-level conference. At first sight, the invitation to say a few words of welcome seemed to be the usual expectation of the host to meet his "director's breakfast duty".

At second glance, however, the Deutsche Museum was suddenly enormously involved. There is an absolute parallel, indeed congruence, between our objectives, our strategies and also our analyses. So I shall take advantage of the moment to tell you something about us !

First of all, however, to be quite official: I am pleased and proud that you are holding your international congress in the Deutsches Museum.

### Lively exhibitions with an integrated success feedback

In the same breath, I can confidently assure you that you have chosen wisely. Indeed, you could not have found a more appropriate location for your concern with discussing the future prospects for engineering and science education for young people and society as a whole and seeking models and best practice examples. The Deutsche Museum has always tried to follow new ways of presenting science and technology and to provide the exact opposite of "frontal teaching" and "top down instruction", namely emotional, haptic , cognitive - by all means lively and active exhibitions with an integrated success feedback. In contrast to schools and universities, where a state of emergency is constantly being declared, you will never have heard of museums of science or technology, proceeded by such a concept, being subject to such crises !

But, of course, you can't leave it at that. Technology and science have changed and are changing more and more rapidly, not only in terms of range and scope but also in their essential structures: "big science", interdisciplinarity, lifelong learning, globalised industries are the catchwords. The "substantial" progress still euphorically celebrated around 1900, has also raised deep-seated social problems. We have to promote an understanding of science and technology, in the awareness that not everything should be done that is scientifically possible. The Deutsches Museum is in the process of adapting its presentation concept to the new millennium.

So we intend to move away from the traditional subject boundaries in engineering and science and to provide a more interdisciplinary presentation. We wish to integrate social aspects more closely.

Over and above our central function of presenting science and technology in exhibitions, we have been engaged in the subject of "future education in science and technology": for some time we have dealt intensively with the important problem as to how we can make science and technology more attractive for women. From initial conferences in the 80's, through specific exhibitions to our special events "Women lead Women" and "Women's Weekends", we are trying to find new ways - just as you are trying at this conference - , sometimes successfully, sometimes there is a lot to learn of others as well.



We also have realised that we will have to make special offers to women if we want to win them over to fields, which are apparently not very popular, such as physics, mechanical engineering or electrical engineering. We therefore try to involve women more closely in planning new departments - in particular in senior positions. The very masculine, so male-dominated Deutsche Museum now has two female directors !

### Science and technology "edutainment" for girls

I believe, that we have to begin still much earlier in addressing specific groups. Our family weekends, for instance, are very successful: parents and children explore the Deutsche Museum together. This should be extended into regular information and education events providing science and technology "edutainment", especially for girls. How can we appeal to them in particular? Surely not just with textile technology or ceramics, in accordance with the traditional image of women! What about mechanical engineering? This could be done using a narrative element: telling stories. What specific resources - books, media, etc. - can be recommended, how could they be edited or prepared, for example for age groups under six years? This would probably warrant a project itself - provided financial support could be obtained for it.

What we are already doing is extending our increasingly successful children's birthdays by specific events for girls - for instance, an imaginary flight. Our "Children's World" is a larger-scale project. In the first weekend of March in Advent 2002, a science and technology "playground" for children is to be opened here. "Children are researchers" writes the artist and project leader in his Children's World brochure and on the next page it says "Researchers are Children". How true! This exhibition is designed to interest the children in other features of the museum, in fact with the help of their ....mothers ! This means we have envisaged a new target group, that was rather ignored as yet. Indian educationalists and museum staff called our attention to this and it is only too logical: mothers are subject to endless questioning, by which the youngsters learn about the world.

Other campaigns are successful too:

- the series of events on the topic of "Girls into Research"
- an EU project already in its second round in which we "measure" the interest of girls in I- and K- technology, in conjunction with museum partners in Helsinki
- or the Dutch project "Technika 10- technology for girls" by Mieneke Knottenbelt, which has run very successfully for a long time, to name just a few.



**"Children are Researchers - Researchers are Children"**

Apart from these campaigns, we believe that a large potential number of young people also has to be introduced to science and technology in a different way - via their social and cultural significance. I read with interest about an exercise in the famous PISA-Study, which was designed to test the problem-solving behaviour of young people. Evidently a Waterloo for German schoolchildren. I shall present one exercise of the study as an example: in the 19th. century Dr. Semmelweis in Budapest had investigated the so-called childbed fever, an illness which carried off large numbers of women after childbirth in the clinics. This story is told in the exercise and then two graphics are shown, presenting the numbers of fatalities over several years in sections 1 and 2 of the university clinic - there are consistently more deaths in the first than in the second and the initial question is then: why on the basis of this graph, did Semmelweis immediately discount one of the theories of the time that earthquakes were responsible for the origins of the fatal disease?

This exercise required no calculation, nor recalling previous knowledge. Rather it implies the usefulness of scientific, methodical procedures for mankind, for example as here in ascertaining the causes of disease. However, behind this lies the realisation: science and technology are created by mankind, for mankind, and they flourish only in a particular cultural environment. Of course, responsibility plays a big part - or should do so. Society must ensure that.

To address all these problems we need new ideas and new ways to find solutions! In this respect, we are naturally very interested in your results.

I wish you every conceivable success for this important, excellently attended conference, which comes at a very appropriate time.

# Welcoming Speech by the General Secretary of the Bund-Länder Commission for Educational Planning and Research Promotion (BLK) MinDirig Jürgen Schlegel at 01.02.2002 in Munich

On behalf of the two chairmen of the Bund-Länder Commission for Educational Planning and Research Promotion, Frau Bulmahn, Federal Minister and Herr Zehetmair, State Minister, I welcome you most warmly to the conference "Future Opportunities generated by Diversity in higher Education and Training". They wish every success for the conference and regret very much that they are unable to take part personally in the discussion.

The aim of this conference is to demonstrate ways and means, above all by presenting and discussing examples of good practice, of attracting more young women to engineering, science and information technology courses, including those at our universities in Germany. The objectives of this congress fit in with a policy followed by the BLK for well over ten years aimed at improving equality of opportunity for women in science. In the framework of the BLK, the Federal Government and the states have for a long time been working towards structural changes aimed at sustainably achieving equality of opportunity for young girls and women at school, at work, at university and in research outside universities; they have also provided substantial financial resources for this purpose:

I would mention in particular the large number of BLK pilot projects for providing, on one hand, better access to the new information technologies for girls at school through specific forms of learning, and, on the other, creating better opportunities for access to appropriate courses in the university sector.

## BLK - Pilot projects to achieve equal opportunities of girls and women

In the 90's, specific measures were supported in almost all the federal states, among other things to improve access to science and technology courses for women, firstly in the Hochschulsonderprogramme II and III (Special University Programmes), jointly funded by the Federal Government and the states, later through the Hochschulwissenschaftsprogramm (University Science Programme) from 1999 on.

In the last decade, awareness regarding support for women in science has intensified through reports and recommendations, mandatory annual reports by universities and extra-university research institutions, the appointment and employment of women in scientific establishments and the requirements of funding decisions: the participation of girls and young women in education in some cases now exceeds the demographically expected level. Girls and women are no longer under-represented in schools and universities as educational establishments, although there are still subjects and courses, in which selection behaviour is quite obviously gender-specific.

In general, much has been achieved. The education system has made great progress; however, the job market – whether public or private – is still lagging behind. This is shown by our surveys of appointments and employment of women at universities and in extra-university research establishments, by reports by the Federal Government and many state governments on equal status for women at work. We still have much to do, not only fom the viewpoint of the basic right of equality between man and woman but also from the aspect of our social development. Allow me to expatiate a little at this point. The Bund-Länder Commission for Educational Planning and Research Promotion concentrates in its work on the further development of our education, science and research systems; in so doing it attempts to plan the development of education in tune with financial necessities and possibilities in employment, economic and social policy. In October, the BLK forwarded its report "The Future for Education and Work" to the heads of government – national and regional – for their decision, in fulfilment of this function. This report makes plain the far-reaching changes in store for our society over the next 15 years.

Even if we cannot believe it – given the current figure of around 4 million unemployed – the demand for labour will increase and in certain areas there will be a shortage of skilled labour relatively soon. Our society is getting older; this not only means that people lost to the workforce can be replaced only with great difficulty, sometimes not at all, by young men and women new to the job market, but also that the proportion of older people in work is becoming greater and greater. Shortages will occur in science-based and engineering jobs; information technology training will pervade all qualifications and will determine new occupational images.

We can no longer afford to waste the potential that young women have for these occupational fields. We need this potential for the general development of our society, that is, not only should they be recruited for education in these fields but also be enabled to correlate family life and profession. For it is clear that – in tapping the full potential of qualified people – we neitherless have to ensure that there is no break in the sequence of generations. This is a topic of the utmost importance, affecting both men and women equally. For that reason, I am a little sad to see so few male faces in the auditorium.

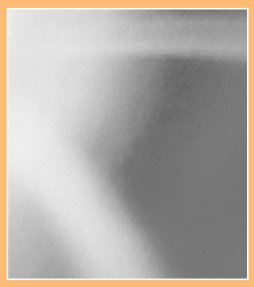
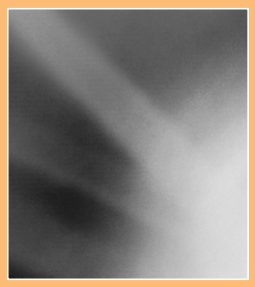
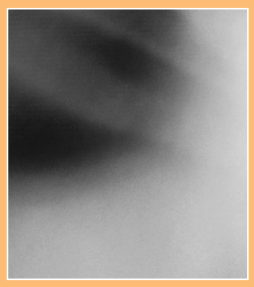
**Profiting from the potencial of women for the general development of society**

BLK committees are at the moment discussing the draft of a report "Women in Engineering and Science Courses, particularly in Computer Science", which uses current data analysis to describe the need for action and tries to come to various conclusions and recommendations for the school and university sectors.



I am glad that the conference is taking place just now, because this provides a chance that mutual dialogue support the government side in its decision-making regarding further measures for improving conditions for equality of opportunity for women in the study of computer science, natural sciences and engineering courses in Germany. I would invite you to express your views on the draft report , which is available outside the hall.

With this in mind, I wish your conference every success and, for us in the BLK, insightful and knowledgeable comments on the draft report.

# Programme

**Survey of the lectures, panel discussions and the supporting programme of the international high - level - Conference: Future Opportunities generated by Diversity in higher Education and Training – Gender mainstreaming as an impetus and driving force behind the course reform in computer science, engineering and natural sciences on February 1st | 2nd, 2002, Deutsches Musuem, Munich**

## Friday I 1.2.2002

**18.30 - 19.00** **Welcome greetings** | *Prof. Dr. Dr. h.c. Wolf Peter Fehlhammer, MinDirig Jürgen Schlegel*

**19.00 - 19.30** **Gender differences and gender arrangement in industry and administration – a future model for university education?** | *Prof. Dr. Sibylle Peters*

**19.30 - 21.00** **Panel and audience: Aim "diversity" – New target groups for universities and companies**
*Prof. Dr. Monika Bessenrodt-Weberpals, Prof. Dr. Moniko Greif, Dr. Peter Ramm, MinDirig Jürgen Schlegel, State Secretary Dr. Uwe Thomas, Chair: Dr. Jeanne Rubner*

**21.00 - 22.00** **Reception and light refreshments** | *State Secretary Dr. Uwe Thomas*

## Saturday I 2.2.2002

**9.30 - 10.00** **Initiatives of the Federal Ministry of Education and Research for a new diversity in computer science, engineering and natural sciences** | *Veronika Pahl*

**10.00 - 10.30** **Technological Competence: Educating girls in the new computer age. Results of the Tech Savvy-Report**
*Sharon Schuster*

**10.30 - 11.15** **Programme of the Federal Government and its Länder: Increase in the efficiency of maths and science lessons – experiences with the concept "Special support for girls and boys"** | *Prof. Dr. Manfred Prenzel*

**Successful co-educational and cooperative concepts for a higher degree of equal opportunities in mathematics at secondary level** | *Dr. Eli Eisenberg*

**Girls and physics – Co-education in science lessons** | *Mag. Helga Stadler*



**11.15 - 11.30** **Break**

**11.30 - 12.00** **Latest developments in the number of young people studying computer science, engineering and natural sciences**
*Martin Beck*

**Prospects for new target groups in scientific and technical disciplines: Are there new standards with regard to their content, structure and sphere?** | *Karl-Heinz Minks*

**12.00 - 13.00** **Lunch**

**13.00 - 14.00** **Poster Session "Reform projects at university level and diversity approaches in companies"**

**14.00 - 14.30** **Bund-Länder Initiatives on Gender Mainstreaming within course reforms** | *MinR'in Barbara Hartung*

**14.30 - 16.00** **International and only for women: Computer science at the University of Applied Sciences, Bremen**
*Prof. Dr. Axel Viereck*

**Industrial engineering and its new look – Do "old" target groups also need new choices?** | *Prof. Dr. Petra Jordanow*

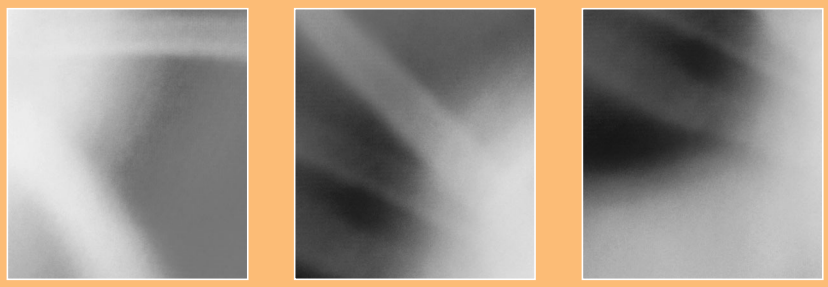
**Transforming the culture of computing** | *Prof. Lenore Blum*

**New target groups for higher education. Experiences from curriculum reform processes at three institutes of technology in Sweden** | *Assistant Prof. Minna Salminen-Karlsson*

**16.00 - 16.30** **Break**

**16.30 - 18.00** **Panel and audience: Diversity and equal opportunities at school and university – Creative approaches and clearly defined benchmarks in computer science, engineering and natural sciences**
*Hans-Jochen Lückefett, State Secretary Dr. Wolfgang Meyer-Hesemann, State Secretary Dr. Uwe Thomas, Prof. Dr. Margret Wintermantel, Chair: Ranga Yogeshwar*

**18.00 - 18.30** **Conclusion**



# Providing impetus and profiting by it

***Universities [have] a mandate from society to actively participate in creating fairness between the genders, to give impulses for the transformation, modernisation and democratisation in the relationship between the genders and to moderate the change.***

*From: Heike Kahlert. Wissenschaftsmodernisierung durch Frauen- und Geschlechterforschung - Impulse für die Reform von Studium und Lehre* [1]

The title of the conference "Future Opportunities generated by Diversity in higher Education and Training" documented here is called "Profiting by impetus". This slogan was borne from the thought that there are already impulses for this new diversity: various programmes at schools, universities as well as companies at home and abroad have motivated girls and women for technical and science subjects and jobs. Already at the specialist conference "Women's Courses of Studies in Engineering and Computer Science - Opportunities for the Future" in 1999, sponsored by the BMBF, promising approaches were presented in the higher education field. Now it is important to utilise these impulses, to learn from the best-practice concepts presented in the following sections and to further develop these ideas.



