



Five Gender-Inclusive Projects Revisited

A Follow-up Study of the Swedish
Government's Initiative to Recruit
More Women to Higher Education in
Mathematics, Science, and Technology

Inger Wistedt, Department of Education Stockholm University

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National Agency for Higher Education (Högskoleverket) • Birger Jarlsgatan 43,
Box 7851 • SE-103 99 Stockholm • phone 08-563 085 00 • fax 08-563 085 50
e-mail hsv@hsv.se • www.hsv.se

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Author: **Inger Wistedt**

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Preface

In 1992 an initiative to promote change in higher education was taken by the Swedish Government. In a Government bill (Prop. 1992/93:169) a special grant of 5 million Swedish Crowns per annum over a three-year period was allocated with the aim of attracting new groups of students to university programmes where male, middle-class students are in majority. Two goals were formulated for the initiative by the Swedish Council for the Renewal of Undergraduate Education the agency which distributed the Government funds through a national competition: To broaden the recruitment of students to science-related studies, above all the recruitment of female students, and to enhance the quality of teaching within higher education by encouraging new teaching methods that would appeal to these new categories of students and make the most of their capabilities.

In 1993, five Swedish universities received about 3.5 million Swedish Crowns each for developing gender-inclusive programmes involving a rethinking of the traditional ways of teaching and examining students. This study presents an evaluation of the Government's initiative. It comprises the results from a previous evaluation, conducted from 1995 through 1998 (Wistedt, 1996; 1998a), but it also updates these results in a follow-up study carried out from 1999 through 2001.

Both quantitative and qualitative methods for gathering and analysing data have been used in the latest study, which makes up the bulk of this report. Following the introduction to the study, and a summary of the results from the previous evaluation, an overview is offered which renders a statistical picture of the continuous recruitment results as well as a picture of how the new groups of students succeed in their studies. It also comprises interviews with teachers and students at the five universities that received funds from the Council. In these interviews the interviewees comment on the development work as ways of attracting female students to male-dominated subject areas and as ways of raising the quality of teaching by taking into account the variation in the students' experiences and approaches to learning.

Have the five projects that received funds from the Council succeeded in fulfilling the aims expressed in the Government bill? Have they been successful in their recruitment of new groups of students to the program-

mes, female students in particular? Have they been successful in implementing new teaching methods, and can these methods be said to fill the students' needs in terms of developing their competence within the subject fields they have chosen? These are the questions raised in this study. I wish to thank all the students, teachers and administrators at the five universities who have helped me in answering these questions. I also want to thank Gudrun Brattström, senior lecturer at the Department of Mathematics, Stockholm University who helped me to bring order to all the statistical data. Much of what appears in the quantitative analyses presented in this report reflects understandings which Gudrun and I arrived at together. I'm also indebted to Tom Lavelle at the Stockholm School of Economics for his sensitive and professional comments on my English.

Finally I want to express my thanks to the Swedish National Agency for Higher Education and the Council for the Renewal of Undergraduate Education who initiated and funded the evaluations, giving me the possibility to visit, and revisit the teachers and students involved in the development works. Some of the results from this study give cause for concern, other results are more promising. I hope they will all, good or bad, encourage a discussion about the possibilities for realising a more inclusive kind of education.

Stockholm, December 2001

Inger Wistedt

Summary

In this study we take a second look at seven degree programmes launched in 1995 at five Swedish universities. In 1993 these five universities received about 3 million Swedish Crowns each within a Government initiative allocated to broaden recruitment to male-dominated programmes within higher education

How has the recruitment of female students to these programmes developed over time? How have students from different categories succeeded in their studies? How have the educational reforms developed designed to be sensitive to the needs of these new groups of students? How are the programmes regarded, and have the ideas from the initiative spread to other programmes at the respective universities? These were the questions asked in this follow-up study of the initiative. The data used to answer these questions comprise a census, covering all students entering the seven programmes in 1995, 1996, 1999 and 2000, 1,494 students in all. The study was also based on interviews with teachers and students at the respective universities, 20 teachers and 14 students, revisited five years after the implementation of the programmes.

The results show that three of the seven programmes were quite successful in recruiting and retaining female students (*Scientific Problem Solving* at Göteborg University, *Energy and Environmental Engineering*, and *Innovation and Design*, both at Karlstad University). The proportion of female students at these programmes was high (about 40-50 per cent), the drop-out rates were evenly distributed between the sexes, the examination rates were high compared to national statistics, and they all had a high proportion of female degrees as measured in October 2000, five years after the implementation of the programmes. The credit productivity was also high among the female students, relative to the credit productivity among the male students, even if we found a tendency for women to lose ground. We could note a slight reduction in an earlier female lead for students admitted during the academic year 1999.

Four of the programmes were not as successful. One of the programmes was closed down in 2000 (*The Project Programme* at Stockholm University). The three remaining programmes, all within the field of computer science and engineering, encountered problems in raising the proportion of women

above the national average (*Computer Science and Engineering* at Chalmers University of Technology, *Computer Engineering* at Karlstad University and *The IT-programme* at Linköping University). Among these, the IT-programme was the most successful. During the implementation phase the proportion of women at this programme was quite promising (40-49 per cent), but it dropped drastically in the later years. The drop-out rates were found to be higher among female students at all of the computer science and engineering programmes compared to the male drop-out rates, and the credit productivity among women showed a negative development. These programmes also showed a negative development in the recruitment of female student and students from non-traditional student groups, whereas the other programmes increased their proportion of such students during the five-year period. Since one of the goals of the initiative was to broaden recruitment to categories of students who do not traditionally choose tertiary programmes within natural science and technology, these results give cause for concern.

The Council established the principle that the funds should not be allocated to recruitment projects only, but to promote pedagogical renewal. This seems to have been a wise decision. The recruitment efforts, which were smaller or larger parts of all of the projects have not yielded the expected outcomes. The leading principle of the initiative, adopted by most of the programme designers, was the conviction that there is something exclusionary about male-dominated programmes, something which calls for a more profound reform of their content and structure.

One characteristic of the programmes that were successful in recruiting and retaining female students was that they offered what we may call “an open entry” to male-dominated study programmes: the possibilities for the students to get acquainted with various subject areas, such as mathematics, physics, and environmental science/mathematical statistics, without having to choose a single subject from the start. What the successful programmes offered the students was not only the possibility of postponing the choice of one or another subject area, but the possibility of getting to know these subjects through projects to work on in co-operation with their peers, and with their tutors who could inspire them and show them what it could mean to be a human being working within the areas in question.

Creating an alternative to the male-dominated culture of computer engineering is not accomplished easily. The results show that the attempts to revise and reform existing programmes have not been fortuitous. The more radical attempts to launch new programmes with an alternative

organisation of the subject matter in terms of structure and content, have been more successful. It takes more than modest changes in the structure and content of male-dominated degree programmes in order to achieve gender-inclusiveness. Among the programmes linked to the Government's initiative more radical changes were implemented at the new programmes, and these programmes were, in general, the most successful in reaching the goals set for the initiative.

However, such substantial changes in structure and content of the current curricula are not easy to implement. To suggest alternative ways of educating mathematicians, physicists or engineers is, in essence, to criticise the existing programmes. Such criticism is bound to stir up feelings among people not directly involved in the developmental work. In order for the new programmes to gain a foot-hold within the broader culture of their respective departments and universities, it seems to have been necessary for them to create strong internal cultures. Such strong cultures are easier to create if the project-groups are fairly small. The successful projects were small, both in terms of the number of students enrolled and in terms of the number of tutors involved in the developmental work. Another factor seems to be staff continuity. If mobility among the tutors involved in the project is high, it is hard to build the further development of the programme on experiences which have become parts of the programme's history. A strong internal culture may help the project participants to endure the ups and downs of developmental work. The numerous questions that arise concerning the changes made, not least questions that have to do with the academic status of the alternative programmes, may eventually find answers if the tutors are allowed to try out their ideas in the company of critical friends. However, a negative side to building such strong internal cultures is that the projects may develop into closed circles with little contact with colleagues outside of them. Such tendencies were reported in the interviews. Isolation may, however, be countered if the project groups join forces with colleagues at other universities who are involved in similar efforts to renew higher education.

One threat to the survival of the programmes within the initiative is their current economic situation. At present, the established programmes are expanding their number of study places, and the prospective applicants are at the same time fewer than they used to be due to demographic fluctuations in the Swedish population. As a consequence, the newly launched programmes all report difficulties in recruiting students, an obvious result of the expansion since the marginal effects will hit them the

hardest. In short this means that the Government's initiative to enhance the recruitment of women to tertiary programmes dominated by men, is blunted by another initiative launched by the same Government — the effort to enhance the recruitment of students to natural science and technology studies in general. Nevertheless, the initiative can be viewed as a worth while effort, putting gender issues on the agendas of universities and departments where many had little experience and knowledge of gender questions and perspectives. As such, the initiative can be viewed as a first step in a process which, hopefully, will survive the critical years ahead.

I. Introduction

The Swedish Government's Initiative

In Sweden, as in many other countries, men's and women's choices of tertiary education are still bound by tradition. Although female students are in the majority among registered university students as a whole, about 60 per cent in 1999/2000 (SCB, 2001), they are still in minority within certain areas of study. In 1999/2000 the share of women in mathematics was 33 per cent, in physics 32 per cent, and in technology 30 per cent (*ibid*, p. Appendix 2). However, compared with previous years this was a substantial increase in female student enrolments. For a number of years the proportion of women entering programmes leading to a professional degree in technology lay steadily around 20 per cent. During the last six years this proportion has risen by about 9 per cent, and the same trend can be noted within the natural sciences. It would seem as if the many recent initiatives to recruit more women to higher education in science and technology are paying off. One such initiative is evaluated in this report.

The Swedish Government's Initiative to Recruit More Women to Mathematics, Science, and Technology

In 1993 the Swedish Government formulated a programme to encourage increased participation of women in male-dominated degree programmes (Prop. 1992/93:169). One of the proposed measures had the form of a special grant of 5 million Swedish crowns per annum during a three-year period, allocated to promote change in the form and content of study programmes within male-dominated fields of enquiry.

The grant was distributed through a national competition for funds for development projects aimed at designing and launching inclusive degree programmes (of 120-180 academic credits) in mathematics, physics, and technology. Two goals for the development work were formulated by the Swedish Council for the Renewal of Undergraduate Education, which distributed the funds:

- To broaden the recruitment of students to science-related studies, to reach out to students who do not traditionally choose science-related studies, above all female students, and
- To enhance the quality of teaching within higher education by encouraging new teaching methods that would appeal to these new categories of students and make the most of their capabilities.

The Five Development Projects

What teaching methods might appeal to female students in mathematics and science? An assumption often expressed about female learners is that they prefer working in groups and in close contact with teachers and peers (e.g. SOU 1995:110, p. 260; Cordeau, 1993; cf. Belenky, Blythe, Goldberger, & Tarule, 1986; Gilligan, 1982, cf. Burton, 1995, Damarin, 1995; Hawkesworth, 1996). This assumption also formed the basis for the Swedish Government's initiative. In the review process five projects were singled out:

- **Scientific Problem Solving** a new M.Sc. programme of 160 academic credits (four years of full-time studies) in mathematics, physics and environmental science at Gothenburg University, admitting about 30 students.
- **The Project Programme** a new M.Sc. programme of 160 academic credits in mathematics, mathematical statistics and physics at Stockholm University, also admitting about 30 students.
- **Reforming the Computer Science and Engineering Programme, D++**, as the name indicates a reformed M.Sc. programme of 180 academic credits (four and a half years of full time studies) at Chalmers University of Technology, in 1995/96 admitting about 100 students.
- **The IT Programme** a new M.Sc. programme of 180 academic credits in information technology at Linköping University, admitting about 30 students.
- **Women in Engineering Education**, including three new engineering programmes of 120 academic credits (three years of full time studies), in 1995/96 together admitting about 110 students directed towards the fields of computer engineering, energy and environmental engineering, and innovation and design¹.

1. The latter two programmes were new, the former (Computer Engineering) was revised in 1995.

These five projects differed in many respects. They had, however, some essential characteristics in common. They were all involved in:

1. **A re-thinking of the traditional forms of teaching and assessing students**, moving from lecture-based teaching to collaborative forms of work and from traditional forms of assessing student learning based on written tests to assessment methods that call for communication of subject knowledge in a variety of settings.
2. **A development of problem-solving approaches to learning**, moving from subject-oriented to problem-oriented ways of organising the subject matter.
3. **An implementation of interdisciplinary studies**, moving from single-subject studies to interdisciplinary course work, where teachers from different scientific disciplines co-operate in planning the programmes and in teaching, tutoring and examining the students.

Previous Evaluations of the Government's Initiative

The Swedish Government's initiative was evaluated in 1995–1998 (Wistedt, 1996; 1998a). Part of the evaluation was co-ordinated with a research project focusing on qualitative studies of mathematics learning in gender inclusive contexts (Wistedt, Brattström, Martinsson, 1996; 1997; Wistedt, 1998b).