The papers in this section are intended to give a first insight into the current political efforts on the Federal level, as well as the historic/theoretical perspective.

Prof. Dr. Sybille Peters considers the promotion of women not an issue purely for women but an integral part in the process of change and the modernisation of organisations in administration, commerce and industry. Women's ideas about different forms of organising their lives, their work and learning should be represented in the new management strategies in Human Resources and organisational development. There are three rather participatory, global strategies that are the drivers and prepare the path for equality and equal opportunities: Gender Mainstreaming, Diversity Management and Change Management; the underlying principles of these strategies should also be applied in higher education. These principles would enhance a greater utilisation of the diversity through students and teachers and to improve the quality of higher education, research and university management.

The idea of Gender Mainstreaming is further pursued by Veronika Pahl. Gender Mainstreaming does not mean promoting women but "designing measures in accordance with the requirements of all involved". The reforms developed on the basis of these ideas do not only benefit women, who may experience a stronger appeal through the training of key competencies and through the practice-orientation. They also benefit male students who will be made fit for the requirements of industry and commerce. At the same time, the capability of the different faculties to maintain relevance for the future as well as the competitiveness of companies is secured. Pahl gives a documentation of the many initiatives of the Federal government at schools and universities, implementing approaches to Gender Mainstreaming in practice. She appeals to the Federal and State administrations, to industry and commerce, to schools and universities to further strengthen the cooperation in order to achieve a broad multiplication effect from these existing impulses.

[1] Paper given at the Karl-Franzens University, Graz on 22nd November 2000

# Discourse on Gender Differences and Arrangements in Industry and Administration – A Future Model for University Education ?


***Prof. Dr. Sibylle Peters***

*Prof Dr. Sibylle Peters is professor at the Institute of Education of the University of Magdeburg. Her special field of research relates to women in executive positions and the development of junior staff for executive functions, development of services and changing requirements in respect of qualifications and competence. Further topics are: links between work and learning (using the example of placements), socialisation in education and at work, specialist-house training and the development of regional networks. Prof. Peters graduated in sociology, education, adult education and economics.*

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The gender debate is a debate of the post-modern age and no longer raises eyebrows – that women and men have equal rights is common property today. Viewed historically, society uses the difference between the sexes to structure their social and cultural roles and thus to control arrangements that have evolved in society. However, these are increasingly giving rise to the need for discussion and action, as women actively devote themselves to the modernisation of social spheres and demand recognition of their worth. These considerations, in turn, do not stand in isolation. The gender debate has at present many plural advocates of the modern age, who take it as "paving the way" in language, values and rules for dealings in organisations and institution and so use it to push forward with their agenda. Various forms of demand for recognition characterise discourse in the gender debate and its ideas on arrangements between the sexes. [1]



Equal rights, or, more precisely, equal status between the sexes, is in fact a self-evident matter and yet: discourse, the active (expressed) presentation of various demands for recognition through equal rights, equal status and equality of opportunity, has not just increased over recent years but has become more complex. More and more facets are emerging from new forms of improvement in society – put another way, they are actively incorporated in the discussion of various demands for recognition. How these discussions develop as discourses within organisations and institutions in business and administration and how various aspects are taken up will be examined in the following. Finally, possibilities for transferring this discourse to the field of higher education will be examined.

## Social Policy Frameworks

Various changes and transformation processes are reflected in the transition from an industrial to a service society in different discourses. One matter of concern for society is to influence these debates, if possible through disciplined control, in such a way that possibilities for development and existing conditions are both satisfied equally. The risk society endeavours repeatedly to develop new

[1] Cf.: Peters/Bensel (Ed.): Frauen und Männer im Management. Diversity in Diskurs und Praxis, 2nd ed. Wiesbaden 2002.

possibilities of control in various sections of society for this purpose. And more and more complex forms of intensification and structural links are repeatedly offered as new control models to be negotiated anew between various sections of society. In general terms, it is again and again a matter of theoretical and practical attempts to understand the unstable modern age reflexively and make available new options for "reasonable" structuring steps to deal with the future in various sections of society.

Discussion of gender difference and arrangements is included as part of the varied forms of discourse in society. The questions involved relate to equal rights, equal status and equality of opportunity, as for example in publications on the subject of women in executive positions. In recent years, the topic of women in executive positions[2] has been driven forward by numerous "pioneers" and "pacemakers" for processes of change in social policy, in society and in business in various expert reports on modernisation. Developments in the law, in the form of expert reports on the relevant legislation in Europe and the USA, play an important part as "pioneers" for these discussion processes. Various laws relating to equal status (which will be looked at later) have contributed appreciably to the fact that gender mainstreaming and also managing diversity and (to an extent) change management are accepted as important current management strategies, where the question of women in executive positions in business and administration is concerned. Encouragement and support for women has become an essential part in organisational development.



**Promote new forms of linking work, life and learning**

The world is no longer a unit as it was in the time of the industrial society. It is subject to constant change, becoming ever more complex, more heterogeneous and enters into ever more complex alliances with intensified forms of bundled functions in society. Questions of gender and equal status are part of forms of progression in society and promote new forms of linking work, life and learning. They thus contribute to a situation where:

- women were never more qualified than they are at present,
- women were never more motivated than they are at present,
- women were never more prepared to take on responsibility at work than they are at present.

Yet women remain under-represented in executive positions in business, administration and science.

## Encouragement of Women is Nevertheless not a Matter for Women

In the spirit of the times, discourse on questions of equal status and equality of opportunity encounters questions of structural change , at the heart of which lies change in organisations of administration and business, recently in higher education too. Equal status options are no longer to be seen as lying outside organisations and their control processes. The future includes seeking structural principles, which demand more autonomy for individuals and sections in organisations and which stress plural, interactive forms and can create new forms of thinking. For the spirit of the times also includes measuring the present against the future and not against the past.

Equal status and equality of opportunity are part of various developments and interlinkings and support for women is not a matter for women in these. Expert reports on modernisation in relation to processes of change take up new forms of structuring equal rights, equal status and equality of opportunity at ever higher levels of deduction.

## Expert Reports on Modernisation as Precursors

Three modernisation developments in particular have come to the fore as worthy of discussion and discourse and are now treated as expert reports on modernisation acting as social pioneers and precursors.
These are:

- expert legal report(s),
- philosophical reports on reason and their differentiation between plural rationalities in processes of change and transformation,
- gender mainstreaming as an expert report on organisa tional development

[2] Höhler: Wölfin unter Wölfen. Warum Männer ohne Frauen Fehler machen, Munich 2000.

Krell: Chancengleichheit durch Personalentwicklung. Gleichstellung von Frauen und Männern in Unternehmen und Verwaltungen, 3rd ed., Wiesbaden 2001.

Rühl/Hoffmann: Chancengleichheit managen. Basis moderner Personalarbeit, Wiesbaden 2001.

Lehnert et al : Männer, Frauen und Frauenförderung. Frauen und Männer an der Uni MS, Muenster 1998.

All reports are based on the premise that state and politics are re-defining their functions within transformational and organisational developments in organisations of business, government and, increasingly, higher education. That is, the state is increasingly drawing back from its functions, for example making provision to provide appropriate living conditions for its citizens, and is leaving it to the protagonists concerned to undertake new functions and arrangements (e.g. independent designs for modern ways of living, working and learning) under their own initiative.

To manage these – historically – new social processes in self-regulating fashion, therefore, it is now necessary to take account not only of what has always been there and is familiar. It is now necessary for everyone in their section of society, in organisations and institutions to take part in active (verbally) discourse and debate with each other the direction of their intentions for change and development possibilities, applying rules set by themselves.

The rule or the code for agreement is that differences and diversity in society are perceived as the new and different by everyone. Accommodating difference and diversity presupposes that no new functions can be developed and new arrangements negotiated without looking out for the interests of others, because otherwise there is no one there prepared to accept these.

In organisational development there is a common code that equal status and equality of opportunity come in plural form and can be structured. This common code is essential because it is common property. It feeds on the certainty that in business, for example, economic action alone does not promote innovation any longer. It needs to be complemented by interactive factors, which are able to provide the resource of people as human resources. Of course, not all management and organisation development strategies use elements of social, communicative factors in change.

### Administration of Justice as an Expert Report on Modernisation in Respect of Gender Difference

Awareness of gender difference has developed particularly through the wording of acts passed in recent years.

**legal equality**

1918: women s suffrage
1919: equality regarding civic rights and duties

**equal opportunities**

1958: law of equality:
a.o. abolishment of the husband s right to cancel the job of his wife if she is working
a.o. abolishment of celibacy clause, according to which women could have been dismissed, as soon as they got married and permanent supply was ensured
1993: amendment of art. 3, para. 2 of the constitutional law:
[a]Women and men are equal. The state promotes the actual equality of women and men and works towards abolishment of existing disadvantages

**equivalence**

1997: law of equivalence in North Rhine Westphalia (was accepted by the European Court of Justice)
1997: Amsterdam Treaty for adjusting disadvantages in career amongst the numerically inferior sex within the framework of the Gender-Mainstreaming-Approach = recommendation (1998 ratification in Germany)
1999: European charter of basic rights for adjusting differential interests of member states(a.o: protection against discrimination), consultancy paper
1990 — 2000: E-Quality-Guidelines: to meet EU-EST-Postulation
2001: Federal Law of Equivalence (at: Federal Council)
1995: USA: Affirmative Action: equal deal with all employees concerning target and time arrangements at a company in order to desist from unwanted discrimination

**Fig. 1: Laws concerning legal equality, equal opportinities and equivalence**

### The Expert Report on Modernisation: Good Sense and Plural Rationalities

As long as the world was viewed as one unit in the industrial society, the relationship of work and life was structured through the state's provisions for living. The state endeavoured to stabilise the living conditions and ways of life of its citizens in employment relationships as normal working conditions. It did this with the resultant specific consequences for the organisation of working and family life and with the professional career paths for men. This separation of work and life was taken as reasonable and could lay claim to universal validity. The employed status of the man as the normal circumstance was protected by social security provisions. This was viewed as the general condition, to which relationships between life and work and any special circumstances arising had to be subordinated. This also meant that the general, the familiar and the controlled had currency.

Further developments and discrimination of the particular for the good of the general were consequently also to be embedded in the central idea of state provision. The difference between general and particular has not yet been made in the concept of reason. In the industrial society a number of "rationalities" were not recognised to apply side by side and so were unable to lay claim to be valid. Social developments are today becoming ever more complex, heterogeneous and asynchronous; normal life patterns, too, break up as a result of temporary unemployment, changes of job, and so on. Conflicts between the rationality of the universal and the new rationalities, which are also laying claim to validity at this point, are increasing in number. The new also demands equality and recognition.

Following the transformation from the industrial to a service society, it is important to be aware of new ways of life and of work and to accord legitimacy, i.e. validity, to them. As these arise in plural form, given the heterogeneity of possible forms of them, it is not only one new form of way of life and of work, which has to be recognised but a plurality of new developments, which demand the recognition of various forms of rationality. Impartiality between the industrial society's idea of reason and the new rationalities of the service society as an unstable ultra-modern age requires many new pluralistic central ideas. The various groups in society should be able to find their way to each other in these. Discourse must be used in society to negotiate the rationalities which are to enjoy society's approval.



**Modernisation Expertise – Gender Mainstreaming**

This links organisation and gender with each other. The state is withdrawing from the control of various sectors of social life. This can be seen in the organisation of the infrastructure in the postal service, the railways, health service, education, and so on. Likewise, it is increasingly withdrawing from control of social provision (e.g. the relaxation of wage and career regulations) and is leaving the development of new functions, arrangements, etc. to self-regulation by the protagonists and NGO's formed by the protagonists.

The EU states have united on a transnational basis in the gender mainstreaming approach. The decisive regulation is that organisations and institutions in public and private spheres are able to give themselves options. Indeed, this includes the question as to how they wish to deal with the commonly held view that in law women and men are equal, have equal rights and are of equal worth. However, as this general view is present neither in relationships of life or family nor in employment relationships, the protagonists will have to think over and negotiate arrangements for themselves in discourse between them. They have to consider how they can make the existing segregated forms of women's work of equal value (job pyramids in favour of women) and give them equal status with the normal work relations of men. This – as the basic idea behind gender mainstreaming has it – is a matter of organisational development processes.