A summary of the results from the 1995–1998 evaluation is presented in the next chapter. However, since 1998 much has happened, not only within the programmes but also within the university system as a whole. The most notable change is the expansion of the number of degree programmes within the natural sciences and technological sectors. For example, the number of programmes leading to a Master's degree in technology increased from 15 study programmes in 1991/92 to 32 different study programmes in the academic year 1998/1999 (Ingermarsson & Björk, 1999, p. 5). Existing programmes have also expanded in terms of the number of students admitted. Before the expansion, that is, in the year 1993/94, 46,000 students were enrolled in university studies in the field of technology. Six years later, 1999/2000, there were 66,000. The same trend can be observed within the natural sciences, expanding from about 64,000 to 83,000 students enrolled during the same time-period (Högskoleverket, 2001, p. 16). In 1995/96, the Computer Science and Technology programme at Chalmers admitted 106 students. In 2000/01 they admitted 159. At Karlstad University 46 students registered for studies in Computer Engineering in 1995/96, 130 in 2000/01.

This expansion has been motivated by an expected rise in the demand in society for expertise in science and technology. Prognoses say that balance between supply and demand will be met in about ten years if the expansion is allowed to continue (SCB, 1999). There are, however, worrying signs that run counter to such a positive prediction. Many degree programmes already have problems recruiting students to fill the study-places available. A recent survey enquiring into the study interests among students about to leave upper secondary school (SCB, 2000b) showed that only 60 per cent of the students at the top form of the Natural Science programme planned to continue their natural science or technological studies at the tertiary level. Even more worrying is that this trend is most notable among female students. In 1994/95 three female students out of ten at the top form of the Natural Science programme said that they had plans to further their education in technology. In 1999 only one out of ten reported such plans (SCB, 2000b).

The universities are expanding their offerings. The students, however, seem less inclined today than five years ago to take up these offerings. As a result, degree programmes have to compete rather harshly in order to recruit students. Glossy brochures are sent out to prospective applicants, traditional programmes are given new and more attractive titles, and as the competition hardens, newly launched programmes fight for their existence. All these circumstances have to be taken into account when we revisit the programmes for a follow-up study, five years after the implementation of the programmes linked to the Government's initiative.

Summary of the Results From the Evaluation 1995–1998²

The Recruitment Aspect of the Initiative

In 1995 the first students entered the seven programmes linked to the five projects that received funds within the Government's initiative. In 1996 five of these programmes had reached the desired goal of recruiting at least 30 per cent women. Four of the programmes scored well above average in comparison to the mean percentages available in the national statistics, recruiting 36–56 per cent female students.

Table 1: Proportion of female students within each programme. Total number of entrants in 1995 and 1996. Female entrants in numbers and percentages.

University	Programme	1995			1996		
		Total	Female	%	Total	Female	%
Chalmers	D++	106	16	15	111	21	19
Göteborg	Scientific Problem Solving	33	18	55	34	19	56
Karlstad	Computer Engineering	46	7	15	65	10	15
Karlstad	Energy & Environmental Eng.	18	5	28	31	9	29
Karlstad	Innovation & Design	20	3	15	22	10	45
Linköping	The IT Programme	35	14	40	35	17	49
Stockholm	The Project Programme	23	7	30	25	9	36
Total		281	70	25	323	95	29

The evaluation of the recruitment aspect of the initiative was based on statistical analyses of data comprising all 604 students entering the programmes in 1995 and 1996 (sex, study background, grade-point average, drop-out rates, results on course examinations for students entering in 1995). The results showed that:

- The recruitment results varied among the programmes, from 56 per cent to 15 per cent female entrants
- The percentages increased in all of the programmes during the second year, considerably in some of them

2. This summary has, in a slightly different version, been presented as a paper at the Fourth Conference on Women and Mathematics, Uppsala, Sweden, April 16–18, 1999 (Wistedt, 2001).

- New programmes tended to attract more female students than degree programmes which were developments of more established programmes

However, the initiators of the projects not only expected women to enter the programmes; they also want them to stay. Table 2, below, gives an overview of the total drop-out rates within the programmes linked to the initiative.

Table 2: Tendency to leave the programmes. Total number of students enrolled 1995 and 1996, female and male drop-outs in numbers and percentages of each sex-group.

	Number of students	Number of drop-outs	% drop-outs
Female	165	26	16
Male	439	33	8

We found that:

- Female students tended to leave the programmes to a greater extent than male students did.

However, before we could draw any conclusions from these drop-out rates, we needed to know whether there were variables other than sex involved in producing the results. The alternative teaching methods implemented within the programmes were also meant to favour new groups of students, for instance students from non-traditional student categories (see Wistedt, 1996), applicants with a background that is more varied than is usual among entrants to higher education in mathematics, physics and technology. When we investigated the drop-out rates further we found some interesting results:

- Students who did not have a natural science background tended to leave the programmes to a greater extent than other students did. Of the 59 students who dropped out during their first years of study, 24 were students with an upper-secondary education in the humanities or social sciences, students who had acquired the necessary entrance qualifications by attending supplementary natural science courses. We also found that:
- Female students were over-represented among students who did not have a natural science background.

From the statistical investigations of the relationship between sex, study-background and drop-out rates³ it seemed reasonable to conclude that the seemingly high proportion of female students leaving the programmes could not be attributed to sex alone.

From the interviews with students on the programmes we learned that students often give poor study results as one of the reasons for leaving the programmes. This called for a broader definition of 'recruitment' which included not only enrolment and drop-out rates but information about the students' study results as well. In March 1997 data was gathered about the results of students enrolled in 1995. Test results and grades were reported from two ordinary assessments in mathematics and two tests given in one of the supplementary core subjects, covering the first term. Again we investigated the variables sex and student category, now regarding results from courses and projects.

We could not find any general tendency for female students to do better on examinations following certain types of course work. However, students with a non-traditional study background did significantly less well than other categories of students on course examinations. Project examinations did not seem to cause the same difficulties. However, this may have been an effect of the assessment procedures. Most of the teachers involved in the new programmes had less experience in assessing individual knowledge acquired through co-operative work forms than in designing course examinations. Nevertheless, it would seem as if the programmes had not yet succeeded in adjusting their teaching methods to meet the demands of the non-traditional students.

A Short Comment to the Results

The results summarised above show that the development projects, on the whole, were quite successful during the first two years in their ambitions to recruit female students⁴. In 1996 five of the seven programmes had reached the desired goal of recruiting at least 30 per cent female students to subject areas traditionally dominated by men.

3. For a more elaborate description of the statistical methods used and the results obtained, see Wistedt, 1998a, p. 31–37.

4. If we exclude the computer science programmes at Chalmers and Karlstad University, which scored slightly under average in their recruitment of female students in comparison to the mean percentages available in the national statistics in 1995/96, all of the other programmes scored well above average.

From a gender perspective these were promising results. One drawback was, however, that the computer science programmes remained problematic in terms of female recruitment⁵. Another drawback was that the projects had not been successful in their aim of recruiting students from non-traditional study groups. It seemed as if we were dealing with a group of students who were exposed to an academic culture which was unfamiliar to them. This group also happened to be one of the targets of the recruitment campaign — students who did not choose science-related programmes at the upper-secondary school but who had reconsidered their career choices and who had devoted substantial time and effort to acquiring the competence needed for admission. And, furthermore, in this group female students were over-represented.

How could these recruitment results be accounted for in an inclusive perspective? What could explain the rise in interest in science-related studies among women observed within five of the programmes, and what could explain the setbacks? As pointed out above, we could not rely solely on statistical measures when addressing these questions. We had to address them from a qualitative point of departure.

The Pedagogical Aspect of the Projects

The initiators of the development work were mostly men or women well adjusted to academic cultures. Many of them found it difficult to express any firm beliefs about what would be relevant changes in the recruitment process. Most of the reformers did not really know what would be workable means for achieving the end of making their educational programme inclusive. The measures were first and foremost pedagogical: a rethinking of ways of organising the course-work, and the introduction of teaching methods that would supposedly attract more women.

5. We could not provide any explanations for this other than the observation that these programmes had a history. People may have formed views not only about computer engineering programmes as dominated by men but of men with hacker-tendencies and with extensive experience in handling computers. Such ready-made opinions exist in society and might, even if inaccurate, have influenced the career choices made by the prospective applicants. The revisions of the programme policies within the computer science area may, however, be rewarding in the long-term perspective. University programmes are not only the objects of the formation of student attitudes: they are actors on a social scene where these attitudes are formed and, hence, may change as a result of changes within the educational system.

This illustrates the confusion between making gender inclusive education and recruiting more women. As the reformers really did not know of any criteria for gender inclusive education, the percentage of women recruited became the only relevant criterion. Of course the reformers also hoped that female students would enjoy their education and not drop out, but recruiting them was the primary concern — and if problem-based learning could help that and provide for a new pedagogical context, it was worth trying. (Salminen-Karlsson, 1999, p. 131-132)

What was the message to the prospective students signalled by the pedagogical changes, and how did they work out? Three case studies were included in the evaluation (Wistedt, 1998a) in which 65 students (27 women and 38 men) took part, and 36 interviews were carried out with teachers and students within the programmes (10 teachers and 26 students). In these in-depth studies we followed students within three of the development projects in a variety of settings consistent with the inclusive policies of the programmes, that is, they were problem-oriented, co-operative and interdisciplinary in nature. As such they provided cases for a discussion of the forms of work implemented within the programmes and how changes in the ways of experiencing teaching and assessment influenced the ways in which the students approached the subject matter.

The Collaborative Forms of Work

There was one conception which joined together all the diverse functions of the collaborative forms of work implemented within the programmes linked to the Government's initiative. This was the conception of learning as a process of gaining knowledge by interacting with the content in dynamic ways which include exchanges with teachers and peers. Thus, the implementation of alternative work forms, i.e. alternative to the traditional lectures and exercises, signal to prospective students that within these programmes **teaching matters**. The teachers had expressed their concern by re-thinking their ways of teaching and assessing student learning, which in itself may have functioned as an invitation to those students who were sensitive to the educational environment. Such considerations may be one important factor that can account for the increasing number of female student applying to the new programmes.

The functions of the groups to facilitate student learning may, however, come into conflict with their social functions. Students who are socially sensitive may take on a great deal of responsibility for the organising of group work which may be harmful to their studies, an observation we made

in the case-studies. From a gender perspective these dimensions of the collaborative work forms are worth reflecting on, especially if we ascribe to the female students a tendency to be socially perceptive.

It can also be noted that if the responsibilities for carrying out the assignments are shared among many students, the demands on an individual student become less clear and distinct. Viewed from the perspective of a more inclusive education this is a crucial aspect of the collaborative forms of work. Students who do not have a background in the natural sciences may find it difficult, at least in the beginning of their studies, to contribute to the group discussions. If they have doubts about their own capabilities they may rely on others to carry out the work. In a large group there is a broad spectrum of social roles to play, and there will be ample opportunity for students who are less sure of themselves to take on relatively passive roles in relation to the topics discussed. In such cases the collaborative forms of work may obstruct rather than enable progress toward the goal of promoting student learning, an observation which may, at least to some extent, account for the higher drop-out rates among students with a non-traditional study background.

The Problem Solving Approaches to Learning

The introduction of problem-solving approaches signals to the students that the teachers are sensitive to a variation in qualities of student learning, in short that within the programmes **learning matters**. However, such approaches do not in themselves facilitate learning. Assignments, whatever form they take, have to be interpreted by the learners, and the intended interpretations, even if obvious to an informed reader, may be far from obvious to the students (Halldén, 1988; Wistedt, *et al*, 1996). One of the case studies included in the evaluation specifically addressed this aspect of the development projects (Wistedt, 1998a, pp. 51–74).

In traditional teaching the task of helping the students to define relevant problems is often met by presenting standard tasks defined in terms of procedures or algorithms used to carry them out. This means that the students are never confronted with the problem of delimiting ambiguous situations. It also means that the creative and heuristic aspects of the subjects remain hidden from the students. Within the programmes linked to the initiative, however, these aspects were brought into focus.

The students may, however, find it difficult to adopt a heuristic approach to their tasks. In doing their projects the students come across questions, issues and concepts which they would like to understand more fully. However, in order to carry out their projects efficiently they may have

to leave these topics of interest unexplored. The problem can be described as a problem of combining the responsibilities of learning and the responsibilities of completing a project in an efficient way (cf. Halldén, 1982, 1988; Wistedt, 1987).

Restricting the enquires to matters immediately relevant to a local situation may affect the possibility of reflecting upon the theories, which may, in fact, lead to shallow knowledge (*ibid.*, cf. Bergqvist, 1990; Bergqvist & Säljö, 1994), or to a surface-level processing of the task content (Marton & Säljö, 1976a, 1976b). If practical goals are allowed to dominate, it could mean depriving the students of the opportunity to engage in theoretical enquiry, which clearly would be doing them a disservice (cf. Hanna, 1994, Wistedt, *et al*, 1997).

The results of the evaluation showed that the problem-solving approaches require an awareness of the overall aims of introducing more open-ended tasks to the students. The teachers must find ways to balance the **know-how** or design-oriented approaches to problem solving, and the **know-why** or theoretical orientations (Kjersdam & Enemark, 1994). The results of the evaluation told us that such a balance was not fully reached within the programmes when the evaluation was carried out.

The Inter-Disciplinary Approaches to Learning

The alternative forms of work implemented within the programmes also aimed at developing a broad understanding of the subjects by integrating different subject perspectives and by helping the students discriminate among complex patterns of interpretation. Thus, the inter-disciplinary approaches tell the students that the whole **academic setting matters** to the programme organisers, not only the subjects in a limited sense, but also their links to other fields of interest and to issues relevant to society.

When students are assigned tasks that concern more than one subject area, they are confronted with questions of how to approach these tasks. What factors should they pay attention to and what questions should they pursue? An emphasis is put on questions which are rarely asked in traditional teaching: questions about the nature of the subject knowledge, meta-theoretical questions which, when asked, illuminate a range of theoretical presuppositions informing the cognitive practices of the academic cultures—What is a proof? What is a variable? What is the character of hypothetical reasoning?

Since such theoretical presuppositions operate on a tacit level, they may be hard to unravel, not only for those who are seeking entrance into the cultures but also for those who are fully socialised into them, and for whom

they constitute a 'natural attitude' (Hawkesworth, 1996, p. 91). However, the evaluation showed that interdisciplinary co-operation can promote reflection upon this meta-theoretical realm (Wistedt, 1998b).

What makes such reflection essential in an inclusive context? Many of us share the experience of having learnt in taken-for-granted contexts where the presuppositions for the reasoning were hidden from us (see examples in Wistedt, 1994a, 1994b). Students who are self-reliant may easily overlook such gaps in their prerequisite knowledge. They may feel comfortable anyway, trusting in the promises that all will eventually become clear, and that it is possible to go on without being fully informed. But students who belong to minority groups, or students who are less familiar with the cognitive practices of natural science or technology or generally less familiar with academic discourse, may feel less confident if they are left to figure out the fundamentals on their own. To refer to matters which 'go without saying' may effectively exclude students who are unaware of the cultural norms, even unaware of the fact that such norms exist (Halldén, 1986, 1990; Bergqvist & Säljö, 1994; Wistedt, 1994a, 1994b). Research has shown that difficulties in discovering and utilising taken-for-granted meta-communicative tools co-varies with achievement level (Miller & Parlett, 1974; Säljö & Wyndhamn, 1988, 1990; Säljö, 1991). Students who are regarded as 'low achievers' are often found to have problems deciphering information of a meta-theoretical kind.

Inclusive programmes have to consider such difficulties. In many ways the programmes within the Governments' initiative had the ambition to do so — by introducing a variation in perspectives, the students were offered an opportunity to become aware of knowing as a culturally related phenomena (Wistedt, 1998b). However, the relatively higher drop-out rates among students with little experience of natural science studies indicated that the teachers had not fully investigated the consequences of these possibilities at the time of the 1998 evaluation.

Concluding Remarks

The Government's initiative started a process of reflection among the teachers involved in the development projects on how to change university teaching to meet with the double challenge of attracting new groups of students, female students in particular, and to adapt the ways of teaching to meet with these students' needs. In terms of recruitment the initiative was successful during the implementation years. In terms of stimulating change

in approaches to teaching it served as an incitement to try out ideas and to reflect upon educational issues which stretched beyond the projects that received funds.

In this report the projects are revisited five years after the implementation of the ideas. The next chapter presents the outline of a follow-up study of the initiative and describes and discusses the methods for gathering data about the long-term effects of the programmes: What has been gained from the initiative? Have the projects been successful in achieving their goals?

Methodological Considerations

The Aim of the Study

The evaluation summarised in the previous chapter was carried out in the midst of an on-going implementation period, where the evaluator took on the role of a partner in a critical discussion of the aims and outcomes of the initiative. The objectives of the evaluation was defined on the basis of interviews with teachers and project leaders, and the empirical studies presented in the evaluation report (Wistedt, 1998a) were designed in close co-operation with the teachers and students involved in the development work.

In this study we are taking a second look at the recruitment results: How has the recruitment of female students developed over time? How well do students from different student categories succeed in their studies? In the previous evaluation we found that women tended to leave the programmes to a greater extent than male students did. This effect was, however, complicated by the fact that students from non-traditional student groups, that is, students who had an upper secondary school certificate from the humanities or social science programme, had a higher drop-out rate than students from traditional student categories, and among these non-traditional students we found a higher proportion of women. In this study we can test the hypotheses formulated on the basis of the results of the 1998 evaluation (Wistedt, 1998a, p. 31): that the higher proportion of female students leaving the programmes cannot be attributed to sex alone, but to the fact that women are over-represented in a category of students who have problems coping with a study situation not yet adapted to meet their needs.

We are also taking a second look at the educational reforms deemed to be sensitive to the needs of these new groups of students, female students in particular: co-operative forms of work, problem-solving approaches to learning, interdisciplinary studies were measures taken to develop a gender-inclusive education. How have they worked out? Have the ideas from the initiative spread to other programmes at the respective universities? How are the programmes regarded by people involved in the development work, and by people outside of the programmes? These were questions raised in interviews with teachers and students in the programmes. Twenty teachers were asked about their experiences of the development projects (see Appendix 1). With few exceptions they were teachers who had been with

the programmes since they started, nine of them were interviewed in the previous evaluation and revisited five years after the implementation of the projects. In addition, 14 students were interviewed (see Appendix 2). They all belonged to the classes of 1995 and 1996 and many of them had taken part in the in-depth studies made in the previous evaluation. Seven of these students had taken their degrees and moved on to graduate studies or work outside of the university. Most of them were successful students, which means that their views of the projects may be more positive than the views held by those who failed or dropped out. They were, however, able to take a critical look at the programmes and what they had offered them and their peers. In their comments they raised crucial questions about the programmes which will be used in this report to shed light on some of the initiative's basic assumptions.

The Recruitment Initiative

As mentioned, this follow-up study of recruitment to the programmes has the form of a census covering all students entering in 1995, 1996, 1999, and 2000 – 1,494 students in all. The aim of the study is to establish an overall picture of the recruitment results over a five-year period, and to look into the long-term effects of the development work.

Variables Considered

As mentioned in the summary of the results from the 1998 evaluation, 'recruitment' was not only defined in terms of enrolment, that is, we were not merely interested in the total number of students entering the programmes and the proportion of female students among them. We also considered drop-out rates and information about how different student groups succeed in their studies. This broader definition of 'recruitment' has also been used in the present study. Thus, four variables are considered when we revisit the five projects:

- 1) The total number of students enrolled in each programme, and the proportion of female students among them.
- 2) The proportion of students from non-traditional student groups within each programme.
- 3) The proportion of drop-outs for different student categories, female student in particular, and
- 4) Student success, i.e. achievement level for students from different student categories.

Quality of Data

Data for the present evaluation of the recruitment results was gathered during the period Oct.–Dec. 2000, and was based on data from the LADOK-system⁶, sent to us by the administrators at the respective universities, comprising information about sex, age, study background, grade-point average from the upper-secondary school or results from the university standard aptitude test, time of drop-out if applicable, information about study leaves, credits earned within the programme, date of graduation if applicable.

LADOK is a very reliable system, but every administrative system has its shortcomings. Some comments on the quality of the data are necessary if we are to avoid the problem of over-interpreting our results.

- The LADOK-system does not include credits obtained from studies abroad. In some of the programmes the students were encouraged to spend one or two semesters outside of Sweden. Credits earned at foreign universities are not included in the LADOK-reports. However, such credits are reported when the students receive their degrees, which means that the overall picture of the examination rates will not be effected by this missing data.
- Grades from the upper secondary school are not always included in the LADOK-material. In our data grades or results from the university standard aptitude test are missing for 179 of the 1,494 students in the census. This is, in part, due to the fact that students who have received their grades from the social science or humanistic programmes at the upper secondary school, and who have attended the university foundation year in order to qualify for natural science studies are admitted on the basis of their performance during this preparatory year, and, hence, their grades or results from the university standard aptitude test are not always reported in the LADOK-system. This also goes for some of the students on the waiting list, admitted to the programmes at a late date. The 179 student are, however, evenly distributed over the years, and over the different student categories, which means that the missing data will probably have a negligible effect on the overall results of our study.

6. LADOK is an administrative system used by most Swedish universities. It is a study-documentary system into which all credits earned by the individual students registered for studies are reported. Data from LADOK are used by CSN (The Central Study Assistance Committee) to decide if a student is eligible to receive a grant and/or a study loan. Data from LADOK is also used by the Swedish Government to establish the universities' annual performance equivalent.

- Leaves of absence are not always reported to the LADOK-system. Some students may leave their studies during one or two semesters without reporting their intentions to the programme administrators. In our data we cannot always discriminate between poor study results from continuous studies, and poor results due to the fact that the student has not attended any courses during a certain time period. Thus, the group of 'low-achievers' (see definition below) may include students who have taken a leave of absence without reporting it.
- Drop-outs are not always reported to LADOK, or reported later than they occurred. Students may be hesitant about whether to leave or not, they may take one or two semesters off while considering their options, or they may just leave without a word to anyone. In our definition of 'drop-outs' we have tried to circumvent such information gaps (see below).
- Examination results are not immediately registered in LADOK. There is a delay between the examination date and the registration date of about four weeks. This means that some students may have the required number of credits (ranging from 120 to 180 depending on the length of the programme) but no reports of a degree. Caution must be observed when interpreting the examination rates.

Above we have mentioned some problems inherent in the LADOK-system. Some problems, however, are not due to this system but to decisions made during the data-gathering process:

- Data used in the study of the recruitment initiative comprises credits and degrees obtained by each registered student from the Autumn semester 1995 to the Spring semester 2000. Since the students enrolled in 2000 had spent only half of a semester at the university when data was gathered we decided not to include the class of 2000 in our reports of the students' credit production. A three-month period is too short to provide a basis for any conclusions about credit productivity.
- For some of the students enrolled in 1995, 1996, and 1999, there are no reports of credits produced, 33 students in all. Of these, 22 are drop-outs from the IT-programme in Linköping (ten from the class of 1995, eight from the class of 1996, and four from the class of 1999). The administrator at Linköping University did not report any credits for students who had left the programme. However, these students will be regarded as 'drop-outs' in our study (see definition

below) which means that they will not effect the results of credit productivity, since we have decided to consider the students who have dropped out of the programmes separately when we judge student success, rather than including them in the statistics on credit productivity.

Validity of the Measures Used

When data was gathered for this study, five years had passed since the first students entered the programmes. Ideally all students who were enrolled in 1995 would have passed through the programmes by the year 2000, and many of those enrolled in 1996. However, this kind of progress is just an ideal. Of the students who entered universities in Sweden in 1993/94 about 30 per cent managed to take their degrees in five years, about half of them graduated in seven years. About 6 per cent never took any credits at all (Högskoleverket, 2001). In the report from the Swedish Parliamentary Auditors (Riksdagens revisorer, 1999) the low graduation rates from Swedish universities are discussed:

“Despite the fact that the number of students have increased considerably during the last ten years, the number of degrees has remained fairly constant. According to the National Agency for Higher Education, experience shows that during the last ten years the mean study-time has been prolonged. The graduation rates for a certain cohort can only be decided after a long time, about ten years. Of the university entrants about 60 per cent take their degrees in ten years time.” (ibid, p. 15, my translation)

This also applies to vocationally-oriented programmes, such as the programmes directed towards a Master of Science in Engineering:

“The examination rates for Masters of Science in Engineering have been relatively stable for a long time despite the fact that the programmes were prolonged in 1987/88 from 160 credits to 180 credits. (...) The annual report from the National Agency for Higher Education, 1999, shows that five years after initial registration graduation rates vary between 24 to 38 per cent. Ten years after enrolment the graduation rate has increased to 69 per cent. There is a tendency for graduation rates, after five years of study, to decrease for those who started their education during the 1990’s. After seven years the differences are negligible.” (ibid, p. 17, my translation)

This means that it is a bit early to evaluate the success of the projects since only five years have passed since they started. There are few alternatives available to comparing the results of the projects to the national statistics. However, the aim of this study is not to evaluate examination rates or credit

productivity as such. We are interested in comparing how different student groups succeed in their studies. We will need definitions that can help us compare the relative success of men and women within the programmes linked to the initiative and the relative success of students from traditional and non-traditional student categories.

Definitions

Below we define the variables used in this study. The definitions are crafted to circumvent the problems mentioned above.

The number of credits earned could be viewed as a measure of students' success if we restrict ourselves to a comparison of the relative success of students from different student groups. However, caution has to be exercised in several respects: The study programmes evaluated comprise a different total number of credits⁷. Some of the students have interrupted their studies for longer or shorter periods of time, making them likely to earn fewer credits than they otherwise would have earned. For these reasons, we make the following definitions for every student for whom the relevant data is available:

Effective study time

Effective study time = [2000 or date of degree if known] – [year admitted] – [length of interruption in years].