**Recognise women's conditions as forms of work with equal rights**

Conditions and forms of work for women in gainful employment are to be accepted and fostered as work conditions of equal status. Women are increasingly demanding recognition of their segregated conditions of work as new forms of the organisation of the relationship of work to life, which are becoming ever more evident in the service society. The concept and management strategy of gender mainstreaming reflects this.

At present, these new employment conditions come up against the current controls on the normal work and career relationships (based on working conditions for men). However, the tempo and explosive growth of the service society demands and promotes the development of new ideas on the organisation of the way in which life, work and learning mesh with each other, ideas which are seen as reasonable and are put into practice in life.

It no longer seems reasonable to separate life from work and employment and family. Many skills and abilities from everyday life come into play in many new job situations in the service society, for example when advisory functions, process controls, developments in network organisations are called for. Professional and private life often interlink in such cases and this increasingly brings recognition of and equal status for new relationships between work and life. The fundamental idea of the Amsterdam agreement on gender mainstreaming is to arrange and control this through discourse.

### Awareness and Acceptance of the New

Awareness and acceptance of the new develops as a code via various rules. All three expert inputs outlined earlier – are adopted asynchronously and sometimes only partially in business and administration organisations. However, since this is a matter of the common property of the equality of men and women, these fundamental ideas are accepted everywhere. This body of thought finds an entry into organisations and institutions via specific rules or a specific code, depending on what in the individual case is deemed reasonable, what the organisation is prepared to accept and negotiate in verbal discourse as the new, the different.

The way this happens in business is that the economic code, which has been concerned exclusively with the transfer of money, is obliged to open out to the new non-economic and participative management strategies, if new outlets are to be held or found on the global market. Business opens up to non-economic forms of exchange through organisational development. It opens up to strategies based on a communicative and non-material direction of resources by bringing in human resources as a competitive factor side by side with or within the economic code of money.

Business is consequently opening up to new forms of arrangement, in which new forms of organisation of the relationship of work, life and learning are (have to be) taken into account. This has to be done, if social human resources are not to be sacrificed. It is also opening up to non-material forms of arrangements and links in participative management strategies, in which the various protagonists intervene in the rules of the economic code, make differentiations within it and extend it, all on a self-regulating basis. The old economic code is modified as an important factor for success through staff development. New forms of work relationships are pressing for acceptance and awareness of the difference between the familiar and tried and the new and different. The economic code of the transfer of money and products can no longer ensure innovation potential and creation of value on its own. Accordingly, organisations in business and administration are holding discourse as to how acceptance of the different can be achieved in order to avoid disadvantaging the other, the different. This includes discourse as to how women view their ideas on various forms of organisation of the relationship of life, work and learning and how they can assert these.

Women lay claim to recognition through:

- equal rights,
- equal status,
- equality of Opportunity.

## Global Management Strategies

Three global management strategies take up part of these discussions and inputs or are pioneers and precursors, which are gaining influence in organisational development concepts and strategies. These are:

- gender mainstreaming,
- diversity-management,
- change-management.

| spheres of action: | administration/ communal sector | global acting companies | companies in transformation process |
|---|---|---|---|
| | Gender Mainstreaming | Diversity Management | Change Management |
| actors: | organisational development + women's representative | human resources departments/ management | organisational development (a.o. management consultancy) |
| target groups: | women | specific groups of employees and women | management (selection) |
| instruments: | national supportive instrument at administration, commune, etc. | supportive instrument of global companies with heterogeneous/ plural staff | often temporary Instruments of professionalisation of non-economical core competencies |

**Fig. 2: Participative management strategies**

### Higher Objectives

New forms of work, amongst other things, are being tried out with new participative management strategies by taking account of ways of life and privacy in working and employment conditions. The three participative management strategies mentioned adopt the idea – with varying intentions –of taking account of overcoming gender dif-

ference in their organisational development processes. In so doing, difference and arrangements are interwoven , simultaneously and with each other, in new combinations of rationalities in specific forms each time, applying the code of equal rights/equal status and equality of opportunity. Within these strategies, it is left to individual businesses to decide how they in their company code approach awareness of the other in their corporate cultures. [3] Overall the situation can be summarised as follows: Life is no longer an appendage to work and work which does not include social, non-material human resources aspects can no longer be innovative and competitive. [4]

**The Strategy "Gender Mainstreaming" in Agreements on Objectives and its Instruments**

Gender mainstreaming is seen as an approach to organisational development based on the European legal initiative of the same name.

Gender mainstreaming

- has as its objective the category "gender" as a sectional category in all restructuring and transformation processes,
- focuses on maintaining and negotiating impartiality between the sexes in governmental and administrative structures,

- aims at dismantling existing segregation in female job markets (incl. equal pay),
- demands recognition that the worlds in which the sexes live are different,
- aims at fostering "neutrality" in State Government and countering male-dominated objectives in state provision for living and functioning,
- questions the power structures inherent in the hierarchies of organisations and administrations,
- proceeds on the basis that work and decision-making structures differ according to gender in terms of internal hierarchy and proximity to customers and are linked to decision options and career paths.

The most important instruments of gender mainstreaming include:

- laws or quotas promoting equal status,
- agreed objectives,
- instruments for staff development,
- measures for providing qualifications.

In detail, these are, apart from the forms and legitimisation provided by equal status laws:

- supervision by audit systems and certification of these as supervision systems,
- mentoring programmes and networks,
- private-public-partnerships.

Staff development programmes, including controlling procedures, comprise:

- incentive systems for staff and organisations (external/internal),
- remuneration systems,
- working-time and part-time work models.

**The Strategy "Diversity Management" in Agreements on Objectives and its Instruments**

As a management strategy, diversity management has its roots in the USA on the basis of the legal initiative of Affirmative Action (=> Table under Expert Legal Report) and aims at preserving diversity in difference and accepting it through equal status for the other, the different. This includes, among other things, support for women within various global strategies but above all the equality of different races and people of different origins. In this context, it is a matter of differentiating between equal status and equality of opportunity in various new combinations and progressions. These take on importance in company codes in corporate culture in relation to the aspect of identifying non-economic negotiation and exchange processes, i.e. the code also takes account of and complies with aspects of equal status and equality of opportunity. Aspects of the development of human resources are thus included in considerations relating to economic calculations and are combined in new synergies with other factors to give improvements in innovation performance.



[3] Companies are increasingly presenting their corporate culture on the internet and so also present their objectives regarding equality of the sexes and equality of opportunity.

[4] In the service sector work and professional activities are increasingly merging in forms of activities such as advising, coaching, assisting, etc., because these activities demand not only a basis of specialist knowledge but also a considerable measure of deep knowledge of life and everyday living, i.e. everyday experience and scientifically gained concepts fuse.

Outside Germany, diversity management is practised in globalised companies with administrative overheads, in which businesses feel obliged to adopt fundamentally transnational cultures.

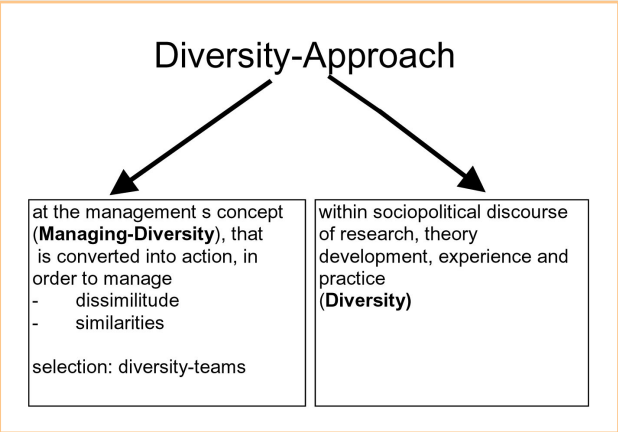


**Fig. 3: Diversity-Approach on management and sociopolitical level**

On the basis of the structural options in affirmative action, agreed objectives and topics of concern have to

- create conditions, in which all employees are able and wish to develop their efficiency and enthusiasm without restraint,
- accept protection against discrimination as a responsibility of organisations and their personnel administrations in respect of every employee,
- accord equal treatment to specific employee groups, i.e. allow for the different interests of each individual and group by using instruments which meet these respective interests and needs,
- integrate all employees within organisational development and culture – plans for support and for career development are part of integration strategies and of dealing with under-representation,
- prevent discrimination – this can be done through representation of various employee groups according to position and function.

The most important instruments include:

- diversity-audits,
- target agreements,
- remuneration systems,
- staff development instruments.

Staff development instruments include in particular those which take account of difference of gender, origin, race and age and other secondary criteria.
These secondary criteria in differentiating between groups are increasingly becoming the focus of staff development and measures for providing qualifications for staff, which take into consideration varying views on language, education and culture and, in particular, varying ideas regarding individual structuring of the link between forms of life and work. These are probably the touch-paper for the future development of human resources.

### The Strategy "Change Management" in Agreements on Objectives and its Instruments

This is a collective term for heterogeneous strategies, which as a whole take up change as an organisational and sociopolitical issue. Change management focuses on extending processes of change through aspects of more intensive concern with human resources, as these have not hitherto been given the necessary attention and businesses have been cautious about participative strategies for change.



Within these strategies, one concern, among others, is to get associations or alliances of companies to adopt standard, globalised business processes in the fields of IT, purchasing, trading, logistics, etc. in order to ensure the survival of businesses. Connected to this are integrated personnel programmes, which require in particular timely information, elucidation and career development within human resources strategies. Reliance is placed on a "new" expert knowledge to manage change through control of human resources and to widen the view of previous technical key skills (relating to the economic code).

This management strategy is directed, without explicit recourse to legal reports at:

- integrating staff development programmes into transformation processes so that the workforce is informed in good time of change/transformation/ mergers and can gear their own interests (internal/external) to these, and
- promoting staff development programmes for women's human knowledge potential through a knowledge management process geared to equal status.

The most important instruments include:
- agreements on objectives,
- new staff development instruments,
- motivation and incentive systems (not remuneration systems but systems aimed at influencing motives for actions).

## Future Model for University Education?

What chances discourse has of driving forward commonly held views remains an open question and will not be discussed here, but the question that is raised is whether these models, both in respect of their differences and of their common ground, can be transferred to university education.

The three dominant management strategies reflect a new understanding of the economic benefit of human resources in that, as well as economic factors, they now also take account of non-economic aspects, which mirror the importance of human resources. They represent new "rationalities", that means that there are no longer only traditional forms of social provision which are acceptable.

As well as traditional career patterns and employment conditions tailored to men, new claims to validity are now taken into account in discussions of and discourse on equal status and equal opportunities. Not only women are the focus of people-oriented considerations: other primary criteria (age, race, origin) and scarcely perceptible factors such as lifestyle, education, language and cultural values are now important and lay claim to validity in work and pay systems. In particular, the secondary criteria can be used for transference to university education, i.e. be discussed in that context too.



The four secondary criteria – lifestyle, education, language, cultural values – are differentiated through plural forms of attitude to life and work. They provide impetus and momentum, from them top-down models for management level are developed and passed over for testing in bottom-up initiatives by teams to construct varying forms of employment and life. Diversity teams are assigned to staff development for this purpose, for example. Expert legal reports are not directly available but are integrated in all forms of progression and assume preventive, open-structure functions within the planning and commitment incumbent upon organisations in the framework of agreements on objectives. This applies to the appropriate areas in the business world and can also probably be transferred to university education. Common to all strategies is that the difference of the different from the existing, the well-known and the familiar has first to be worked out before the offensive can be taken in structuring a joint, united approach.

If this is applied in outline to university education, the challenge is to develop codes in the models for organisational units of the university (i.e. faculties/institutes) and provide instruments within the study and examination regulations as options, which promote awareness of the difference between secondary and primary criteria within the student body. They would be subject to the proviso that features such as discrimination, inappropriate selection, etc. are avoided by taking account of the diversity among the students and not regarding the student body as one group en masse.

Secondary criteria, such as lifestyle, education, language and cultural values, are in all probability different at some point, for example, if the life of courses were to be "dissected" and the interfaces between the sequences taken into account, or , for instance, compulsory courses were to be examined for their "parroting of technical facts", with which selections between groups of students are made. Another example would be the essential laboratory phases under xy-conditions with yz-requirements, which in turn are linked to selection examinations, or again the practical phases, which can only be completed in technical departments under wx-conditions.

For awareness of diversity, the following measures would be helpful:

- audit procedures in laboratories,
- prizes for faculties which assign inter-disciplinary topics for dissertations,
- benchmarking workshops between comparable institutes of various universities organised by one institute using procedures it selects itself,
- self-marketing by faculties/institutes in non-technical presentations, assigned by the vice-chancellor as a marketing strategy,
- invitations from faculties one to the other to events presenting distinctions in the model for the university in question and concentrating on specific institutes, laboratories, etc.,
- presentation of final results under E-quality criteria as examples of best practice,
- bringing schools "into the network" (this is already known but there is no organisation development and therefore in my view has no effect on its own). These are some suggestions for accommodating the different, i.e. different conditions, different cultural and social actualities, which perhaps lay claim to recognition at some point. Nonetheless, it is a matter of attentiveness to differences, the varying ways of looking at the social realities of a world, in which differing ideas of lifestyle and cultures are at work. University education must not be left out of this.

# Initiatives by the Federal Ministry of Education and Research for a New Diversity in Computer Science, Engineering and Natural Sciences


***Veronika Pahl***

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"Future Opportunities generated by Diversity in higher Education and Training – Gender mainstreaming as an impetus and driving force behind the course reform in computer science, engeneering and natural sciences". The lecturer in teaching methods in physics, Martin Wagenschein, formulated the thought lying behind the title of today's event 30 years ago as the basic principle for teaching physics: "What helps girls is also good for boys; unfortunately the reverse is not true." When we consider today how the proportion of women on science and technology courses can be increased, however, not only women benefit from doing so – the appeal of courses is enhanced for all students. This is the essence of gender mainstreaming: the optimisation of political measures aimed at making equality of opportunity the basis for all policy and purpose of all those responsible. The spotlight is not merely on encouraging women but also on gearing measures to the needs of all concerned.