We remark that credits earned up to and including Spring 2000 have been reported to us, and interruptions are counted up to that time. This means that students admitted in the Autumn 2000 are automatically assigned an effective study time of zero.

Credit Productivity

Credit productivity = Estimate of the number of credits obtained within the programme divided by effective study time.

Here it should be noted that some students (about 5 per cent) have more credits than the total number of credits on the programme. We have enquired into this, and found that all credits reported are in fact credits earned within

7. As mentioned in the introduction the programmes vary between 120 credits and 180 credits, that is, from three to four and a half years of full time studies.

the programmes, but some students take more courses than they need to get a degree. In our estimate of credit productivity credits above the total number of credits do not count. For the students admitted in the Autumn 2000 no credits are reported, and we set their credit productivity at zero.

Drop-outs

As mentioned we have decided to consider drop-outs separately when judging student success in terms of credit productivity. We define 'drop-outs' as follows:

Drop-out = In addition to the registered drop-outs we have decided to count as drop-outs:

1. for those admitted in 1995 or 1996: students who either have 15 credits or less, or have an effective study time of one year or less.
2. For those admitted in 1999: students who have 5 credits or less.

For students admitted in 2000 the only drop-outs are the formally registered ones.

Low-achiever

We also need a definition of what counts as a less productive student, not in order to value their work, but for reasons of comparison. Who is to be regarded as a 'low-achiever' within the programmes?

Low achiever = a student who, while not a drop-out according to our definition, has a credit productivity of less than 30 credits per year, 30 credits being what is required in order to be eligible for a student grant or student loan from the Central Study Assistance Committee (CSN). However, we do not count as low achievers those students who have either

1. obtained a degree or,
2. produced within 15 credits of the number of credits required for graduation in the programme in question.

This means that we will allow a fairly long study time provided that the student has a degree within reach.

Student Categories

One of the goals expressed in the Government bill (Prop. 1992/93:169) was to increase the number of women within university programmes traditionally dominated by men. This inclusive ambition was also manifested in a more general aim of broadening recruitment to higher education within the fields of mathematics, science, and technology, for instance to enhance the recruitment of students from non-traditional student categories (see Wistedt 1996), applicants with a more varied background than the usual upper

secondary certificate from the natural science or technical programmes. In the 1998 evaluation (Wistedt, 1998a), four categories were defined:

- A. **New recruits:** Students who come more or less directly from a natural science or technology programme at upper-secondary school with little or no work experience or experience of tertiary studies.
- B. **Experienced students:** Students who have an upper-secondary certificate within the fields of natural science or technology and who have, in addition, experience (credits) from tertiary education.
- C. **Re-starters:** Students who have an upper-secondary certificate within the fields of natural science or technology, and, in addition, work experience, but no credits from tertiary education.
- D. **Career-shifters:** Students who do *not* have a background within natural science or technology, who for instance have an upper-secondary certificate from the social science programme, and who have acquired the necessary admission qualifications by attending supplementary natural science courses.

In this study category D students are of special interest. In the 1998 evaluation (*ibid.*) we found this group to be particularly vulnerable. They dropped out significantly more than other students did, and in general they did less well on course examinations than students from other categories (*ibid.* p. 33-37). Have the programmes managed to adjust to the demands of these students? This question is particularly important from a gender perspective since female students are over-represented in category D.

The Educational Initiative

As mentioned above, the Government's initiative had two goals: to broaden the recruitment of students to science-related studies, above all to recruit more women, and to enhance the quality of teaching within higher education, the latter goal thought of as instrumental in the recruitment process.

The educational initiative was, for many of the teachers involved in the development work the primary incitement for taking part in the projects. The recruitment of new student was described by many of them as a secondary goal (Wistedt, 1996). They were all in favour of the idea of recruiting more women to the programmes, but they found it extremely hard to point out effective means of recruitment, and they often found examples that would counter their own arguments for certain measures

(*ibid*, p. 23). In a study of curriculum reform and gender in engineering education, two of the programmes within the initiative were scrutinised from a gender perspective – the IT-programme at Linköping University and the project D++ at Chalmers University of Technology (Salminen-Karlsson, 1999). In the report it is stated that:

“Both of these programmes can be applauded for recruiting many female students. However, they were not described as gender-inclusive by those engaged in them on a daily basis. There were many women and they made an impact on the atmosphere of the educational environment, but they were generally described as a feature in the education. The way the teachers talked about the programme was not as gender-inclusive programmes which even men found attractive, but as engineering programmes (a masculine concept) which had even managed to attract many women.” (p. 214)

This conclusion is similar to the results from the previous evaluation of the initiative (Wistedt, 1998a). The question: “What is good for women?” was often turned around – “What are women good for?” Quality arguments were raised: Women would add something to the scientific disciplines, they would open new markets by bringing in female views on technological change, new perspectives on the research questions raised, or new qualities to the institutional environments, for instance a better social climate. Men simply work better when there are women around.

Despite the fact that few of the initiators could express firm views on how to recruit women by making changes in the educational environment, we can still ask questions about the effectiveness of the means chosen to create a more inclusive education. In the interviews carried out as parts of the present evaluation, 20 teachers and 14 students were asked to comment on the educational changes made. The interviews lasted for about an hour each, they were tape-recorded with the consent of the interviewees and later transcribed in full. Eight of the 20 teachers who were interviewed were women as were eight of the 14 students, evenly distributed among the programmes.

The interview material was the subject of a thematic analysis which focused upon variations in ways of viewing the topics covered in the interviews (see Appendices 1 and 2). The transcribed interviews comprise about 600 type-written pages. Clearly, if such a large body of data is to be organised so that it can be used in answering the questions raised in the evaluation, it must be grouped into a limited number of categories. Thus, utterances made in the documented interviews was sorted into eight categories, comprising all comments relevant to a certain topic, teachers’

comments in one group, students' comments in another. Such a thematic analysis was chosen to ensure that all comments were given the proper attention.

Two categories concerned the recruitment endeavour:

1. The recruitment of female students
2. The recruitment of non-traditional students

Four categories comprised all the various comments on the alternative ways of teaching, first as vehicles for raising the quality of learning and then as vehicles for adapting the teaching methods to the needs of students not traditionally inclined to choose science or technology-oriented programmes:

3. The problem-solving approaches to learning
4. The inter-disciplinary forms of work
5. The co-operative work among students and teachers, and
6. The alternative forms of assessing student learning

Finally, two categories comprised comments on:

7. The in-service aspects of the projects⁸, and
8. External views of the programmes, that is, views about the initiative held by colleagues or peers not directly involved in the development works, people at the departments, or at other university departments, or people outside of the university.

The interviewees were not chosen to represent public opinions about the programmes. The analysis did not aim at generalisations about attitudes and beliefs about the initiative. Rather, the aim was to give in-depth descriptions of steps taken to create a more inclusive educational environment, such as the co-operative forms of work, the interdisciplinary efforts, and the problem-solving approaches to learning.

The interviews were open-ended, covering the main topics described above (cf. Appendices 1 and 2): the interviewees were asked to give their personal views of the essentials of the programme, and its main objectives. In the descriptions of the educational initiative given below (p. 55) such views are sometimes presented in direct quotations. The excerpts from the transcripts, translated into English, are, in such instances, italicised.

The descriptions of the realisation of the educational initiative at the respective universities have been sent out to the teachers concerned, along

8. Comments relevant to this category were only found in the interviews with the teachers.

with an invitation to comment on the presentation of the project and to make corrections of factual errors. Such comments have, in very few instances, resulted in minor modifications of the content and phrasing of the texts.

2. The Recruitment Initiative

Recruitment Results

The Recruitment Situation

In the academic year 1999/2000, 71,100 first-year students entered Swedish universities, which was an increase of 3,400 compared to the previous year. This increase was higher for women than for men; women counted for 2,900 of the increase, 40 per cent of them 35 years or older. The mean age among the entrants, however, was 22 years for men and women alike (SCB, 2001).

Many of these female students had a study background within the social sciences or humanities. Among the female entrants in 1999/2000 the proportion of students with an upper secondary education in natural sciences or technology was only half that among the male entrants and a few percentage points lower than the year before (*ibid.*), something which must be kept in mind when the issue of recruitment to tertiary studies is discussed.

As mentioned above, the increase of new entrants was most pronounced within the fields of natural science and technology. During the first half of the 1990s the expansion of the student population was fairly evenly distributed among different fields of study. From 1996 to 1998 the increase of about 11,000 entrants was almost exclusively dedicated to the expansion within science and technical areas (Riksdagens revisorer, 1999). From the academic year 1993/94 to 1999/2000 the number of entrants to technical studies increased by 43 per cent and in mathematics and natural sciences by 31 per cent. The average increase for all courses and programmes at the tertiary level was 18 per cent, a visible sign of the Government's initiative to recruit more students to mathematics, natural sciences, and technology. However, during the years 1998/99 and 1999/2000 the number of students within these fields reached a stable level. The number of students in technology was constant during these years, and a slight decrease could be noted for mathematics and science (*ibid.*). There simply were not enough applicants for a further expansion.

This puts recruitment of new groups of students into perspective. The competition between the universities offering courses and programmes within this heavily expanding field is more pronounced today than it was five years ago. Newly launched programmes are the most vulnerable in this harsh competition. A recent study (Öckert & Regné, 1999) discusses

various factors of importance to applicants who choose among different programmes when they are about to enter higher education. The results show that the applicants are very sensitive to the market-value of the programmes in terms of prospects for future employment and salary. New programmes, not yet tested on the market, have difficulties proving their competitiveness. Hence, they have to devote a lot of time, effort, and resources into making the programmes known to prospective applicants. In the academic year 2000/01 the Project Programme at Stockholm University was closed down. In 1999/2000 the number of entrants had dropped rapidly, and despite major efforts this trend could not be reversed.

Among university entrants as a whole the proportion of women was about 60 per cent in the academic year 1999/2000. However, within the fields relevant to this study the figures were more modest. In computer science and engineering the proportion of women was 24 per cent (of 21,492 entrants), in physics 32 per cent (of 18,295), and in mathematics 33 per cent (of 43,490) (Högskoleverket, 2001, Appendix 2). These are the national figures within the fields of topical importance to the initiative evaluated in this study. How does female recruitment in the programmes linked to the initiative compare to these figures? Have the programmes succeeded in their ambitions to recruit more women? Have they succeeded in recruiting non-traditional students, and how has recruitment developed over the five years that have passed since the programmes were launched?

How Many Female Students are Recruited to the Programmes?

Five development projects received funds from the Council in 1993 (p. 10 above). One of these projects, *Women in Engineering Education* at Karlstad University, consisted of three different programmes. The table below shows how the seven programmes encompassed by the initiative succeeded in recruiting women during the years 1995, 1996, 1999, and 2000. In this and the following tables and figures the names of the programmes are abbreviated: CS is *Computer Science and Engineering* (Chalmers University of Technology); SPS is *Scientific Problem Solving* (Göteborg University); K/CE, K/E&E, K/E&D are the three programmes at Karlstad University: *Computer Engineering* (K/CE), *Energy & Environmental Engineering* (K/E&E) and *Innovation & Design* (K/I&D); IT is the *IT-programme* (Linköping University), and PP *The Project Programme* (Stockholm University). As mentioned above, no students were admitted to the Project Programme in 2000.

Table 1: Proportion of female students within each programme. Total number of entrants in 1995–1996 and 1999–2000. Female entrants (F) in raw figures and percentages.

University	Programme	1995			1996			1999			2000		
		Total	F	%	Total	F	%	Total	F	%	Total	F	%
Chalmers	CS	106	16	15	111	21	19	161	26	16	157	16	10
Göteborg	SPS	32	18	56	34	18	53	38	23	61	22	8	36
Karlstad	K/CE	46	7	15	65	10	15	110	12	11	130	12	9
Karlstad	K/E&E	24	7	29	25	9	36	66	27	41	34	17	50
Karlstad	K/I&D	20	3	15	22	10	45	29	19	66	56	28	50
Linköping	IT	35	14	40	34	16	47	39	10	26	41	10	24
Stockholm	PP	25	8	32	25	10	40	7	5	71	–	–	–
Total		288	73	25	316	94	30	450	122	27	440	91	21

As can be seen, the proportion of female students varies substantially among the programmes. During the years 1995–1996 and 1999–2000, three of them scored well above the national average of 24–33 per cent female students: the programmes at Göteborg University (from 56 per cent in 1995 to 36 per cent women in 2000) and two of the programmes at Karlstad University, K/E&E and K/I&D (from 29 per cent and 15 per cent respectively to 50 per cent each). The programme at Stockholm University was also successful in attracting female students (32–71 per cent) but, as can be seen, the programme had an overall negative recruitment development over the years, and the students are too few to form a basis for conclusions about female recruitment.

At the IT-programme (Linköping University) the recruitment of women decreased from a promising 40 per cent in 1995 and an even better result in 1996 to 24 per cent in 2000 a figure consistent with the national average. The IT-programme is a master of science programme in computer science and engineering with some slight changes in terms of content: about 20 credits of the total 180 are given over to courses in the humanities and social sciences. Thus, it seems as if all the computer science and engineering programmes have severe problems recruiting women. The trend is negative in all three programmes directed towards this field. The initiative has not helped them to rise above the average figures. The programmes at Karlstad (K/CE) and Chalmers (CS) were both well under the national average in 1995–99, and the proportion of women dropped drastically in 2000. An interesting observation is that the *number* of female students has remained fairly constant over the years (± 10 women). The decreasing share of women is due to the fact that these programmes have expanded considerably between 1995 and 2000. The increase in the number of students admitted has not lead to a corresponding increase in the number of female students entering the programmes.

This picture turns out to be even more depressing if we consider the drop-outs from the programmes. In Table 2 below the proportion of women within the programmes is described in raw figures and percentages, after drop-outs are excluded.

Table 2: Proportion of female students within each programme. Total number of students enrolled in 1995–1996 and 1999–2000, drop-outs excluded. Female entrants in raw figures and percentages.

University	Programme	1995			1996			1999			2000		
		Total	F	%	Total	F	%	Total	F	%	Total	F	%
Chalmers	CS	86	11	13	79	14	18	154	23	15	157	16	10
Göteborg	SPS	22	11	50	23	14	61	29	18	62	22	8	36
Karlstad	K/CE	36	5	14	53	6	11	91	10	11	128	12	9
Karlstad	K/E&E	23	7	30	20	8	40	59	22	37	34	17	50
Karlstad	K/I&D	18	3	17	17	7	41	29	19	66	55	28	51
Linköping	IT	25	9	36	26	11	42	35	7	20	40	10	25
Stockholm	PP	10	1	10	18	7	39	6	5	83	–	–	–
Total		220	47	21	236	67	28	403	104	26	436	91	21

Few students have been reported as drop-outs from the class of 2000. As mentioned drop-outs within this sub-group only consist of registered drop-outs, and the students had only been enrolled in the programmes for a few months when data for this study was collected. But if we look at the other sub-groups (1995–1999) we find that the computer science programmes have lost many women. The proportion of women decreased in all these programmes (CS, K/CE, and IT) when the drop-outs are considered. Table 3 below describes the change in female recruitment to the programmes by comparing the implementation period 1995–1996 and the period during which the programmes moved into a more stable phase (1999–2000).

Table 3: Changes in female recruitment. Total number of entrants in 1995–1996 compared to 1999–2000, drop-outs included. Female students in raw figures and percentages.

University	Programme	1995–1996			1999–2000			Up/down %
		Total	F	%	Total	F	%	
Chalmers	CS	217	37	17	318	42	13	-4
Göteborg	SPS	66	36	55	60	31	52	-3
Karlstad	K/CE	111	17	15	240	24	10	-5
Karlstad	K/E&E	49	16	33	100	44	44	+11
Karlstad	K/I&D	42	13	31	85	47	55	+24
Linköping	IT	69	30	43	80	20	25	-18
Stockholm	PP	50	18	36	7	5	71	+35
Total		604	167	28	890	213	24	-4

The decline in female recruitment is most notable at the IT-programme, a matter which will be commented on in the next chapter, in which we report the results from the interviews with teachers and students involved in the initiative. The loss of women in four of the programmes indicates that women are leaving the programmes to a greater extent than male students do, a matter we will now look into more closely.

Which Students Leave the Programmes?

Table 4 below gives an overall picture of the drop-out rates during the years 1995, 1996, 1999, and 2000.

Table 4: Tendency to leave the programmes. Total number of students enrolled in 1995, 1996, 1996 and 2000. Female and male drop-outs in numbers and percentages.

	Number of students	Number of drop-outs	% drop-outs
Female	380	71	19
Male	1 114	128	11

As can be seen, more of the women are leaving the programmes, their average drop-out rate being 19 per cent compared to 11 per cent for the male population (although of course in absolute terms more men drop out). However, caution has to be exercised when interpreting the figures. One has to bear in mind that the students are not a homogeneous population: They come from seven programmes at five universities with different recruitment profiles and different goals, and, in particular, different sex ratios and drop-out rates. This could bias the figures severely. For instance, suppose that one of the programmes has a high drop-out rate for both sexes relative to the other programmes, and also a large population of female students. This could produce a result such as the one shown, without a single individual programme having a higher percentage of women than men leaving the programme! Under these circumstances the total percentage would be misleading. In order to avoid an over-interpretation of our results, we supply a break-down of the percentages into individual programmes, as shown in Table 5. This will enable us to compare drop-out rates for each programme separately.

Table 5: Tendency to leave the programmes: Female and male drop-outs for each programme. Total number of female (f) and male (m) students enrolled in 1995/96 and 1999/2000, female and male drop-outs in numbers and percentages of each sex-group.

University	Programme	Sex	Number	Drop-outs	% drop-outs
Chalmers	CS	F	79	15	19
Chalmers	CS	M	456	44	10
Göteborg	SPS	F	67	16	24
Göteborg	SPS	M	59	14	24
Karlstad	K/CE	F	41	8	20
Karlstad	K/CE	M	310	35	11
Karlstad	K/E&E	F	60	6	10
Karlstad	K/E&E	M	89	7	8
Karlstad	K/I&D	F	60	3	5
Karlstad	K/I&D	M	67	5	7
Linköping	IT	F	50	13	26
Linköping	IT	M	99	10	10
Stockholm	PP	F	23	10	43
Stockholm	PP	M	34	13	38

As can be seen in the table above, the proportion of women leaving the respective programmes varies a lot. In four of the programmes the drop-outs are more or less evenly distributed among female and male students (Göteborg [SPS], Karlstad [K/E&E, K/I&D], and Stockholm [PP] where the drop-out rates are high among all students in the programme, male and female students alike). The problem of a higher proportion of women leaving the programmes seems to rest with the computer science and engineering programmes (Karlstad [K/CE], Chalmers [CS] and Linköping [IT]). Another worrying sign!

However, as mentioned above, we must be even more cautious when interpreting these figures. In the 1998 evaluation we found that variables other than sex could be involved in producing these results, for instance the over-representation of female students in category D, that is, students who do not have a natural science or technological background when entering the programmes, and who have attended supplementary science courses in order to qualify for admittance. It is time to test the hypothesis: that the seemingly higher proportion of women leaving the programmes is due to an over-representation in a specific student category.

However, before we enter into that discussion, we need to inform ourselves about the recruitment of non-traditional students to the programmes. The table below (Table 6) shows the recruitment of category D-students in raw figures and percentages. The total number of students differs

slightly from the figures in Table 1 above, due to missing data about the study background for 64 of the 1,494 students (4 per cent).

Table 6: Proportion of category D students within each programme. Total number of entrants in 1995–1996 and 1999–2000, drop-outs included. Category D entrants (D) in raw figures and percentages.

University	Programme	1995			1996			1999			2000		
		Total	D	%									
Chalmers	CS	106	16	15	111	22	20	147	11	7	115	9	8
Göteborg	SPS	32	7	22	34	8	24	38	14	37	22	5	23
Karlstad	K/CE	42	12	29	65	22	34	110	25	23	130	23	18
Karlstad	K/E&E	24	1	4	25	4	16	65	31	48	34	13	38
Karlstad	K/I&D	20	3	15	22	9	41	29	9	31	56	18	32
Linköping	IT	35	6	17	32	2	6	39	1	3	41	0	0
Stockholm	PP	25	4	16	24	6	25	7	2	29	-	-	-
Total		284	49	17	313	73	23	435	93	21	398	68	17

As can be seen from the table, the proportion of non-traditional students has changed over the years. Table 7 below shows the average increase and decrease of category D-students for the periods 1995–1996 and 1999–2000.

Table 7: Changes in the recruitment of students who do not have a natural-science background (Category D: career shifters). Total number of entrants in 1995–1996 compared to 1999–2000. Category D students in raw figures and percentages, drop-outs included.

University	Programme	1995–1996			1999–2000			Up/down %
		Total	D	%	Total	D	%	
Chalmers	CS	217	38	17	262	20	8	-9
Göteborg	SPS	66	15	23	60	19	32	+9
Karlstad	K/CE	107	34	3	240	48	2	-1
Karlstad	K/E&E	49	5	10	99	44	44	+34
Karlstad	K/I&D	42	12	29	85	27	32	+3
Linköping	IT	67	8	12	80	1	1	-11
Stockholm	PP	49	10	20	7	2	29	+19
Total		597	122	20	833	193	23	+3

We find a negative trend in the recruitment of non-traditional students to the computer science programmes. All the other programmes have increased their proportions of category D-students over the five-year period. Since one of the goals of the initiative was to broaden the recruitment to categories of students who do not traditionally choose tertiary programmes within the natural science or technological areas the recruitment results for the computer science and engineering programmes give cause for concern.

And what about drop-out rates among category D-student? Table 8 below shows the proportion of category D-students leaving the programmes:

Table 8. Tendency to leave the programmes, category D-students: career shifters. Numbers of students in category D or Others (i.e. A: new recruits, B: experienced students, and C: re-starters) who entered the programmes in 1995, 1996, 1999 and 2000. Number of drop-outs within each category in raw figures and percentages.

University	Programme	Category	Number	Drop-outs	% drop-outs
Chalmers	D++	D	58	22	38
Chalmers	D++	Others	421	36	9
Göteborg	SPS	D	34	11	32
Göteborg	SPS	Others	92	19	21
Karlstad	K/CE	D	82	18	22
Karlstad	K/CE	Others	265	24	9
Karlstad	K/E&E	D	49	3	6
Karlstad	K/E&E	Others	99	10	10
Karlstad	K/I&D	D	39	2	5
Karlstad	K/I&D	Others	88	6	7
Linköping	IT	D	9	3	33
Linköping	IT	Others	138	19	14
Stockholm	PP	D	12	7	58
Stockholm	PP	Others	44	15	34

The table shows that category D students tend to leave the programmes to a greater extent than students from other categories. This trend is notable for most of the programmes, but most pronounced at the computer science programmes (D++, K/CE, IT) where the drop-out rates are twice to four times higher for D-students than for other categories of students.

It is true that female students are over-represented in category D, and this goes for all the sub-groups 1995, 1996, 1999 and 2000. As can be seen from Table 7, it is also true that category D students drop out more frequently than other student categories do. Can this explain the higher drop-out rates among women?

We have stratified the data anew with reference to sex, in order to investigate whether category D students among them tend to drop out more frequently, and, inversely, we have stratified with reference to category D/ Others in order to investigate whether women tend to drop out more frequently. Both effects turned out to be significant, which means that we cannot explain female drop-outs with reference to their over-representation in category D. Rather it is true that both categories drop out at a higher rate than other students. Thus the hypotheses formulated in the previous evaluation was not confirmed in the statistical analysis.

But could the higher drop-out rates among both female students and category D students be explained by some other common feature, for instance grades from the upper secondary school?

Comparing grades is a somewhat complicated task. Three different grading-systems are presently in use when students apply to university⁹. These systems are not comparable. Grades from the old system are not even comparable between the periods 1995–1996 and 1999–2000 since the students who were admitted in 1999 or 2000 on the basis of old grades belong to categories of older students (B: experiences students, C: re-starters and D: career shifters). Thus, we need to stratify the data with reference to study period (1995, 1996 and 1999, 2000) and type of grades (old grades, new grades, and results from the university standard aptitude test), if we want to investigate the possible influence of grades from earlier stages of education on drop-out rates.

For each category (year of enrolment/type of grade) we established the median value. The students in each category were divided into two equally large groups: those with grades above the median value and those with grades below. It must be noted that this tells us nothing about the students' actual performance, it only tells us if the student has high or low grades relative to the median value of the sub-group under study.

The results show that category D students have significantly lower grades than other student categories during the years 1995, 1996 and 1999, comparable grades in 2000. But even when we control for these lower grades we find that category D students drop out more frequently than other categories of students do. This is particularly true for the computer science and engineering programmes, where the results are significant on the 5 per cent-level.

How Well Do the Students Succeed?

Examination Rates

As mentioned, it is not easy to compare the relative success of the programmes within the initiative to the national statistics. However, according to

9. In the present evaluation we have to consider entrants who either have received their grades within the old, group-referenced grading-system (grades from 1 to 5, where 3 is the mean grade), the new performance-based system (a four grade scale with grades from fail to pass with special distinction), or who have been admitted on the basis of results from the university standard aptitude test (a group-referenced system with points given from 0 to 2, where 1 is the mean grade).

the Swedish Parliamentary Auditors' report (Riksdagens revisorer, 1999) the average examination rate for Masters of Science and Engineering (180 credits or 4.5 years of full time studies) lies between 24 and 38 per cent after five years of study, in our case this is what we could expect for the students who were admitted in 1995. For students who aim at a diploma in engineering (120 credits, or three years of full time studies) the examination rates have decreased during the 1990s. After four years only 23 per cent of the entrants at the new engineering programmes enrolled in 1993/94 had taken their degrees, after seven years 47 per cent of the male students and 50 per cent of the female students (*ibid.*, p.17).

In Oct.–Dec. 2000 data was gathered on the results of students enrolled in 1995, 1996, and 1999 comprising date of graduation for those who had passed through the programmes. Table 8 below gives the total examination rates for students admitted in 1995, and the number of female students who have graduated from the programmes in raw figures and percentages.