**What helps girls is also good for boys**

***Martin Wagenschein, Lecturer in Physics teaching methods***

In December 1999 a meeting of specialists from the Federal Ministry of Education and Research considered the topic of "Women's Courses in Engineering Sciences and Computer Science". The measures for higher education reform taken and completed in the meantime, which were originally intended for the encouragement of women, show that they do not only benefit women. Such measures also enhance the quality of courses overall. The thrust of our conference today is therefore intentionally more broad-based.

The perspective has also been widened. Not only colleges and universities but also schools are now closely examined, because the decisions on subject options are taken on that level. Even if many school students of both sexes are still undecided shortly before or after their A-levels as to which course of study they should follow, their predilections and preferences for particular subjects develop throughout their schooldays. They are influenced by – amongst other things – lesson content, quality of teaching and also by individual teachers. An early start must therefore be made if subject options are to be guided in any way.

But why do we want to win over girls and young women to science and engineering courses anyway? First and foremost we wish to get them to fulfil their potential in individual abilities. They have talents in the area of science and technology but often do not make the most of them. At the same time, a glance at the present and the future labour market shows what opportunities there are for women.

## Trends in the Labour Market

The labour market over the next few years for female and male graduates in engineering and sciences is marked by two trends, which both point to the fact that an increase in the proportion of women in these areas is urgently required and desirable.

The German economy records an increasing demand for technically qualified staff and managers, which the German labour market cannot meet in the foreseeable future. The shortage of qualified staff is already resulting in bottlenecks now and this situation is expected to intensify further. The innovative capacity and competitiveness of companies and other organisations are constrained by this, which is something we cannot afford in the light of advancing globalisation. Our economy is short of raw materials and is dependent on human resources to a particular extent.



A new trend has indeed already appeared in the numbers of first-year students: more applicants are again opting for the sciences or engineering. However, the numbers of graduates are still lagging far behind future demand. The proportion of women among graduates in engineering sciences has indeed risen from 13.5 % in 1993 to 19.2 % in 2000 but it is still low, particularly in terms of international comparison. According to the OECD-study "Education at a Glance" carried out in 2001, Germany's percentage of women graduates in engineering sciences lay at 18% below the OECD-average of 22 % in the year 1999. It does not look much better in the subjects of physics and chemistry. We must ask ourselves in all seriousness whether our society can afford not to make full use of the potential talents of a large group of the population – women.

Apart from this quantitative component, it is also necessary to look at what demands will be made in future in respect of the qualifications of engineers of both sexes. Qualifications required are now already different and far more complex than 30 years ago. In many areas, a technical education alone is no longer enough. Key qualifications of a social, linguistic and organisational nature are required. Teamwork in projects is especially important for prospective engineers and for scientists, independent of their gender. The complexity of world markets, social relations, economic objectives and ecological parameters increasingly demand inter-disciplinary thinking and action. This trend will continue in the future as a result of increasing globalisation of the economy and greater and greater customer-orientation on the part of companies.

However, this also means that the opportunities for women in these professions will increase, because as a rule they bring the qualifications demanded in greater measure than men do. Women prefer inter-disciplinary approaches and enjoy working in small laboratory groups and projects. Their language skills are extremely useful in using the media, in structuring internet entries for projects. Communications and co-operation skills are normally found to be greater in women than in men.

## Aims of the Reform in the Teaching Area

Two objectives, which will be of concern over the next few years, thus become clear:

- to recruit more girls and women for science subjects in order to make the most of a wider potential talent,
- to reform education so as to provide the qualifications required by the labour market.

Two birds can be killed with one stone with these reforms, which are aimed at greater emphasis on applications, inter-disciplinary approaches, internationality and imparting key qualifications: the future of the subjects is ensured and at the same time these new course contents appeal to more women.

## Reasons for the Low Percentage of Women

To attract more women, it must first be asked why so few women have been interested in professions in science and technology up to now.

In recent decades, girls have caught up with boys or long since overtaken them in formal final examinations. Women make up 55.2 % of school-leavers with university entrance qualifications. However, clear differences are

found between girls and boys in respect of subject options even at upper school level. Physics is by far the most unpopular subject, followed by chemistry. Only 4 % of girls with higher education entry qualifications chose physics as an A-level subject, but still 28 % of boys.

**Study of engineering lies far from the thoughts of technically gifted women**

The thought of studying engineering is completely foreign to most women even if they describe themselves as technically and practically gifted or as having a technical-mathematical bent. In these groups especially there is a potential for scientific-technical study which has not been exploited to date.

What is the reason for this? Studies show that women, in choosing a profession, give clearly more consideration than men as to whether they can also reconcile family life with their future career. Given the still generally male-dominated job patterns in scientific and technical professions, the choice is then clear. The teaching profession, for example, presents a considerably better opportunity to reconcile work and family. Therefore, predominantly women are found in it.

Course contents taught in schools and colleges often put girls off. The didactic methods are still mainly tailored to what has been up to now a predominantly male target group. Applications-led approaches and project work are deferred until later semesters. For this reason, many young women give up as early as the first semester and choose a more applications-related subject.

In schools, too, studies and experiments have shown that girls can be better enthused in respect of technical and scientific topics by using new forms of teaching and learning. Graphic experiments based on everyday life, interdisciplinary approaches and teamwork on projects can be of influence in getting more girls to opt for science sets.

## Initiatives by the Federal Government

We must begin at the two interfaces discussed earlier – reforms in the area of teaching and presenting future-oriented job descriptions. It is the aim of the Federal Government to increase the percentage of girls and women in the technical and scientific subjects and to open up professional fields with a future for them. A series of projects has already been carried out in recent years. The Federal Government has introduced a wide range of measures to encourage girls and young women to take an interest in technical and scientific professions.

kompetenzzentrum
frauen in informationsgesellschaft und technologie

The Federal Ministry of Education and Research and the BMFSFJ fund the Centre of Excellence "Women in the Information Society and in Technology" at the Technical University in Bielefeld, the function of which is to assist in increasing the participation of women in science and engineering courses and professions and also in computer science. The centre supports women in taking an active part in shaping the information society. Networks, organisations, associations and companies are included in this venture. A wide variety of projects are designed to motivate girls and young women to acquire an interest in technology and the new media.

www.kompetenzz.de

In addition, the aim is to awaken receptiveness among girls to scientific subjects, in particular to the new information and communication technologies, for example through the following projects:

Be.ing In Zukunft mit Frauen

be.it

The information campaign for female engineers "Be.ing – in Future together with Women" has helped in getting women to take up engineering and information technology courses by introducing new models and innovative courses. In similar fashion, "be.it" has been promoting the study of computer science since 2001.

www.be-ing.de
www.werde-informatikerin.de

The project "Do.ing" is aimed at winning over schoolgirls in the catchment area of the Technical University in Aachen to take science and engineering subjects during their school years and then supporting them in their higher education. The proportion of women in the subject area of mechanical engineering has been doubled to almost 14 % as a result of this.

www.do-ing.rwth-aachen.de

In the framework of the "initiative D21 – Moving into the Information Age", projects have been developed in conjunction with leading companies in the IT field to increase the proportion of girls and women in qualified posts and courses in IT. For example, the "*Idee*_**it**" project supports the training of young women in the four new core computer professions and in modern media jobs. At the same time, the project presents and disseminates examples of best practice in the sphere of home-based work and the establishment of innovative companies.

www.initiatived21.de

The project "Girls @D21" provides placements for schoolgirls to give them an opportunity to obtain an insight into the everyday work of a female IT expert. Similarly, women teachers of information technology are familiarised with the practice and new forms of work in the IT field in the project "Teacher@D21" by shadowing women IT-specialists in their working day.

www.girls-d21.de

www.teacher-d21.de

The mentoring programme "Muffin 21" is supported by female managerial staff from companies in the initiative D21 and female students of information technology. Female students and junior female scientists are also given the opportunity to become familiar with the research workplace in industry. In the specialist and personal care of a female mentor, participants plan their future career in the course of their studies.

The "Girls Day" was held on a national scale for the first time on 25th April 2002. It had already been a great success as a pilot project in April 2001 (limited to the field of IT). The aim of the "Girls Day" is to organise visits by girls to companies, where they obtain information on working and training in those companies and on job and earning opportunities. The response to the day, which followed on from the American "Take-your-daughter-to-work-Day" was tremendous. More than 42,000 girls and 1,200 companies – including many well-known German companies – took part. The Federal Institute of Employment and the German Federation of Trade Unions were also closely involved.

www.girlsday.de

Young girls still at school are introduced to scientific and technical fields of employment on a broad basis:

The multi-media business game "JobLab" enables young women to call up information on new fields of employment presented in an exciting format and very easily accessed.

## Approaches to Reform in Schools

Apart from leading them towards appropriate jobs, it is also of great importance to arouse the interest of girls in technical and scientific topics as early as their school days. Suitable didactic concepts are required. In the framework of the BLK-model programme "Improving Efficiency in Teaching Mathematics and Science" (SINUS), the Federal Government and the Federal States place the main emphasis on developing concepts and materials specifically for supporting girls in mathematics and science teaching. Proposals are developed for applying co-education intentionally. This approach is based on the observation that school teachers are more prepared to accept change in lesson content than a change in their own behaviour patterns which scarcely take account of girls.

The aim of the project planned "Chemistry in Context" is also to win over more girls to the study of chemistry by using inter-disciplinary approaches and applications-led experiments.

www.chik.de

In addition, many of the Federal States are taking separate initiatives to make science teaching more interesting and suitable for girls as the target group. Baden-Wuerttemberg, for example, regularly holds a "Girls and Technology Day", on which professional women from commercial companies and associations report on their everyday work, their education and training or their personal situation at their workplace.

www.maedchen-technik-tage.de

Berlin schools have been given the opportunity to teach science and technology to girls and boys separately so as to be able to take better account of the particular interests and needs of girls. Hamburg has set up an "experimentation field in the science and technology centre", which is aimed at familiarising younger girls in particular, but also boys, with scientific and technical developments and phenomena in a relaxed play-like manner. Sachsen-Anhalt organises summer schools in technology for girls and supports sponsorships with universities and polytechnics. Similar initiatives are also running in Thuringia and are supported by the co-ordination centre "Science and Technology for Schoolgirls".

## Approaches to Reform in Higher Education

Much has also been done over the last few years in higher education to increase the appeal of courses to women. In the meantime there is a wide range of promising strategies and approaches and of exemplary developments in many Federal States.



The resources provided jointly by the Federal Government and the Federal States in the framework of the University and Science sector of the programme "Equality of Opportunity for Women in Research and Teaching" specifically support this development.

The introduction of the new degrees of Bachelor and Master creates new incentives to study engineering. Over a third of new courses already set up come from the engineering sciences. Structural reform also goes hand in hand with reform of course content. The new course contents enhance the delivery of key qualifications, such as language competence, inter-cultural awareness, interdisciplinarity and problem-orientation. The Federal Government supports higher education establishments in providing appropriate new courses in a large number of model trials in the framework of the BLK.

Some colleges, in close co-operation with industry, have taken new, often promising, paths with the development of new courses aimed directly at women. These overcome the technocratic image of engineering and computer science courses, which has a negative effect on women.

The courses for women successfully introduced in Germany to date are courses with widely differing structures. They separate young women and young men, for instance, either in some course units or throughout the entire course.

The subjects range from electrical engineering through industrial engineering to information technology. They have mostly been initiated or co-initiated by deans of technical departments and to a large extent applied for at regional level. However, there are also courses offered which are supported by the Federal Government and the Federal States. There are examples of successful women's courses in computer science at Bremen University, in industrial engineering at Stralsund and Wilhelmshaven technical universities and in energy consultancy and marketing at Bielefeld technical university.

Initial experience shows that with these courses, provided they are permanently integrated into the university's system and display the same quality as co-educational courses, appreciably higher numbers of first-year women students can be attained in the so-called undersubscribed subjects. Furthermore, they create a new climate and study environment which benefit both men and women. The possibility of having their own learning area is viewed fundamentally in positive terms by young women but their views on the "special treatment" this involves are extremely ambivalent.



**New climate and study environment benefit men and women**

The repeatedly stated assumption that students from women's courses cannot be successful in a working world dominated by men is undermined not only by the professionally extremely successful graduates of American women's colleges but also by the appreciable numbers of female professors of science and technology in Germany, who completed their school careers at girls' schools. Women's courses offered in technology, computer science and natural sciences act as a signal to young women.

## Further Opportunities for Education and Training for Women in Higher Education

The "Informatica Feminale" is an inter-college summer course for female students and scientists from all computer science courses at universities, colleges of education and polytechnics and for practising information scientists. At the University of Bremen, it has offered teaching and learning systems in compact form by women for women since 1997. The aim is to develop changed conceptions of study and specialised courses, e.g. through project-led, inter-disciplinary approaches. In so doing it makes an outstanding contribution to new concepts for reforming study in information technology courses.

The project is divided into three closely interlinked parts: discussions of curricula, the summer school itself and further education for women scientists.