Table 9. Examination rates for students admitted in 1995 to the seven programmes linked to the initiative. Total number of students and of degrees within each programme, degrees by female students in raw figures and percentages of the group who had passed through the programme five years after the enrolment.

University	Programme	Students in total	Degrees in total	Degrees in %	Female degrees	Female degrees %
Chalmers	CS	106	30	28	2	6
Göteborg	SPS	32	11	34	7	64
Karlstad	K/CE	46	9	20	1	11
Karlstad	K/E&E	24	16	67	4	25
Karlstad	K/I&D	20	13	65	2	15
Linköping	IT	35	5	14	2	40
Stockholm	PP	25	2	8	0	0

Five of the programmes (CE (Chalmers), SPS (Göteborg University), K/EC, K/E&E and K/I&D (Karlstad University) have examination rates comparable to, or well above the figures given in the national statistics. Two of the programmes have much poorer examination results than could be expected (IT (Linköping University), PP (Stockholm University)). The proportion of female degrees is about the same as the proportion of female students on the respective programmes, and this is true for all of the programmes linked to the initiative (cf. Table 1, above). This means that the female students admitted in 1995 have been as successful as their male peers in terms of getting their degrees.

Credit Productivity

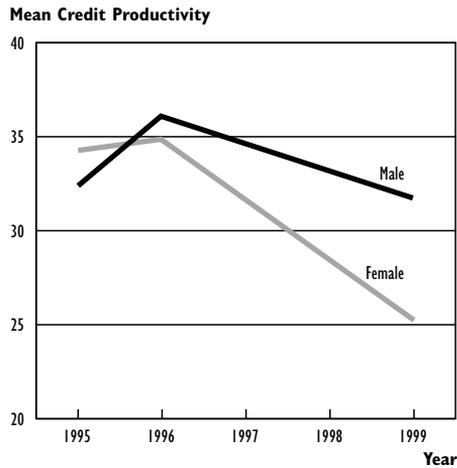
As mentioned it is a bit early to evaluate the success of the initiative on the basis of examination rates. But how about credits earned? Credit productivity can be viewed as a measure of student success even if there are no figures available in the national statistics that will enable us to compare the results from the programmes with similar programmes at other Swedish universities. We can, use this measure to investigate the relative success of different categories of students *in the same programme*. Below we will focus on the credit productivity for students admitted in 1995, 1996, and 1999. We will investigate the variables sex and student category (D/Others), in order to see how different student groups succeed in their studies.

A first investigation shows that neither women nor category D-students are over-represented in the group of low achievers, that is, students who have a credit productivity per year of 30 credits or less, drop-outs excluded. This means that the non-traditional students who stay at the programmes have a credit productivity comparable to that of the students in general.

However, these are the overall results. The credit productivity varies considerably across programmes, and it also varies across the three years, 1995, 1996 and 1999. If we stratify the data by time-period and programme and test the significance of our findings in each stratum, that is, the difference in credit productivity and the number of low achievers for men/women and D/Others we find differences that are significant on the 5 per cent level.

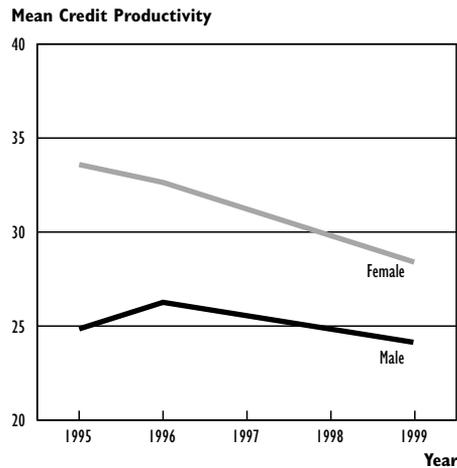
At Chalmers (Master of Science in Engineering) men and women admitted in 1995 and 1996 have comparable credit productivity, D-students within these cohorts even produce slightly better than the other students do. Of the students admitted in 1999 both these groups (women and category D-students) have a significantly poorer credit productivity than the other student groups (i.e. male students and students belonging to the categories A, B and C). Figure 1 below shows the credit productivity for female and male students admitted in 1995, 1996 and 1999. As could be expected, the credit productivity is lower than the ideal of 40 credits per year. Please note that one year is missing in the diagram (1998), and that the X-axis has been truncated:

Figure 1: Credit productivity at Chalmers. (CE) Male students versus female students enrolled in 1995, 1996, and 1999.



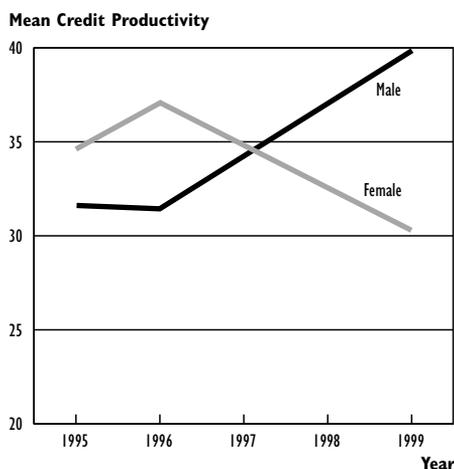
At Göteborg University (Scientific Problem Solving) the female students who were enrolled in 1995 and 1996 produce significantly better than their male peers, and category D students slightly better than other categories of students even if this trend is not significant. The female students still have the upper hand in the class of 1999, but the differences between the sexes are less notable for this cohort, as shown in Figure 2 below:

Figure 2: Credit productivity at Göteborg University (SPS). Male students versus female students enrolled in 1995, 1996, and 1999.



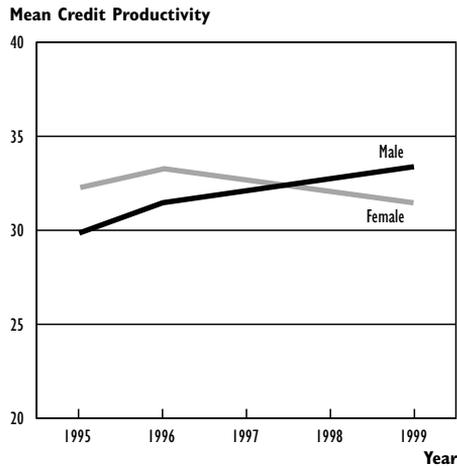
At Linköping University (IT) the women admitted in 1995 and 1996 have a significantly higher credit productivity than their male peers. For the class of 1999 we also find a significant effect on the relation between sex and credit productivity, but it is now reversed: the male students have a significantly better credit productivity than their female peers as shown in the figure below:

Figure 3: Credit productivity at Linköping University. Male students versus female students enrolled in 1995, 1996, and 1999.



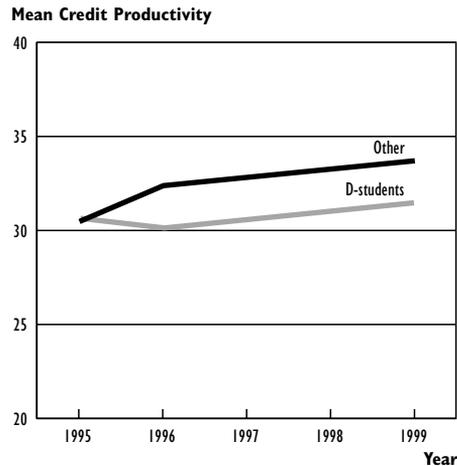
It would seem as though the female students are losing ground. The trend is the same in all of the programmes, even if the differences between the sexes are not always significant. This trend, however, is most pronounced at the computer science and engineering programmes. Regarding the other programmes we can only note a slight reduction of a female lead, and the interplay between sex, credit productivity and year of admittance is only statistically significant for the computer engineering programmes (SC (Chalmers) K/CE (Karlstad) and IT (Linköping)). Figure 4 shows the overall trend for all of the seven programmes.

Figure 4: Credit productivity. Male students versus female students enrolled in all of the seven programmes in 1995, 1996, and 1999.



The trend is the same for category D-students, even if less marked (Figure 5).

Figure 5: Credit productivity. Category D-students versus other categories of students (i.e. A: new recruits, B: experienced students, and C: re-starters)



But what if the overall recruitment to the programmes have changed? We know, for instance, that the recruitment situation was different in 1999

than in 1995–96. Many of the programmes have had difficulties recruiting students. What if the female students admitted in 1999 had lower grades than the women who were recruited in 1995–96 in relation to the male students.

As mentioned it is problematic to compare grades between different years of admittance (see above, p. 45). However we do not want to know if women with low grades have been admitted to the programmes, but if the relationship between female and male grades have changed to the women's disadvantage. To answer this question we investigate those who have a credit productivity above and below the median value for each grade-type (old grades, new grades, and results from the university standard aptitude test), for each time period (1995, 1996, 1999, and 2000) and for each of the seven programmes. This means that we will not, by definition, find any effects of time or programme on the proportion of students over and below the median value since this share is always about 50 per cent. However, if the relationship between male and female grades has changed for the worse in terms of women's grades we will find a larger proportion of women among those who have grades below the median value, i.e. we will find about the same pattern that we found when we investigated the students' credit productivity.

We do not, however, find such a pattern. As a matter of fact, the ratio of men to women among those with grades under the median value does not change much over the years (from 55.8 to 55.3 per cent for male students, and from 49.5 to 51.7 per cent for female students). However, if we carry out the same procedure for credit productivity¹⁰ as for grades, the changes are far greater. The share of men with a credit productivity under the median value decreases from 52.2 to 45.5 per cent and the share of women within this group increases from 40.3 to 49.5 per cent. Thus, we can conclude that lower grades cannot account for the relative change in credit productivity between the sexes.

Summary of the Recruitment Results

For three of the programmes the recruitment initiative has clearly been a success:

10. Using the same subgroups to investigate the proportion of men and women in the groups with a credit productivity higher or lower than the median value.

Scientific Problem Solving at Göteborg University
Energy and Environmental Engineering, and
Innovation and Design, both at Karlstad University

- All of these programmes have succeeded in recruiting a high proportion of female students (about 40–50 per cent).
- They have, in addition, been successful in recruiting non-traditional students (varying between 20–40 per cent), and the recruitment has improved over time.
- The drop-out rates are evenly distributed among female and male students and fairly evenly among students from different student categories. There is no significant tendency for any of the groups to drop out more frequently from these programmes.
- The three programmes have high graduation rates, (38–67 per cent) compared to the national statistics (about 30 per cent). Both of the new engineering programmes have graduation rates which far exceed the figures reported in national statistics.
- The three programmes have a high proportion of women taking degrees¹¹. About 40–60 per cent of the women who were admitted to the programmes in 1995 had taken their degrees in October 2000, that is, five years after enrolment.
- The credit productivity is high among female students at these three programmes relative to credit productivity among male students. However, there is a tendency for women to lose ground. We can note a slight reduction in the female lead for those who were admitted during the academic year 1999.

For four of the programmes, the recruitment initiative has not given the expected outcomes:

The Computer Science and Engineering Programme at Chalmers University of Technology

Computer Engineering at Karlstad University

The IT Programme at Linköping University, and

The Project Programme at Stockholm University

11. The first five students who graduated from the programme Scientific Problem Solving (Göteborg University) were women. One of the teachers said jokingly: "We had 50% women in, and 100% out".

- The Project Programme was closed down in 2000/01. Even if the programme was quite successful in recruiting female students and students from non-traditional student groups during the implementation years, overall recruitment had a very negative development. The applicants were too few and the drop-out rates too high to motivate future investments in the programme. Despite major efforts to enhance the recruitment the programme could not be saved.
- At two of the programmes, both directed towards the field of computer science and engineering, the problem of recruiting female students prevailed (Computer Science and Engineering (CS) at Chalmers and Computer Engineering (CE) at Karlstad). Despite the initiative, these programmes have retained a level of female recruitment at about 10 per cent under the national average.
- The computer science programme at Linköping University (The IT programme) was quite successful in recruiting female students during the implementation years. However, the share of women in this programme has dropped in later years. In 1999 and 2000 the share of women stabilised around the national average for comparable programmes.
- A negative trend can be observed regarding the recruitment of non-traditional students to all of these programmes.
- The drop-out rates are two to four times higher for non-traditional students than for students who have a traditional natural-science or technological study background.
- Female students drop out of the programmes at a higher rate than male students do.
- For students admitted in 1995 the graduation rates are comparable between the sexes. Men and women enrolled in 1995 and 1996 also have comparable credit productivity; at the IT-programme the female students enrolled in 1995 and 1996 had a substantially higher credit productivity than the male students. However, these promising results changed drastically in 1999: Women enrolled in 1999 have significantly weaker credit productivity than men, and this goes for all of the three programmes in the field of computer science and engineering.

How are we to account for these results from a gender perspective? Apparently educational change does not seem to be an adequate measure for improving the recruitment of women to male-dominated study program-

mes or as a means to make the education gender-inclusive (cf. Salminen-Karlsson, 1999, p. 216–219).

But do we really know whether such changes have taken place within the programmes? We cannot judge parts of the initiative as a failure on the basis of cursory knowledge about the educational changes made. In the next chapters we will look more closely into these changes. The information about the programmes is based on interviews with students and teachers who have substantial experience of the programmes and of the development projects linked to the initiative.

3. The Educational Initiative

Creating an Inclusive Educational Environment

New Goals or New Forms of Work?

When reflecting on the educational changes implemented within the programmes, it is tempting to focus the changes made — the collaborative forms of work, the problem-solving approaches to learning, the interdisciplinary organisation of courses and projects. However, to create a more inclusive education is not only a matter of changing the methods of teaching; rather it is a question of reflecting upon these changes as means to alternative ends.

Within the initiative, one such end was to enhance the recruitment of new groups of students, female students in particular. Another end, maybe more pronounced within the development projects, was to enhance the qualities of learning in all students: to break away from rote learning, to strengthen the students' communicative skills, their appreciation of other ways of viewing methods and facts beyond the purely disciplinary-based perspectives, their abilities to co-operate with peers and teachers, appreciating the differences in experiences and perspectives, and, not least, their readiness to take a greater responsibility for their own learning.

It is far more difficult to implement new goals than to implement new teaching routines, and far more challenging. The challenges are not only personal, in the sense that the teachers engaged in the development works have to question their own routines and previous ways of organising their work. Students may find reasons to criticise the changes, for instance if the new learning environments resist their familiar learning strategies; colleagues may question the changes on the grounds that they are out of step with disciplinary norms as they are traditionally understood; the new goals may even question the university culture challenging the very idea of what constitutes professional academic schooling.

However, many of the programmes have found ways to adjust to the academic settings without losing too many of their ideals. For the teachers and students the initiative has involved a lot of hard work, a lot of time and effort spent on co-operating with colleagues and students polishing the initially crude ideas, and doing this in a situation where prospective appli-

cants are hard to find, and where many of the programmes have had to compete harshly with newly launched programmes on an over-crowded market. However, for most of the teachers the initiative has been a very positive experience, despite the hardships:

“One of the most rewarding things has been the many contacts with the students. They have taken a great responsibility for the programme. Not all of them, but a sufficiently large group to enable a type of contact with the students that I have never experienced before. Earlier I have met with students to discuss physics, but this has been something entirely different.”¹²

(Female lecturer A, The Project Programme, Stockholm)

The Outline of the Chapter

The projects all started on the initiatives of individual teachers. In some cases they took form within a small group of people lead by a pioneering spirit. When funding for the projects had been granted, people were selected to form groups responsible for different aspects of the development work. In other cases a group of lecturers joined together to discuss possible ways of re-organising teaching to reach the goals set for the initiative. Whatever form the implementation took, the development process inevitably lead to a re-thinking of the traditional ways of teaching. The goals of promoting enquiring attitudes towards the subjects studied and broadening the views of these subjects to include their relations to other fields of interest and to matters relevant to society paved the way for work forms that were co-operative, problem oriented, and interdisciplinary in nature.

But before we turn to the evaluation of these initiatives we need to know more about the development of the individual projects during the five years that have passed since the first students entered the programmes in 1995. What has happened to the projects, and what has happened to the goals set for the initiative?

The five projects that received grants from the National Agency for Higher Education differ in many respects: they differ in size and scope (varying from 30 to 160 students and from 120 to 180 credits), the academic settings differ (varying from prestigious urban universities with a long history to young small-town universities, or former university colleges), the recruitment situation varies substantially, and above all, they differ in

12. As mentioned, this utterance, like all the other utterances appearing in this chapter, have been translated from Swedish to English by the author.

educational goals. Such differences have to be considered when we evaluate the educational initiative.

Below we start out by taking a look at the university programmes in mathematics and physics at Stockholm University and Göteborg University, both quite successful in recruiting female students and students with a non-traditional study background. But, as described in the previous chapter, these two projects have developed quite differently. While the Göteborg programme is still thriving, the Stockholm programme was closed down in 2000, a decision which many of the teachers in the programme regret.

Despite the Government's initiative, three of the programmes still have problems recruiting female students, all of them programmes within the field of computer science and engineering, that is, the programmes at Chalmers University of Technology, Karlstad University and Linköping University. Female students and students from non-traditional student groups also leave these programmes to a greater extent than other students do. Why? And what has been done to change this trend?

The computer science programme at Karlstad University has not succeeded in reaching the goal set for the initiative, that is, to improve the recruitment of women so that they constitute 30 per cent of an admission class. However, two of the other engineering programmes at Karlstad University have succeeded quite well both in recruiting and retaining students from non-traditional student groups. One may wonder what is wrong with computer science. One may also wonder what is attractive about these other programmes. Maybe something could be learnt from them.

The Development of the Programmes Within the Faculties of Mathematics and Natural Sciences

Means and Ends

As was described in the introduction to this report, mathematics and physics have a fairly low female enrolment (32–33 per cent in 1999/2000). Mathematics is one of the largest single university subjects (National Agency for Higher Education, 2000, p.17). About 14 per cent of all university students study the subject, most of them as parts of their studies of other subjects, such as economics, physics, or law. However, about a third of the students drop out and many of the students who remain never manage to complete their studies, which is causing much concern within the departments and the faculties, especially since the departments do not get fully paid unless the students manage to take their credits (Wistedt & Brattström, 1999).

For many years physics has had problems recruiting students, and this is not only a national trend. An American study of 810,794 students (Seymour & Hewitt, 1997) showed that 51 per cent of the physics majors, and 62 per cent of the mathematics majors changed to other subjects while only 28 per cent of the social science majors switched to other fields of study. The results of the investigation showed that this high percentage of switchers could not be attributed to student characteristics:

"The theory that switchers can be distinguished from non-switchers by their inability to cope with the intrinsic 'hardness' of S.M.E¹³ majors or their unwillingness to commit to sufficient hard work, is a traditional way of explaining attrition rates and reflects a disinclination to see attrition as 'a problem'." (ibid. p.35).

"...we did not find them to differ by individual attributes of performance, attitude, or behavior, to any degree sufficient to explain why one group left, and the other group stayed." (ibid. p. 30)

13. S.M.E. is short for Science, Mathematics, and Engineering.

The problem of recruiting students to physics was commented on by one of the lecturers at Chalmers¹⁴:

"Fewer and fewer students choose physics, and I don't think that this is either a local or a national problem, but an international trend. Fewer students enrol which means that the physics department has to fight to get students in, which, in turn, means that the students run away from the physics courses to an even greater extent. The students in Technical Physics for instance choose applied mathematics courses, computer science courses, or other courses that are optional instead of physics. Some physicists want to expand the number of mandatory courses, but this would not create a better situation for them. It might mean that students do not come at all, they may not even take the basic courses in physics. Such is our situation."

(Male lecturer D, Chalmers)

The programmes in Stockholm and Göteborg, admitting 30 and 40 students respectively, wanted to offer the students an alternative to the traditional course programmes or single-subject courses in mathematics and physics. Within the programmes, the established lecture-based ways of teaching the subjects were challenged¹⁵:

"The whole concept is different. Since we want to foster a problem solving attitude in the students, we have not built on pre-existing teaching-modules. We have constructed themes for each semester, and then we have defined the minimum content of these themes. The examples we have chosen for projects and experiments are just examples of a method or of an area of interest. The students will gain a deep understanding within one such area, and will, as a consequence, cover other areas less well."

(Female lecturer A, Scientific Problem Solving, Göteborg)

Aiding the students in developing a balanced, reflective attitude towards the subject matter was one of the main goals of the programmes. Such an attitude, which can be described as a hallmark of a scientific approach, cannot, however, be developed in solitude. Knowledge may be personal, but a collective is always needed to prove and disprove assertions, and to hold knowledge in trust. In order to enhance the students' skills in expressing their thoughts so as to make them understandable to others, as well as the ability to listen and make use of other people's arguments, co-operative

14. The physics department at Chalmers University of Technology serves both Göteborg University and Chalmers.

15. For a more elaborate description of the programmes, see Wistedt, 1996, pp. 13–31

work was introduced in the form of larger or smaller projects, as a complement to the regular course-work. The programmes were also organised in an interdisciplinary way. Three subjects are studied in the programmes, in Stockholm mathematics, physics, and mathematical statistics, in Göteborg mathematics, physics and environmental science. This also means that the students do not have to choose a single subject from the start:

“When wrestling with the projects the students can try out how it is to work within the respective subjects. They have not made their choices yet. They can test three different subjects and see how they like them. And as it turns out they choose differently. Some are all for physics, others like mathematics better, or mathematical statistics.”

(Male lecturer A, The Project Programme, Stockholm)

The Essentials of the Programmes from a Student Perspective

One of the questions put to the students in the interviews concerned the goals of the programmes as the students had understood them. In the interviews they described the essentials of the programmes and what they had gained from their studies. They all stressed the many chances they had had to develop their communicative skills.

“It feels as if we have been drilled in discussing and arguing, and trained to think things through before we say them. Anything you say may be misinterpreted, which means that you have to be very careful about how you express yourself. I have noticed, when I later studied together with students from other programmes, that this may have made me a bit pushy — ‘But if you turn it around like this, or if you consider this extreme case your theory doesn’t work’. We have discussed matters all the time, we have worked in groups, and if there was something that I did not understand, I always turned to the others: ‘Could you, please, explain this to me’. The teachers have stressed the necessity of sharing our knowledge with others. You should not keep it to yourself, but bring it into use. I have thought about that a lot, and maybe I have also developed my skills. If I learn something, maybe I can communicate it to others, not only within my own research group, but outside of it, considering what use it can have and why.”

(Female student A, Scientific Problem Solving, Göteborg)

The students also commented on the interdisciplinary forms of work, which had put the subjects studied into new contexts, not only broadening the students’ views of what the individual subjects could offer, but also sharpening their awareness of the differences between the subject cultures:

“Understanding the differences between the subject cultures is one goal of this programme, I think. I don’t know if students who study single subjects understand the fundamental differences between subjects even if they are close to their own. We became aware of that during our very first semester. My God! Huge differences! And they did not only have to do with surface features, such as the preference for certain writing styles and the like. To understand the differences between subjects is tremendously important to an environmental scientist. We have to bridge such differences in perspectives. Even if you do not fully understand how people work within other fields, just the knowledge that there are differences will help you: They are not all like me, they do not all think the way I do.”

(Female student B, Scientific Problem Solving, Göteborg)

The fostering of scientific attitudes, such as the ones cited above, has also lead to a recruitment of students to doctoral studies. The programmes resemble research-schools. Not only do the students work on projects, similar to research projects, although more limited in scope and the knowledge required to carry them out, but their assignments are often non-trivial in the sense that they are not standard problems, and even if the methods are familiar to a researcher the questions may be new and sometimes never researched before. The students also work in close contact with researchers and teachers who function as their tutors:

“Many of those who have passed through the programme have been enrolled in doctoral studies. I think this is because we have had much more contact with researchers and people who are active within various fields of study than students normally do. We have had tutors and the groups have been small, which means that we have had many chances to communicate with our lecturers. You get a view of what they do, and you realise that they are not so smart that you do not dare to ask them questions. They are ordinary people, just like us.”

(Female student C, Scientific Problem Solving, Göteborg)

In the interviews, all of the students, without exception, described the programmes in very positive terms. This is not remarkable. The students who were interviewed were the successful ones, those who had stayed on and taken a great responsibility for the development of the project’s ideas. They had grown with the programmes and they were all loyal to the initiatives. In a sense they also had to be. The future of the programmes will mean a lot to the students. Many of them expressed worries about the negative recruitment trends, most notable at the Project Programme where the interviews

took place before the decision was made to close down the programme. The value of their own education is dependant on the success of the programmes, even if the students did not want to overstate the importance of the programmes as such. Competence is what matters, they stated. People outside of the university are rarely interested in the name of the programme, which often tells them nothing. A name may, however, mean something to prospective students who choose between different options when they are about to enter higher education.

“The only negative thing I can think of is that it is hard to describe what you become. What we are up to. People ask you: But what will you be? What is it good for? And you don’t have any ready answers. It’s kind of fuzzy. And the name: The Project Programme, is a bit misleading. We really do not have that many projects, if you spread them out over the four years.”