The school was extended to South Germany for the first time in 2001. Baden-Wuerttemberg was the first Federal State to take up the idea of the summer school for women in information technology. The network "Women.Innovation.Technology" in Baden-Wuerttemberg organised the first "Informatica Feminale" at the Technical University of Furtwangen in close co-operation with the University of the Applied Sciences, Bremen.

www.informatica-feminale.de

Another project supported by The Federal Ministry of Education and Research is the "International Women's University of Technology and Culture" (ifu), which was held for three months during Expo 2000. As a workshop of the future, it contributed to reinforcing the mental approaches, ways of viewing things and the performance of women in science and research and establishing synergies between technology and engineering and also art and culture.

www.vifu.de

The question is frequently discussed as to whether reformed intentionally co-educational technical courses could achieve a similar effect. Re-structured courses with new teaching methods would appeal to both women and men. This approach has been adopted in only a few colleges to date so that no definitive results are yet available in this regard.

Apart from structuring course content, it has been found that to overcome “thresholds", which exist for women in particular in the choice of subjects studied, attendant measures are necessary and helpful to prevent students dropping out and assisting them in entering the world of work. In detail these are the provision of specific information at summer schools, tutorials and mentoring programmes. In this area, too, a large number of modules has already been successfully tested out and established in colleges.

## Conclusions

As became clear in the above-mentioned examples, there is a series of useful measures which have already proved to be individually effective in many cases. The trials have generally produced positive results or else are well on the way to doing so. This path taken must be continued; further facets are to be developed and tested out. However, it cannot rest there. Success in certain aspects is not enough. The positive results must now be put into practice on a broad basis.

What has been achieved so far must be made still more visible and brought to the public eye. This applies in particular to careers information. Even at school, realistic career outlines must be presented so that more girls opt for a career in science or engineering. The Federal Ministry of Education and Research is planning to package the available results and experience in one campaign. This will be centred on courses and professions in the sciences. It will probably begin with an internetportal as an up-to-date information medium. Materials already generated in a large number of projects will be available on the site as well as international approaches to the topic. The information is to be directed at both schoolgirls and teachers of both sexes.

The presentation “Over the Horizon and Beyond – Women in Aviation and Space Travel” held on the occasion of the International Aviation Exhibition in Berlin in May 2002 contributed to familiarising girls and boys with professions in aviation and space travel and enhancing the image of the sciences.

A further focus for future activities must be putting the reforms begun in schools and colleges onto a wider footing. The discoveries made in trials must be incorporated into curricula and, above all, into course content in the education and training of teachers.

In the course of the reform discussions triggered by the PISA-study now is a favourable time to put the results into practice. I therefore appeal to the Federal States to take fuller account of this aspect in the current discussions.

Extending full-day courses to schools may provide room for offering additional features and more project- and application-led teaching, which complies with the interests of girls more closely than hitherto.

**Elements of University Reform**

- Participation and information of the public
- Prestige advertising
- Ensure practical implementation
- Cooperation of schools/universities with industry
- Compatibility of career and family

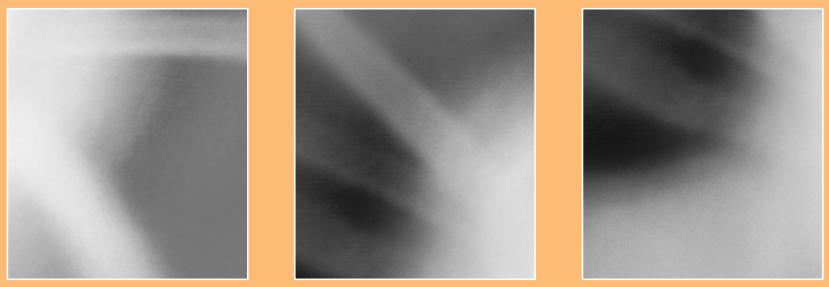
The reform of existing courses and the establishment of women’s courses offer the possibility of innovative forms of teaching and learning. Further modularisation of study in the course of setting up bachelor’s and master’s courses, amongst other things, offers the opportunity for this.

In addition, co-operation with industry and commerce must be strengthened at school and college level. In concrete terms, this means the enlargement of advisory networks and female mentor programmes, already in place in the D21 initiative, and improving the placements offered to girls.

Industry is also required if there is a need to improve conditions for women within companies. Women are indeed interested in sciences but are put off by the job image presented which is still heavily male-dominated. They are concerned that, after their studies, they will encounter working conditions which cannot be reconciled with family life. Some companies are indeed leading by example.

For instance, “work life balance” is the catchphrase for considering flexible working times for men and women in order to ensure compatibility of work with family even at higher levels in the company’s hierarchy. These examples must not remain isolated measures. Companies also need to convince women of the seriousness and practicability of these approaches.

Only if all groups – Federal Government, Federal States and commercial companies – work together, lasting changes can be made. I am therefore especially pleased that all groups at this conference are in dialogue with each other to discuss the common concern of better integration of women in the sciences and engineering.



# Best Practice School

***Due to deeply rooted stereotypes, prejudices and ideologies, girls and women are facing obstacles in a central area of the education in the natural sciences, which have a lasting effect on the development of their interests as well as achievement. Physics and technology become no-go areas within the culture of science so that the full job potential in these areas cannot be tapped by women.***

*From: Physik geht uns alle an. Results from the 'Nationalfond' study "Koedukation im Physikunterricht "*[1]

***Moderation***
***Prof. Dr. Astrid Kaiser***

*Prof. Dr. Astrid Kaiser, born 1948, is professor for didactics in the teaching of subject matter within the department for teacher training at the University of Oldenburg. She is a member of the Educational Council of the state Lower Saxony and in the Society for Didactics in the Teaching of Subject Matter. In 1997, she was awarded the Environmental Award of the city of Oldenburg for the concept and for establishing the learning workshop RÖSA (regional ecological learning workshop for subject matter).*
*Kaiser has graduated in Further Education studies at the Institute of Education of Hannover as well as teaching sciences, sociology and psychology at the University of Marburg.*

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In view of "deep-rooted stereotypes" it is not sufficient to point out new role models and careers to women just before they start their jobs or their studies. Any reforms have to be directed at those situations in which girls for the first time confront physics/technical phenomena in a specialised way – i.e. at school.

It means that schools have a special responsibility in the question of quality of education. Sharon Schuster believes that pupils should not only be taught about the application of computers but also, and primarily, about the internal functions of computers. Pupils should learn to act on their own initiative when using technologies and to independently further their education in technology subjects.

In addition, Dr. Eli Eisenberg of the ORT Israel stresses the importance of wholistic reforms: teachers, parents, the school administration, political authorities as well as media and companies are to be involved in the reform processes. He presents supplementary activities to this integrated approach, such as guided work in small groups, additional courses, getting to know role models etc.

In Germany, school reforms up to now only exist as model trials, e.g. as part of the BLK programme "increasing the efficiency of the teaching in mathematics and science subjects". In view of this situation, Prof. Dr. Manfred Prenzel stipulates that the concepts of this programme are adopted on a broader level – preferably in connection with a temporary gender separation, which led to the greatest success during the trials of the model.

This mono-educative approach is contrasted by Mag. Helga Stadler with the concept of a "reflective co-education". This concept, which has been applied in three Austrian projects, aims at counteracting the construction of the 'social gender' whilst at the same time responding to specific aptitudes and interests of the individual pupil.

[1] Published at the University of Bern, Institute for Teacher Training, dept. Teaching Psychology and dept. for the Teaching Profession, 1998.

# Technological Competence: Educating Girls in the New Computer Age. Results of the Tech-Savvy-Report


***Sharon Schuster***

*Sharon Schuster is the immediate past president of the American Association of University Women (AAUW) Educational Foundation. She spearheaded the Foundation's work as one of the largest sources of funding for graduate women and the catalyst for groundbreaking research on education and equity issues. The variety of her AAUW activities ranges from writing the first Head Start grant application in her community in coalition with other organizations in 1964 to chairing ERA (Equal Rights Amendment) ratification activities in the 70's to participating in California's Group Effectiveness Training Team in the 80's. She just finished serving her fourth year as president of the Board of Civil Service Commissioners for the City of Los Angeles.*

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"Tech-Savvy: Educating Girls in the Computer Age" is a research report published by the AAUW Educational Foundation. The Foundation is the philanthropic arm of the American Association of University Women. We are a private, non-profit organization of college graduates promoting equity and education for women and girls.

Can you believe that it wasn't much more than a dozen years ago that most people hadn't heard of the Internet, the web, or dot com businesses? Today it is difficult to imagine a time before they existed. My communications with the conference planners were all handled by e-mail. I booked my plane ticket on the Internet. Few technologies have transformed our economy, society, culture, communications and politics with such breathtaking speed. But revolutionary as it has been, the new technology has created a digital divide along gender lines. Although girls and women now use the Internet and e-mail in roughly equal numbers to men, they are not well-represented among those who are designing, creating, innovatively applying and transforming this defining technology of our age.



## The Tech-Savvy-Report

In 1998, the AAUW Educational Foundation published the report "Gender Gaps: Where Schools Still Fail Our Children" which found that a new virtual glass ceiling existed for girls and women. It noted that in 1996 girls comprised only 17% of Computer Science "Advanced Placement" test takers, and outnumber boys only in word processing classes, the current version of typing.

The Foundation created the Commission on Technology, Gender and Teacher Education to research how girls view the role of technology in their lives. The 14 commissioners are researchers, educators, journalists and entrepreneurs at the forefront of cyber culture and education. The report "Tech-Savvy: Educating Girls in the New Computer Age" combines their wisdom and findings with the results of our online survey of 900 teachers, qualitative focus group research with over 70 girls, and reviews of existing research.

The report takes a fresh look at the role computer technology plays in girls' lives in and out of school and makes re-

commendations to educators, parents, software manufacturers and researchers on how to broaden girls' involvement with technology and create a more inclusive and inviting e-culture. Our research was done in the United States and in public schools that are, by far, the largest educational system in the country. We made no attempt to apply the results to other countries or systems but it has been our experience with other reports that much can be extrapolated to other systems.

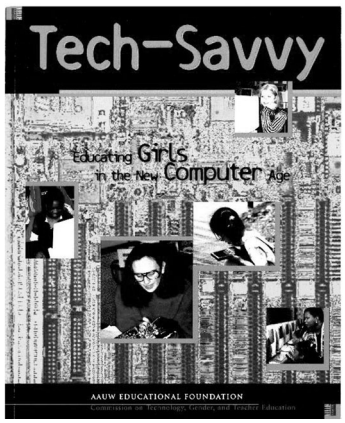




**Fig. 1: Report-Cover "Tech-Savvy: Educating Girls in the New Computer Age"**

The research makes it clear that girls are disenchanted with, not phobic about, computer culture. And with good reason, the Commission concludes. Girls and teachers, three-fourths of whom are women, raise crucial concerns about our use of information technology. For example, they question the emphasis on hardware, speed, and efficiency, at the expense of attention to the social, cultural, and human context and applications of computer technology. If addressed, girls' concerns and insights would help create a more inclusive e-culture for all.

**Statistics**

Here are a few statistics from the report that led to the findings and recommendations of the Commissioners. Girls represent only 17 % of the Computer Science "Advanced Placement" test takers and less than one in ten of the higher level Computer Science "AB" test takers. These tests are taken in high school, after intensive course work, to qualify for college credit.

In the workforce women comprise roughly only 20 % of Information Technology professionals. Women receive less than 28 % of the computer science bachelor's degrees and this is the only field where women's participation has actually decreased over time, from a high of 37 % in 1984. Women comprise just nine percent of the recipients of engineering related bachelor's degrees. When it comes to today's computer culture, the bottom line is that while more girls are on the train, they aren't the ones driving - that is, taking the lead in designing, applying and creating new technologies. This report gives recommendations on how we can start getting girls and women at the forefront of the technology revolution.

Tech-Savvy emphasizes that girls are not afraid of computer technology, but they are often uninterested in it.

The Commission notes that girls have real concerns about computer technology – and with good reason. They find programming classes tedious and dull, computer games too boring, redundant and violent, computer career options uninspiring and the enthusiasm for faster and better hardware limited. Girls' concerns about the computer culture are not a high-tech update of "math phobia." Most aren't questioning their competency. They are saying, "we can, but we don't want to."

Girls who participated in our focus groups say they do not see the relationship between computers, people and other academic endeavors, and when asked to sketch someone who is "really good at computers", the vast majority of girls sketch a male. Most do not predict future interest in computer pursuits, courses, or careers for themselves. They are less interested in technology for technology's sake, but are more often drawn to science and technical courses that emphasize how such subjects apply to social, cultural and human problems.

**Rethink 'Pink'**

There is a growing market in "girls' games" or "pink software", targeted to girls and emphasizing themes such as make-overs and fashion design. While these games do indeed attract many girl consumers, the Commission had mixed feelings about the value of "girls' games". Ultimately, there is more value in games that are not "girl specific" so much as they are user-friendly - customizable, personalizable and inviting to a range of players.

Tech-Savvy challenges us to rethink the idea of "pink-software", or the "girls' game". Girls have keen ideas about what kinds of games they would design - games that feature simulation, strategy and interaction with characters

on- and off-line. These games, in fact, would appeal to a broad range of learners – boys and girls alike. Computer games don't have to be the virtual equivalent of GI Joes and Barbies. Girls tell us they would design games that involve strategy and skill and games with intricate narratives that allow role playing and multiple perspectives. When it comes to computer games and software,

**Girls want high-skill not high-kill**

Some examples of what girls would like in games include opportunities to "work through" real-life struggles, contexts and dramas in the experimental virtual world. They describe games that allow them to play out the consequences of their choices, and to rehearse being a different person. They criticize existing game options not only for redundant and tedious violence, but because they lack opportunities to interact with characters online or off-line, and because they lack intellectual challenges and skill.

**Rethink ‚Pink'-Software – Design characteristics**

- Software that is personalizable and customizable
- Games with challenge
- Games involving more strategy and skill
- Games with many levels, intricacies, and complexities
- Flexibility to support multiple narratives
- Constructionist design – one that allows students to create their own objects
- Designs that support collaborative or group work, and encourage social interaction
- Coherent, nonviolent narratives
- "Puzzle connections," such as rich mysteries with multiple resolutions
- Goal-focused rather than open-ended games

To see if there has been any improvement in the quality of games since the report was completed, I went to my local electronics store and surveyed what it had available in the "children's games" section. I discovered that most preschool games either related to a popular television programme or used animals as the characters. I knew that the major publisher of "pink software" was Mattel, the maker of Barbie. Now Barbie software comes in a variety of options. There were the usual designing games, a Sleeping Beauty game, and a variety of adventure games where Barbie was a detective or something similar. I also noted that Lego has branched out from its usual building and car race software and offers a package called "Friends" that you can use to create a girl band.

To further my research, I asked my six year old granddaughter, Samantha, how she likes to use the computer. She said she likes games that create and solve mazes and playing solitaire and Master Mind, a strategy game. Maybe, as she gets older, she will design such games for herself and others!

The Commission recommends creating software that is not specifically designated for girls or boys. Software for both classroom and home should focus on the many design elements and themes that engage a broad range of learners.



## Getting Girls into Informational Technology Careers

Girls also need to see themselves as designers of software early on. They need "tinkering" activities with code and with programming that can inspire their interest in game design.

As the global high tech economy grows at breakneck speed, the United States, despite the current downturn in the economy, face a tech labor shortage in years to come. It is critical to realize that girls and women are an untapped part of the technical talent pool.

**Have a main character, a girl, who has the mission to break stereotypes.**

***Baltimore high school student***

But remember the numbers, girls received only 28 % of the Computer Science bachelor's degrees in 1996. Indeed, Computer Science is one of the few, if not the only, discipline in which women's participation has declined over time, from a high of 37 % in 1984. Most estimates are that women comprise only 20 % of the Computer Science workforce.

These numbers capture in shorthand a computer culture that has not attracted the participation of a substantial number of girls and women. But why is this so?

The report shows that many girls – erroneously - see computer-related careers as solitary, passive, and sedentary. The "computer nerd" may be an outdated cliché, but he lives on in girls' perceptions of Information Technology careers and computer science. As one girl summarized, "I'd rather do something like interacting with people. I don't want to sit at a desk all day and use a computer." Schools have another point to communicate about careers and the future of work: information technologies are becoming increasingly hard to avoid, across the whole range of occupations.

Even those students who don't pursue information technology careers will excel insofar as they can devise innovative, creative uses for computer science in their careers of choice, whether they are architects, designers, musicians or health technicians.

The growing pervasiveness of computer technology brings me to one final point about what girls - and all students - need to know to thrive in this century.



**Computer fluency is not about machines, it's about thinking.**

## Computer Fluency

Tech-Savvy underscores that we cannot measure gender equity in the Information Technology age simply by how many girls send e-mail, use the internet, or make PowerPoint presentations. These are familiar, but very limited, measures of equity in the technology age. Instead, "computer fluency" should be the new benchmark for equity. It means the ability to use technology proactively, be a lifelong.

learner of technology, understand design concepts, and be able to interpret the information that technology makes available. Fluency is not about machines, it's about thinking. It is the difference between knowing how to send email and knowing something about how networks operate. An educational system that takes computer fluency as a goal holds the greatest promise for the achievement of meaningful gender equity in the computer culture.

Computer Science is becoming a centerpiece in many areas of our economy. Even those girls and young women who may wish to avoid Information Technology careers will have a hard time avoiding computer technology, regardless of which field they choose. To excel across a range of fields, from architecture to music to medicine, girls will need to achieve computer fluency. We do not want a "two-track" society, where a large group of citizens use e-mail, the Internet, and productivity tools, and a much smaller, more homogeneous group of people creates, designs, changes and manages it. There are multiple points of entry to achieve computer fluency. Some learners may develop fluency through music, some through mathematics, and others through the arts. But no matter what the entry point, girls and women need to apply technology to all aspects of their lives, not just use the tools of word processing, e-mail, and the Internet.

**Qualities of Computer fluency established by the National Research Council**

- Understand information technology broadly enough to apply it at work and in everyday lives
- Continually adapt to changes in technology and improvise solutions when systems do not act in anticipated ways
- Apply insights about technology across domains and problems
- Understand basic concepts of programming and human-computer interfaces
- Interpret and understand information available through computer technology
- Define complex problems and imagine ways that information technology might contribute to the solution
- Think about information technology abstractly Communicate effectively to others about it

## Teachers Education

Teachers will play an increasingly critical role in helping girls and non-users achieve this level of fluency. Commissioners say that professional development for teachers needs to shift from teaching the hardware to teaching for better instruction and equity. Teacher education should include how to design classroom material, curricula, and teaching styles that complement information technology and support the involvement of all students. Without ap-

propriate teacher education and design opportunities, we'll have 20th century classrooms dressed in 21st century technology.

Of the 900 teachers polled online for this research, only 267 report that they received any technology training in an undergraduate or master's teacher education programme. Only 11 % report that they received training specifically in how to apply or integrate computer technology into their lesson plans.

Even those teachers "tech-savvy" enough to complete our online survey found little compelling reason to integrate computer technology into the daily life of the classroom. Only a minority report that they use it "frequently" or even "regularly".

At the same time, however, teachers in our survey see the "high-tech" classroom as inevitable in the future, even if it is one that they do not have adequate opportunities to shape or define for themselves. Only eight teachers of 900 surveyed believed that the importance and use of computer technology will decrease even "somewhat" in the future.

The Commissioners recommend that professional development for teachers emphasize more than the use of the computer as a "productivity" tool. It must give teachers enough understanding of how computer technology works and its basic concepts so that they are empowered users.

## Conclusion

Tech-Savvy makes innovative recommendations to educators, parents, software manufacturers and communities on how to broaden girls' involvement with technology and create a more inclusive and inviting e-culture. Among them:

- Rethink "pink-software": Commissioners note that software does not need to be specifically designated for girls or boys. We must work towards producing games that foster a 'we can and we want to' attitude. Software for both classroom and home should focus on the many design elements and themes that engage a broad range of learners, including both boys, girls and students who don't identify with the "computer nerd" stereotype.

- Look to girls and women to fill the Information Computer Science Job Shortage: it is critical to realize girls and women are an untapped source of talent to lead the high tech economy and culture. Curriculum developers, teachers, technology experts and schools need to cultivate girls' interest by infusing technology concepts and uses into subject areas ranging from music to history to the sciences that interest a broader array of learners.

- Educate tech-savvy teachers. Professional development for teachers needs to emphasize more than the use of the computer as a "productivity" tool. It must give teachers enough understanding of how computer technology works and its concepts so that they are empowered users. Despite the complexities of retraining thousands of current teachers, we cannot wait until teacher education catches up with reality.

- Inspire girls to be designers, not just users. Educators and parents should help girls imagine themselves early in life as designers and producers of new technology. Engage girls in "tinkering" activities that can stimulate deeper interest in technology; provide opportunities for girls to express their technological imaginations. Girls need to see themselves as hands-on designers of games early on, not just as consumers of games specifically marketed to them.

- Change the public face of computing. It is critical for the media, teachers and other adults to make the public face of women in computing correspond to the reality rather than the stereotype. Girls tend to imagine that computer professionals or those who work heavily with information technology live in a solitary, antisocial world. This is an alienating - and incorrect - perception. Today, there may be only one "technology professional" in the office. However, in the future, many of us will need to be technological proficient to make the most of our careers, whether we work as lawyers, designers, historians, auto mechanics or medical technicians.

- Strive for a Family Computer: Among other things, place computers in accessible home spaces. Think about shared or family-centered activities on the computer, rather than viewing its use as an individual or isolated activity.

- Set a New Standard for Gender Equity: We face the specter of a two-track society: one where most use the technology and a few – with a handful of women – creates, designs, changes and understands it. Equity in computer access, knowledge and use – across all races, sexes and classes – cannot be measured by how many people use e-mail, surf the Net or perform basic functions on the computer. The new benchmark for gender equity should emphasize computer fluency, i.e. girls' mastery of analytical skills, computer concepts, and their ability to imagine innovative uses for technology across a range of problems and subjects. Learning how to use computers is like learning a new language. As more girls and women become fluent, they will help redefine the computer culture.

To get girls in the forefront of technology, they need to see that it gets them where they want to go. And for a large part of the population that process must start in the classroom.

# Programme of the Federal Government and its Länder: Increasing Efficiency in the Teaching of Mathematics and Natural Sciences – Experiences with the Module "Encouragement of Girls and Boys"


***Prof. Dr. Manfred Prenzel***

*Prof. Dr. Manfred Prenzel, born in 1952, is head of the BLK-Experiment Programme "Increasing Efficiency in the Teaching of Mathematics and Natural Sciences" and Managing Director of the Educational Institute of Natural Sciences (IPN) at the University of Kiel. His research specialisation is in the field of teaching, learning and education research, in which he is concerned with questions of learning motivation, transfer of learning and the application of knowledge, teaching patterns and learning processes, computer-aided learning environments, quality assurance, quality development of education as well as recording competence in the natural sciences. He obtained a Master's degree in Education, Psychology and Sociology at the University of Munich.*

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The concern of the BLK (Federation and Federal States Commission for Educational Planning and Research Promotion)-programme "Increasing Efficiency in the Teaching of Mathematics and Natural Sciences" is to encourage competence and interest in the fields of mathematics and natural sciences among school students of both sexes. In this paper I shall be emphasising the encouragement of schoolgirls.



I shall begin by briefly reporting on the reasons for and the objective of the programme and then present the programme's modules from the perspective of encouraging girls.

The module "Encouraging Girls and Boys" is then looked at in greater detail. I shall give some examples and a brief overview as to how it is to be taken forward.

## Reasons

The reasons for the experimental programme were the TIMMS findings (Third International Mathematics and Science Study). These, which are also underlined by the results from the PISA (Programme for International Student Assessment) study, show that German schoolgirls and schoolboys have difficulties particularly when tasks require conceptual understanding. There are pronounced knowledge deficits in relatively large percentages of schoolgirls and schoolboys and there are relatively small top groups. We have indications of really low rates of improvement in performance over the school years and we have found in a whole series of investigations that interest in mathematics and in natural sciences decreases in the course of pupils' schooldays. The fact that advanced courses in natural science or mathematics or fields of study are not

opted for either is connected with this. There are indications of pronounced gender differences in interest, in the concept of oneself and in performance. However, we also find that girls are definitely interested in natural sciences and questions of natural science. On the other hand, they are not necessarily interested in the questions dealt with at school (in a certain way and manner).

The experimental programme was initiated by the Federal Government and the Federal States in 1998. Its running time comes to an end in 2003. The Leibniz Institute for Education in the Natural Sciences (Kiel), in conjunction with the Chair of Mathematics Didactics of the University of Bayreuth, is responsible for the programme. Nationwide there are 180 schools in the programme and these are organised in 30 small school networks. Within these networks they are able to exchange work and experience and also follow each other's development. Over 1,000 women teachers are taking part in the BLK-programme, the proportion of women teachers of mathematics and natural sciences among them being 40 %. Systematic evaluation is through a series of complementary research activities to ascertain what this programme can contribute to the encouragement of boys and girls.



## Aim of the Programme

The aim is to develop teaching by changing lessons in order to attain greater interest in and greater understanding of mathematical and natural science subjects. This objective is based on the idea that it is most effective to take a direct and purposeful approach in class in order to encourage girls and boys. In preparation, typical problem areas in German teaching were identified. The teachers work out school-related problems in study groups and also try to find solutions together, push developments forward and test them out among themselves. In this process, they are supported by specialist teaching materials and advice. The results are exchanged on a central server. Anyone can obtain information on developments in the programme via a generally accessible site:

http://blk.mat.uni-bayreuth.de

## Programme Modules

The problem areas identified are outlined by a total of 11 modules.

**Modules of the BLK-programme**

- (1) Further development of tasks at school
- (2) Scientific practices
- (3) Learn from mistakes
- (4) Save basic knowledge
- (5) Experience augmentation of expertise: cumulative learning
- (6) Multidisciplinary teaching
- (7) Encouragement of girls & boys
- (8) Development of tasks advancing the cooperation among the pupils
- (9) Strengthen the responsibility for one's own learning
- (10) Controlling: ascertainment and complition confirmation of expertise augmentation
- (11) Quality assurance at school

The modules are drawn up so that work can be started directly on these areas without first having to reform the entire lesson. If the experiences of the individual schools and projects are collated, this provides a good framework for structuring lessons in such a way that interest and competence are supported.

I should like to look briefly at some of these modules from the aspect of gender.

The problem culture proved to be a fundamental area of difficulty. There are few application-oriented, and hence rarely, problems which allow various solutions. In the first module "Problem Culture" attention was therefore given to a closer relation to application in constructing mathematical and natural science problems. This complies with the method of learning found among girls. In addition, designing tasks that permit various methods of solving them is important. In the module "Working in the Natural Sciences", the main focus is on allowing the planning to be taken over by the pupils themselves, working with guidance

by theoretical considerations and reflecting the works consulted. These too are points which are more likely to be congenial to girls. A third point in the module "Learning from Mistakes" is to take up everyday ideas and make them the central theme in the lesson, because everyday ideas in particular are too often disregarded in German education. In the module "Increasing Competence", subject matters are arranged in such a way that girls and boys are able to experience success gradually. Girls and boys in a physics class will be able to see what they can actually achieve in the course of a school year or over several months. This must be perceptible from the skills they have acquired. In the module "Subject-Related and Inter-Disciplinary Teaching" the method is to work on significant and reality-based projects cutting across subject boundaries. However, it is ensured that the perspective of the individual subjects is not lost, e.g. the difference between a view based on biology and a view based on physics when approaching topics in acoustics.

**Everyday ideas must be taken more into account**

In the module "Development of Tasks for Co-operation between Schoolgirls and Schoolboys", short film scripts are used to ensure co-operative group work. In this process, consideration is also given to motivational control, i.e. how do I regulate my efforts when it becomes very difficult.

## Encouragement of Girls and Boys

Module 7 is devoted directly to the encouragement of girls and boys. The background is the experience from a series of earlier experiments, which were also in part developed at the Educational Institute of Natural Sciences (IPN), Kiel. These experiments were very successful in showing that the teaching of mathematics, physics or chemistry can be structured in such a way that girls and boys are encouraged in terms of their interest and their understanding. Here the approach can be at various levels.

Firstly, at the level of lesson content and teaching method. In this case, greater emphasis is placed on interests and the world as it is experienced and the value of education is made visible. Lesson contents are contextualised differently, girls and boys are given more opportunities to learn and to plan from their experiences independently. A typical problem is often modelling or "mathematisation". This should be introduced very carefully and only when content has previously been grasped and understood.

**Encouragement of girls and boys at three levels**

The second level, at which success can become perceptible only over the longer term, is the sensitisation of teaching staff to specific problems: e.g. the problem of differing concepts of the self in girls and boys regarding their abilities in the natural sciences, the varying interactions in the classroom and differences in participation in lessons. Girls have the need really to understand things. That is one reason why they often do not participate so very much in the lesson. Boys pass over their problems more readily.
A third level is that of teaching organisation. It has proved important to teach in separate gender groups at times, above all to attain greater confidence and possibly also to provide certain technical experiences in a single-sex group in the first instance.



## Examples

There is a number of schools which work specifically with module 7 and I would like to present three examples to outline the different ranges in this approach.

Marienschule in Lingen, Lower Saxony, is a secondary school, which uses the inter-disciplinary approach and tries to correlate lessons in physics and biology with each other before proceeding on a project-oriented basis. Amongst other things, the lesson is structured via worksheets, which are organised with a view to the careful introduction of modelling. The work is carried out in single-sex groups. The results emerging there show that this teaching approach promotes comprehension, acceptance and self-confidence among the girls.

Another example is Hildegardisschule, a grammar school in Bochum, North Rhine-Westphalia, which uses small groups to encourage girls in physics lessons. This teaching in small groups is embedded in the "conventional" timetable. The series of lessons begins with an introduction via a talk by the teacher or via a lesson developing in a question and answer fashion. Only then is group work begun. The special feature of the groups is that they are differentiated by gender and by ability. Particular value is attached to in-

dependent experiments in this process. The worksheets and questionnaires are framed so that the girls and the boys set their own main focus and can pursue the topic to varying depths. It is found here that the girls in particular display strong goal-orientation, that good work attitudes are reflected and self-confidence is enhanced.

A third example comes from the Findorff School Centre in Bremen. Here natural science and mathematics lessons proceed on a consistent project-oriented basis with the main focus on health education. Blocks of lessons in natural sciences are formed and then divided into different teaching units. Around 3 to 5 natural sciences blocks are run in a year. The subjects physics, chemistry and biology are correlated. Each block follows a central theme, to which various projects are linked. The girls and the boys can experiment independently in groups. On conclusion, the important results and solutions to problems are summarised in reports. This school trial had a great deal of success in maintaining the interest of girls and boys at the same level and also in winning over a very high percentage of girls to mathematics and natural sciences when they selected the advanced courses they wished to take.



***Physics and Biology in Cooperation — e.g. "Light and Perception"***

| physics | biology |
|---|---|
| from pinhole camera to lens | evolution of the eye |
| refraction on the convex lens | accomodation |
| lens combinations | ametropia |
| light spectrum, colours | perception of colours |

**Fig. 1: Interdisciplinary approaches to a subject at school**

## Outlook

In the immediate future, the central question will be to what extent we succeed, by German education or by this experiment, in promoting the subjects in a differentiated way, i.e. in working with concepts appropriate to encouraging particular groups under differing conditions. However, in that regard we have to await the results of projects currently under evaluation.

We must gradually dispense with "only" exemplary model projects and make the topic a natural one for day-to-day lessons. Efforts are being made to develop a new teaching script from the individual modules. The study groups must continue to think thoroughly and logically about teaching, work together and put concepts to the test. This is unfortunately the exception in German education at present. Our great interest is after all directed at linking up all these approaches.

# Successful Co-Educational and Co-Operative Concepts for a Higher Degree of Equal Opportunities in Mathematics at Secondary Level


***Dr. Eli Eisenberg***

*Dr. Eli Eisenberg, born in1954, is Deputy General Director for R&D (Research and Development) and Training of ORT Israel. He helped to establish a Technology Center in England and a comprehensive Technological Education Network in South Africa. In his career he dealt with research and evaluation of curricula, teacher training programmes, development of teaching and learning materials, and he supported the application of Technology Education at its different levels at schools, colleges and industries. Eisenberg holds a Doctorate, as well as a M.Sc. and a B.Sc. of the Technion, Israel Institute of Technology, Haifa, where he is still member of the research and teaching staff.*

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Before I report on our approach to encouraging girls and young women in mathematics, I would like to inform you briefly about the organisation ORT Israel, of which I am General Director.

ORT Israel is affiliated to the ORT international organisation. ORT stands for Organisation for educational Resources and Technological training and was established in 1880 in St. Petersburg, Russia. At that time, the Jewish people were expelled from the towns into all directions and there was an urgent need to acquaint them with marketable skills. So ORT's vision was to train and educate people in order to make them employable. Today we operate in five continents and in 60 countries all over the world and we have some aspiration to work in Antarctica as well. We do have about 300.000 students. The organisation is a non-profit, non-sectarian and a Non-Governmental-Organisation (NGO), registered by the UNESCO. The motto of ORT is: give a person the tools and there is no limit to what he/she can accomplish".



## The World-Wide Activities of ORT

I would like to present some examples of our world-wide activities. In Latin America, Brazil, we offer distant learning courses in office skills and electrical maintenance used by over 8000 students in rural areas. We run a University in Uruguay, we conduct operations in Argentina, Chile and Venezuela.

In Asia some Indonesian senior transport engineers were trained in the UK, where the headquarter of ORT International Organisation is located. We also run computer application courses, transportation planning and information systems. In Africa, in Chad, we carry out agricultural development and farmer training projects to increase production through improved irrigation and farming techniques. At large, we have about 250 projects, in the fields of banking, tourism, media communication and sports in about 60 countries.

The vision today – and this took roots just a few years ago - is not just to train people to be employable. Today we would rather say – and I stress this for girls and for boys - that ORT Graduates should create employment for others.

Because unemployment is a global challenge and we want our graduates to be able to initiate new start-ups. For this reason we have integrated in our mathematics and science and even in humanity courses special skills such as developing a business plan, how to write a curriculum vitae, how to be interviewed for a job and how to open a bank account.

This is vitally important for our graduates. We want to ensure that all alternatives are open to them. ORT comprehensive schools have very strong science and technology departments but our graduates could also be lawyers or engineers or musicians or whatever they want to be. ORT Israel runs 70 comprehensive schools, which are located all over Israel. In addition, we operate 33 technical colleges and two engineering universities.

In concluding this short report on ORT, I would like to tell you something about our motivation for placing such a great value on the education of people throughout the world as well as on the ability to pass on the values, the knowledge and the skills that they acquire. I would like to clarify this via an example.



You know that in Israel we have two lakes, one is the Lake of Galilee and the other one is the Dead Sea. The Lake of Galilee is full of trees, flowers, animals, fish. The Dead Sea is just that - a dead sea. The same river, the River Jordan, is feeding both of them. So the question is: "How is it possible that one lake is a living lake and the other one is just a dead sea? The answer is not just a scientific explanation, but also involves a philosophical approach: the Lake of Galilee has both input and output, it interchanges. The Dead Sea, in contrast, only has input. It has no output, it doesn't interchange, it is a dead body. I think that we should all learn from each other and share our experiences, and therefore I am grateful to have the possibility of reporting on our programme.

## ORT - Young Women for the 21st Century

Now I want to tell you something about the reasons for establishing a programme to promote girls and young women in higher mathematics. In the national matriculation maths examination (taking place at the end of the 12th grade) there are three levels: the lowest one is a three-credit, the medium one a four-credit and the highest level is a five-credit course.

Much more girls than boys attend the three-credit courses, around 60 %, whereas the rate of the boys is only about 50 %. In this course the girls do much better than the boys. They pass the courses on an average of 90 %, while the boy's average is only about 85-86 %. Even when it comes to the four-credit course, there are more girls than boys sitting for matriculation exams in mathematics. Still more of the girls pass the exams and excel in them. But when it comes to the five-credit course you can see the big challenge: only 13 % of the girls sit for higher level mathematics. The boy's average is about 21-22 %. The average of those passing the exam is nearly the same for girls and for boys. So the main challenge for our graduates is how to encourage the female students to study higher level mathematics.

In 1997, ORT's board of directors took a decision to promote girls and female students to study more mathematics. We conducted a survey and found a tremendously interesting programme, which was developed by Yael Rom

| | 1996/97 | 1997/98 | 1998/99 | 1999/00 |
|---|---|---|---|---|
| Boys attend 3-credit-courses | 24,415 (49.2%) | 25,822 (49.8%) | 29,463 (51.8%) | 30,619 (53%) |
| Girls attend 3-credit-courses | 28,733 (57.9%) | 30,075 (58.0%) | 33,957 (59.7%) | 34,085 (59%) |
| | | | | |
| Boys pass 3 credit-courses | 19,971 (81.8%) | 22,104 (85.6%) | 25,014 (84.9%) | 28,037 (86%) |
| Girls pass 3-credit-courses | 24,279 (84.5%) | 26,436 (87.9%) | 30,086 (88.6%) | 29,341 (90%) |

| | 1996/97 | 1997/98 | 1998/99 | 1999/00 |
|---|---|---|---|---|
| Boys attend 4-credit-courses | 13,697 (27.6%) | 14,778 (28.5%) | 15,130 (26.6%) | 15,021 (26%) |
| Girls attend 4-credit-courses | 14,094 (28.4%) | 14,830 (28.6%) | 15,244 (26.8%) | 16,176 (28%) |
| | | | | |
| Boys pass 4-credit-courses | 12,478 (91.1%) | 13,699 (92.7%) | 14,252 (94.2%) | 30,645 (94%) |
| Girls pass 4-credit-courses | 13,065 (92.7%) | 13,836 (93.3%) | 14,665 (96.2%) | 31,297 (96%) |

| | 1996/97 | 1997/98 | 1998/99 | 1999/00 |
|---|---|---|---|---|
| Boys attend 5-credit-courses | 11,513 (23.2%) | 11,252 (21.7%) | 12,343 (21.7%) | 12,132 (21%) |
| Girls attend 5-credit-courses | 6,799 (13.7%) | 6,948 (13.4%) | 7,679 (13.5%) | 7,510 (13%) |
| | | | | |
| Boys pass 5-credit-courses | 10,914 (94.8%) | 10,824 (96.2%) | 11,788 (95.5%) | 97% |
| Girls pass 5-credit-courses | 6,520 (95.9%) | 6,698 (96.4%) | 7,410 (96.5%) | 97% |

**Fig. 1-3: Statistics of the different levels of Math's National Matriculation Courses**

from IDOROM. Yael Rom is a fascinating person. She was the first pilot in Israel and she is quite committed to and interested in promoting girls in science and technology fields.

The main purpose of her programme is to encourage girls who apply for studying technology and science studies. This was realised by implementing a very systematic programme of challenges and supporting the girls to advance their studies in higher-grade mathematics. We adapted the programme to the constraints and needs of our schools and called it 'ORT - Young Women for the 21st century'.

## Reasons for a Multifaceted-Programme

The programme we developed had many different modules (multi-faceted programme). First of all I would like to outline why we opted for an integral approach. Then I will describe the measures we took in order to achieve this. The main starting point was the consideration that every individual learns in his or her own particular way and that we must take this into account.

We think that each one of us is an individual. We have an idea of what will make teaching and studying better. But we really don't know what each person's individual style of learning is. For example my doctor said to me: "You are a very specific redhead person. You are individual, we can't give you a treatment that will work for everyone." Therefore any intervention in school that is made must be a multifaceted one. It should not be targeted at only one aspect or one group of methods to change the behaviour of the students.

**Treat everyone as an individual**

We operate in 14 lower secondary and in 14 higher secondary schools with children from the age of 12 to the age of 18. We have about 7500 students who are involved in the programme each year. In class, we continue an approach that we were already following when I was the head of the STEP ORT institute in South Africa from 1992-96. We implemented a project for President Mandela in which we pointed out the need to empower the brains, the hands and the hearts. Only if you empower them equally, you can proceed with your whole body. If you just touch your brain or your hands or your heart, the work won't be finished.
Therefore, in the subject areas mathematics, physics and technology we try to take account of the cognitive domain, the instrumental domain and the effective domain. For example in technology we do not teach ICT (Information and Communication Technology) exclusively. This would only affect the cognitive domain. In addition, we educate the pupils in technological problem solving (instrumental domain), self-confidence, motivation and perseverance (effective domain).

## Programme Dimensions

I would like to report a little more on the programme ingredients, which essentially consist of 7 elements.

The first one: the programme is a multi-aged programme encompassing children from the age of 12 to the age of 18 – grades 7 through 12.

Secondly we focus on involving 'agents of change'. The whole school community must change - not only the mathematics teacher but also the school management, the school counsellors, the graduating students and of course the parents, who are very important. Only if the entire school environment is changed, you can see the behavioural change in the mindset of a boy or a girl.

The third dimension is a series of tests that we developed and in which we identified 2nd year female and male pupils. The proportion of female was higher than the proportion of male pupils. About 60-80 % of the group was female, and I'm talking about pupils who got results between 70 % and 80 %. This means the pupils were not the lowest and not the highest achievers.

In order to encourage the girls to sit for five credit mathematics we significantly increased – as a fourth essential element – the opportunities of studying mathematics in small groups. Again we paid attention to the individual needs of the students.

Very important factors in this programme were tutorial lessons. We chose excellent students from the upper secondary school to support and tutor students from the lower secondary school. While we taught the tutors higher level mathematics, we also acquainted them with tutorial skills.

The sixth programme dimension consists of doing career

planning, taking the pupils out into industry and bringing successful female role models back to the schools.

The last but not less important module is a highly systematic and documented feedback from an external evaluator which gives formative and comprising evaluation of the project to its management.

The programme proved successful. The school management, mathematics teachers and pupils expressed their satisfaction. One of the schools involved in the programme, for example, reported on individual pupils' goals and achievements as well as the positive interaction between pupils and teachers.

**The programme proved successful**

These positive changes in the interaction between pupils and teachers were vitally important. They had positive effects not only on the drop-out rate, which is continually decreasing, but also on the self-image of female pupils. If you ask a girl "Why did you succeed in mathematics?", she would probably say "The exam was simple, the teacher was excellent and I studied very well." If you ask a boy "Why did you succeed in mathematics?", what will be the answer? "I'm very smart, I'm clever." Increased positive feedback from teachers and tutors encouraged the girls to become aware and proud of their capabilities.



## Conclusion

The improved learning atmosphere had positive effects on the numbers of both girls and boys continuing five-credit courses in mathematics, as can be seen in the following table.

In the first year of the intervention (1997/98) the percentage of girls sitting for five-credit matriculation exams was about 12 %, the percentage of boys was about 13 %. In the second year (1998/1999) the percentage of the girls rose to 17 % and the percentage of the boys rose to 21 %. In the third year of the intervention the percentage of girls sitting in for mathematics in five-credit courses is 25 % and the percentage of the boys 21 %. For the first time, the percentage of girls was higher than that of the boys.

The number of girls studying advanced mathematics

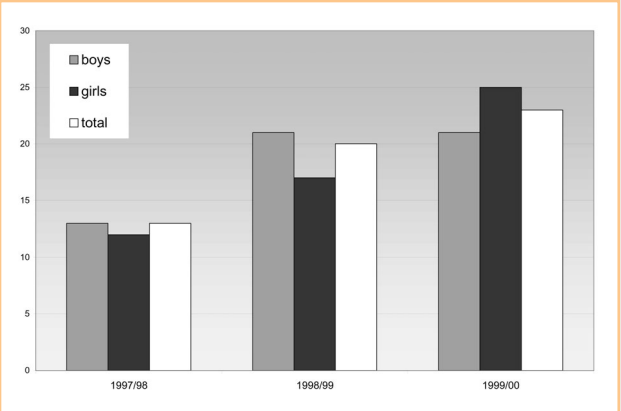


**Fig. 4: 5-credit students at Promme's School**

sitting in for national matriculation exams has increased at least by 100 % at all schools of the programme and we have peaks of 150 -200 % of increase in some of the schools. The programme was successful, because it didn't focus just on one aspect but involved the whole school community. With the aid of the multi-faceted programme, it was ensured that girls and young women could study advanced mathematics successfully and enhance their studies in science and technology.

***Mag. Helga Stadler***

Mag. Helga Stadler, born in 1947, studied physics and philosophy and taught at a high school in Vienna. Since 1992 she has been assistant at the Institute of Theoretical Physics at the University of Vienna in the field of the didactics of physics. Her current main research and work deal with professionalisation of science teachers, gender-sensitive teaching and development of teaching concepts. She is head of focus 3 "Teaching and Learning Processes" in the programme "Innovations in Mathematics, Science and Technology Teaching" (IMST²).

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When mention is made of a lack of acceptance in science lessons, it is always physics which is meant, to a lesser extent chemistry, never biology. If the figures are looked at more closely, it will be seen that physics is unpopular above all with girls and women: wherever possible schoolgirls will opt out of physics – in the choice of school, of subject options, of future study and of professional training.

In my contribution I would like – as a lecturer in physics teaching methods – to concentrate on the subject of physics and school, discussing in particular the question of co-education and briefly presenting some Austrian projects, which appear to me to be important in this context. However, in addition and first of all I would like to consider the cultural conditions lying behind the problem. In Kazakhstan, for example, where scientists working in physics are low paid and have low social status, students in the physics departments of the universities are almost exclusively women. Conversely, in many countries of the world (for instance in Australia and Scotland) girls opt out of mathematics, while here in Austria about half of all new students in the subject are female. The large numbers of female engineers in the former GUS-states or in the then GDR should also give us food for thought.



## Results of Research into Co-Education

In Austria the proportion of women in physics has remained fairly constant at below 20% for some years (this includes those undergoing teacher training) and is therefore far lower than in other subjects. In electrical engineering and mechanical engineering fewer than 5 % of students are women, among the professors and lecturers in the subjects in question women are a dwindling minority. The introduction of co-education has not changed this situation. Many believe it has on the contrary aggravated it. We are also well aware nowadays where the reasons for this are to be found.

Since the 70's there has been much research in this area and we all know the results: physics and technology, as perceived externally and internally, have developed a culture which in our society is associated with male characteristics. Physics and technology are therefore identified by girls and boys as a male preserve from a very early stage, which leads to girls increasingly distancing themselves from them in the course of their gender-specific socialisation and to boys turning to this field more intensively.

Both girls and boys grow up in a world where the topic of gender is made central to our lives. The role of the media and of advertising should not be underestimated in this connection. What perhaps is more important still: gender is constantly redefined – in every situation which the individual experiences. Disposition, interaction, activities are given a role-specific classification and in turn are subject to vogues of the moment. Girls and boys thus do not act against their social environment but in it and with it thereby exclude for themselves areas of life assigned to the other sex at any particular time. They are therefore no longer able to recognise their possible abilities in those areas or to develop them. Men claim the greater part of the public sphere for themselves if the social areas and the professions associated with them are disregarded. There are probably hardly any areas of public life which are deemed unmanly. Women, on the other hand, withdraw to a large extent to spheres where rather groundwork for others is called for. They still seek meaning for their lives mostly in the non-public domain. This reaction is still described as "natural" in many quarters. Women are said to have talents in "domestic" spheres, which in the same breath ascribes to men talents in the technological sphere.



The circle emerging in this way cannot be broken by uprating or devaluing one area or another either (as repeatedly happens in the feminist literature). Both spheres are important and indispensable to human life – the problem is first of all that of "gendering", the classification of these areas as being the realm of the other social gender at a given time.

## Three Pillars of "Gendering"

The question is what we can do to bring down such solidly built structures. About 30 years ago, it was established at a "Gender And Science And Technology (GASAT)"- conference that there are three pillars carrying these structures: the relationship of the sexes to each other, our educational establishments and science itself, i.e. the specific way in which physics and technology perceive themselves and present their image to the outside world.

We must invest in each of these areas if we wish to make lasting changes to the structures, and I think that the chances of doing so are favourable at present. For one thing because political and economic conditions are such that politicians are prepared to invest in this subject, for another because physics and technology over recent decades have abandoned their long practised approach of "everything is possible", have become more open, even to multidisciplinarity. In society, the turn away from the traditional image of the sexes has become perceptible above all in art and in intellectual discussion. The traditional allocation of roles in the family, too, is frequently no longer as self-evident as it was about fifty years ago.

### Reflexive co-education instead of mono-education

We must therefore direct our particular attention to where social gender is construed. Viewed politically – and this applies perhaps to the question of co-education too – we are faced with an apparently insoluble problem. On the one hand it is important to avoid anything that contributes to creating differences between the sexes; on the other existing inequalities and disadvantages have to be removed. Referred to the question of co-education in schools, particularly in the teaching of physics, this means that mono-educational institutions create differences and at the same time fix and restrict the possibilities for individuals. On the other hand we know that co-education too, in its usually practised form, heavily disadvantages girls or boys at any one time – in physics, girls in particular.

The usual way out of this dilemma today is called reflexive co-education. Referred to physics, this means providing learning environments in which girls and boys find opportunities for learning appropriate to their respective individual talents and interests. At the same time, it should also be ensured, however, that no one is disadvantaged – for instance by reason of gender. The quality standard for teaching formulated in this way is a very high one and its achievement requires outside support. Formulated the other way round, girls are in general a good sensor of the quality of science teaching, as everything that motivates boys, i.e. gaining status, communication in the peer group, job prospects, is missing.

## The Quality of Science Teaching – Examples from Austria

### Innovations in Mathematics, Science and Technology Teaching (IMST²)[1]

We know very well today what high-quality teaching should look like – the problem is in achieving it. I would like to present to you a number of programmes currently running in Austria aimed at enhancing the quality of science teaching. These also take account of the "gender" aspect under the title "Gender Mainstreaming" (in a definition of the programmes still being developed in some respects, at least). Firstly there is the widest-reaching programme designed for science teaching: Innovations in Mathematics, Science and Technology Teaching (IMST2)

The immediate reason for this programme was the findings among students taking the school-leaving exams for university entrance qualification. Austria has not only done poorly in terms of subject knowledge in mathematics and physics by international comparison, but also the gender gap in comparing the performance of boys and girls was, viewed internationally, particularly wide.

A special feature of the programme is support for and promotion of initiatives carried out by individual school teams (similarly to the BLK-model "Increasing the Efficiency of Mathematics and Science Teaching"). In 2002 – the second year it has been in operation – a total of 241 schools are involved in the project, 53 as co-operating or focus schools.

**Girls as sensors of quality**

The programme concentrates on two focal points:

- In one of the focal areas, support is given to teams of teachers who wish to set a science focus in their schools. For example, they take the introduction of laboratory classes as their objective. In doing so, it is also quite possible to do away with co-education.
- Another focal point ("Teaching and Learning Processes") is essentially a professionalisation programme. The objectives of this focal area (headed by H. Jungwirth & H. Stadler) correspond to those of reflexive co-education. On the one hand it is a matter of disseminating the idea of greater individualisation in teaching mathematics and science and the possibilities of achieving this, that is, amongst other things, making high-quality teaching concepts visible. On the other hand, however, structures have to be developed to foster and support reflection on the teaching by those involved in the lesson. Thus, for example, a video feedback system has been developed in this connection. Schoolgirls and schoolboys analyse a video film of their lessons together with the teacher, using a question and answer technique, and jointly discuss and decide on improvements.

In this focal area, teachers are supported by a research programme, in which individual aspects of teaching are examined and the research results made directly available to those involved. The results becoming clear in this process are often surprising. It was found in one class, for example, that girls and boys assessed the difference in their interests in particular scientific or technological questions far greater than it actually was. These results triggered the teachers to discuss conceptions of roles with this class. Reflecting on gender-specific behaviour in a way suitable to the situation together with a teaching programme, which appeals to girls and boys and invites them to learn, is in our view a good possibility of resolving the problems of co-education.

Motivation of teachers to co-operate is on one hand of an intrinsic nature – teaching staff are interested in developing their teaching further – but on the other it is also extrinsic: in the framework of autonomy, schools are required to formulate a school profile and lay down quality standards.

### Women into Technology

Intrinsic motivation of schoolgirls to concern themselves with anything is essentially connected with their concept of themselves, i.e. also with the question as to how they assess their ability in a particular field. Almost as important to young people is whether what they learn provides them with better chances in life, especially in respect of employment. Boys expect a profession involving technology and physics to have good prospects – they are also assured by industry. In addition, this choice of profession coincides with the common image of masculinity. This is not the case for girls. The profession of physicist or technologist for them means on the one hand being a minority in their professional environment, on the other it also

[1] The first IMST-project was run in 1998-99.

represents a decision which goes against the commonly held image of women. In the main, there are no leading figures or women in general, with whom they can identify or who at least can act as contacts and sources of information. In Austria, the project "Women into Technology" (FIT) comes in at this point. Schoolgirls are invited to visit institutions to meet women physicists and technologists at their place of work, etc.. A mentoring programme is also planned from 2002.

http://imst.uni-klu.ac.at

**Science as Culture**

Another project is interesting in connection with the GASAT recommendations mentioned earlier. "Science as Culture" is an inter-disciplinary project initiated by the "Institute of Interdisciplinary Research and Further Education" of the Universities of Klagenfurt, Vienna, Innsbruck and Graz (IFF) (Executive Head of Project: Roland Fischer). Cultural practices in individual sciences are analysed in the framework of this project, as manifested in lectures, for example. It becomes clear, for instance, that the individual sciences are introduced to new students completely differently. History, for example, is presented as an open field, in which every student – regardless of gender – has the opportunity to play a part, in which the interpretation of facts is to the fore. Physics, on the other hand, is introduced as a finished framework without any relation to life, as a science in which there is no room for doubt, one's own interpretations or individuality. It presents itself as a field to be learned laboriously by repetition and imitation. Only at a later stage can an individual search for truth begin.

http://www.tn.uni-linz.ac.at/FIT/

**Conclusion**

It will be seen from what has been said above that a science presenting itself in that way, such as physics, demands a great deal of self-assurance in students. He or she must put away any expectation of being able sometime to make sense of life for himself or herself. Women are disadvantaged in this case, for they set greater store on making sense of things than do men. This results in their self-confidence, which is clearly less pronounced in these fields anyway, being tested once again. They have to believe in discovering this meaning for themselves sometime, although not in their studies.

In the sense just mentioned above, all measures taken to open up physics and technology to women also mean reconsidering science and technology. Not so much content has to be rethought as the culture which has developed, particularly in the external and internal perception of science. In similar fashion we can say of the teaching of physics in schools that opening up lessons for women and girls means enhancing quality: not because – as Wagenschein maintains – teaching appealing to girls also appeals to boys, but because physics teaching "appropriate to girls" means that every individual is presented with a variety of methods and contexts, in which he or she finds those areas and learning possibilities that represent the optimum for himself or herself.

http://www.iff.ac.at