(Female student A, The Project Programme, Stockholm)

Nevertheless, the students’ positive attitudes tell us something about what can be achieved within the programmes. To summarise the interviews, the students pointed to the following essential features of the programmes:

- The close contact with the teachers, and their willingness to listen to the students’ proposals for changes in the programme. *(The dialogue has always been alive. Even if they have been stubborn at times, and I guess they think that we have been stubborn too, they have listened, and the debates have given results.)*
- The co-operative work, and the project or problem-oriented approaches to learning, offering ways of studying the subjects which the students view as critical to a good understanding of the subject matter, and to a deeper appreciation of concepts and their applications. *(These are tough subjects, as I experience them. I couldn’t sit on my behind for four years cramming them. It would have been unbearable. I would have done something else. But this is an interesting way to study and a way to gain knowledge that lasts. You really learn for life.)*
- The variation in assessment procedures *(You can never hide, pretending that you have learnt. If you haven’t learnt, people will notice it. The oral presentations, for instance, are exciting. You prepare yourself over and over, you get the chance to tell about something that you have done. It’s kind of a big deal. And the relief afterwards! Such processes are tremendously inspiring.)*

- The development of communicative skills (*They will certainly be valuable to me and help me to keep in contact with people, to present my work, to describe what I'm doing, maybe in a different language than what is used at the department or the work-place. I hope so.*)
- The opportunity to take personal responsibility for the learning process. (*Within some areas I can find that I lack the knowledge. Within other areas I know more. But that is not really a problem. You can always catch up, and we have learnt how to do it: Okay, I don't know this, so I will have to find it out.*)
- The interdisciplinary forms of work, which have broadened the subject perspectives and given a sense of connection between different subject fields. (*Maybe the integration has not been absolute. I thought that there would be more of integration. But the will has been there, and the feeling that there is a need to integrate. That is something we will all carry with us.*), and closely linked to the interdisciplinary work:
- The many chances to seek out a personal field of study. (*This programme invites you to find your own field of interest: you carry out projects, and you often have the possibility of choosing among topics, you come into contact with many people who are active within different research fields.*)

The Development of the Projects

Qualities of learning, such as those described by the students above, do not come by themselves. Creating a fruitful educational environment takes time and effort, and a lot of willpower. The new forms of work did not all work smoothly from the start, and the teachers could not always foresee the problems they would run into, problems which in many cases stemmed from their own lack of experience and knowledge. Keeping their goals in mind, they had to re-think their initial ideas of what would be fruitful strategies for reaching these goals:

“The means have changed considerably. For instance, initially we had not thought through how to enhance the students' communicative skills. From the start we had the idea that this training should be integrated into the other subjects. We did not want to have a separate, two-week course on how to write and present results. This goal has remained. But what we lacked was the knowledge and the ideas of how to implement it. To express it simply, I guess we hoped that they would learn it all at once. But with the help of a language consultant we have formed a strategy for choosing what skills

would be developed during the first semester, how they are to be introduced, and how to train them, and other aspects will be left to the second semester, and so on.

(Male lecturer A, *Scientific Problem Solving*, Göteborg)

Sometimes the teachers were so focused on the goals that they neglected to see the need to move slowly, not to introduce too many new learning objectives at once:

“The difference between traditional mathematics studies and the studies we aim at is that the students should be given the opportunity to solve more extensive problems in co-operation with their peers. They were supposed to present their solutions orally and in writing. They should reason and reflect upon the problems, seeing the connections between them and other fields of enquiry, and evaluate the results in different contexts. At the beginning we introduced all of this at the same time – all of it on the first assignment! And, of course, the students could not manage all of that in one single task. And we could not give them the appropriate feed-back, or respond to that many aspects in any meaningful way. So we totally changed the strategy. We reduced the number of tasks, not very much, but we reduced the work-load. And, above all, in presenting a task we tried to ask ourselves: What specific aspects do we want to focus on in this assignment?”

(Male lecturer A, *Scientific Problem Solving*, Göteborg)

This process of acquiring knowledge is often neglected in traditional teaching, and when you are not used to attending to it, it will take you some time to learn the new ways of approaching student learning:

“One of our colleagues said: “It seems as if the students get more and more skilled in presenting unsatisfactory solutions”. We caught hold of that statement and asked ourselves: What do we really want to achieve? And then we realised that an assignment which may look small to you, involves a lot of work for the students. If you have a traditional teaching role you will only ask yourself: Could they do it or not? You do not attend to the learning process behind the product. But if you are attentive and use assessment procedures that will reveal the process behind the results, you can learn a lot.”

(Male lecturer A, *Scientific Problem Solving*, Göteborg)

The students pointed out that some of the teachers and tutors on the programmes needed guidance in how to handle group-processes, and how to help the students move in a fruitful direction without steering them too

much. Some tutors were less attentive to the students' learning processes, and would have needed support in understanding the students' ways of reasoning about the subject matter.

The laborious work of creating and redefining the means to reach the goals set for the initiative was described by many of the teachers as a process of in-service training (cf. Wistedt, 1998b). The teachers all described how they had learnt a lot from working with the projects, not least from the interdisciplinary effort:

“It is a brilliant idea. Fantastic. I cannot understand why we haven't worked together like this before. And for those of the students who will stay and devote themselves to physics, for experimentalists, the knowledge of mathematics and mathematical statistics is fundamental.”

(Female lecturer B, The Project Programme, Stockholm)

However, the integration of subjects was not easy to accomplish, and, as the students pointed out, this effort was not as far-reaching as the teachers initially had planned:

“We don't talk about integration of subjects any more, but of co-operation between subjects. This is crucial: We have realised that the subjects within the programme are different – the cultures are different, and the genres are different. One of the students commented on this at a meeting: You learn that teachers from different subject fields do not have the same opinion about how to approach a problem and you learn how to handle such differences. This is something we have become aware of over the years.”

(Female lecturer A, Scientific Problem Solving, Göteborg)

Both of the programmes, the Project Programme and Scientific Problem Solving can be described as development work in the true sense of the word: The groups of people engaged in the projects have been fairly stable over the years, which has provided fruitful environments for pedagogical discussions. Some of the teachers who were interviewed described this as a move into a more scientific attitude towards teaching:

“Traditionally every teacher is on his own. Everyone makes his own brick-building hoping that the students will design their own houses. But we never help them with the blue-prints. This is the traditional way: Don't touch my classroom! But it doesn't have to be that way. If you are doing research you get yourself a tutor and you work in teams because that is often the most effective way of doing it. Why don't we work together in teaching? Why do we believe that everyone has the ability to come up with

suitable techniques all by himself? And there are educational techniques that have been developed during the last 50 years. You would not use 50-year-old techniques in research. This is rather interesting. The scientific attitude is often lacking among the researchers themselves when they move into education.”

(Female lecturer B, Scientific Problem Solving, Göteborg)

The Survival of the Programmes

But, even if the programmes offer the students excellent learning opportunities, this message does not easily pass through to the prospective applicants. One reason for this is that the programmes are fairly new, not yet established in the minds of students, teachers, and career advisors at the upper secondary school. A recent study of the recruitment of students to physics courses at Stockholm University (Wistedt & Brattström, 1999), revealed that about 80% of the new entrants to the Project Programme in 1998/99 had selected programmes at the Royal Institute of Technology as their first choice, programmes which were well known, prestigious and highly regarded on the labour market. The expansion within the natural science and technological sectors, in terms of the number of programmes offered and the number of study places available to the applicants, has made it harder for the new programmes to recruit students who have the necessary entrance qualifications, and the competence that will enable them to make use of what the programmes can offer:

“One draw-back is that the programme has recruited students who have chosen it on the wrong premises. They get hold of the project-idea and they may learn a lot, but they are not willing to confront the theoretical challenges and hardships. That is discomfoting. Of course there are shining exceptions, students who emphasise the academic advantages of this programme, but in general the selection of students has been rather negative, which feels like a heavy burden.”

(Female lecturer B, The Project Programme, Stockholm)

This problem has not been as pronounced at Göteborg University, even if such students exist:

“During the last years the grade point average among the students has decreased. It has become much harder to recruit students. And we know that people who have only passed in mathematics and physics at the upper secondary school will run into problems on the programme. As I recall no such student has passed the first two years on the programme. Regrettably, it has not been possible to save them, not even within

this programme which, more than other programmes or courses, is specially designed to bring out the latent abilities in the students, abilities that have not been realised at the upper secondary school.”

(Male lecturer A, Scientific Problem Solving, Göteborg)

If you run into difficulties you will need support. At Stockholm University the Project Programmes was met with sceptical attitudes from the Faculty of Mathematics and Natural Sciences from the very beginning (see Wistedt, 1996, p.26). The faculty members were concerned about the scientific status of the programme:

“But then we have to discuss what we mean by being ‘scientific’. I don’t think there is one definition which everyone would ascribe to. The definitions vary between the subjects. What they mean by ‘being scientific’ in mathematics is that you should be formidably theoretical. Maybe it is an unfounded feeling, but many people do not seem to understand that other approaches can be just as demanding, sometimes even more demanding. They are satisfied if they can go on doing science in their own way, the hard way, and they do not appreciate the importance of other approaches. If they were to understand that these are every bit as hard, they would be more respectful.”

(Female lecturer B, The Project Programme, Stockholm)

And, it certainly did not make it easier, as one of the teachers pointed out, to speak for a programme which soon ran into problems recruiting students. To stop the downhill trend, one of the students on the Project Programme succeeded in convincing the faculty to grant the programme 100,000 Swedish crowns for an advertising campaign:

“But was it wise to invest in a PR-campaign? We also have to make the programme better, and we need the resources to do it.”

(Female lecturer A, The Project Programme, Stockholm)

The new project leader was not granted any reduction of his teaching hours for his work on the campaign, but had to invest his own spare time on the effort, even some of his time set aside for research. Such a situation opens the door to teachers on the programme losing faith.

“You lose the grip. I still think that the programme is great, it isn’t that, but it becomes a matter of routine, you lose your devotion somehow.”

(Female lecturer A, The Project Programme, Stockholm)

At Göteborg University the programme had the support from the Faculty for Natural Sciences from the start. When the programme was launched, a faculty-level steering group was formed with responsibility for the development of the programme. At the beginning this steering-group did not have any formal status. Today it has, and it has even become a model for other interdisciplinary programmes at Göteborg University, such as, for instance, the programme for teacher education. The Göteborg programme has also received additional funding from the faculty and from the university over the years, grants that have helped the teachers to develop the programme. This support may be one factor which explains the difference in the programme histories.

The Recruitment of Female Students

One of the goals of the educational initiatives in Stockholm and Göteborg, was to create an environment which would attract new groups of students to subjects traditionally dominated by men. To accomplish this goal the pro-programme makers not only changed the forms of work, they also introduced new combinations of subjects. The third partner on the programmes is, in both cases, subjects that normally have a reasonably high proportion of female students: mathematical statistics in Stockholm, and environmental science in Göteborg. “*We are the drawing card*”, said the lecturer in environmental science in the interview.

However, in many ways the programme developers had to be cautious about their plans to create a programme designed to recruit women:

“This is in essence an initiative directed towards women, but it was not possible to even breath about that. The matter was tremendously controversial.”

(Female lecturer B, The Project Programme, Stockholm)

Not only men, but also women working within the departments, had second thoughts about affirmative action. In general, women do not like to get favours solely on account of their sex:

“And this is the crux of the matter. ‘We will show them that we are every bit as good as they are’. But, what does it mean to be ‘good’? Norms differ. You are supposed to be ‘good’ on the terms set by young or middle-aged men.”

(Female lecturer B, The Project Programme, Stockholm)

In the interviews many of the female lecturers pointed out that the young female students who enter the university cultures bear with them attitudes that are not always visible to themselves:

“They get jammed. They want to be loyal to the men, for natural reasons. I can recognise the attitude in myself when I was in that age: ‘I will show them that I can be just as good!’ But it later dawned on me that the ideals were set by men. For centuries they have had the power of freely setting the criteria, and these criteria are male. But when you are 20 years old and about to start a family it matters a great deal what men think of you. Some of the women are arrogant about it, not all of them, but some. In general, I believe that many young women concur with the norms set by men.”

(Female lecturer B, the Project Programme, Stockholm)

Male structures exist and may hinder the development of integrative efforts:

“One of the students was wondering what had happened to the department’s gender equality plan. In this plan it was stated that measures should be taken to enhance female integration, and she was wondering what these measures were. She had not seen any. I asked her: ‘Have you seen any female lecturers?’ ‘Yes’, she said, ‘we saw three doctoral students at a lab last semester, since then we haven’t seen any’. A couple of assistants in maths were also women, she recalled. Such is the power structure at this department. You understand, don’t you?”

(Female lecturer B, Scientific Problem Solving, Göteborg)

This does not mean that the men working at the departments are opposed to an enhanced recruitment of women to the subjects:

“No, absolutely not. On the contrary. In that way we have moved forward. If you would ask them they would gladly say that they would like to see more female students on the programmes. But there is a certain limit to how far you can reach, and this limit has to do with the male norms.

(Female lecturer B, The Project Programme, Stockholm)

The only way to change these norms is to get more women interested in the subjects, to an extent large enough to start a process of cultural change:

“It is very important to create role models, so that young women have something to aim at. But if there are no women...”

(Female lecturer B, The Project Programme, Stockholm)

As mentioned in the previous chapter, both programmes within the mathematics and natural science sectors have been successful in attracting women, and the lecturers believe that this has to do with the design of the programmes, the new forms of work, the new combinations of subjects, and, not least, the close co-operation between the students, and the students and their tutors and lecturers:

“To put it simply, I think that this programme attracts a new group of young people, and within this group there is about 55-60 per cent women. The programme is designed to attract people who otherwise would not have chosen to study these subjects.”

(Male lecturer A, Scientific Problem Solving, Göteborg)

But, what if a programme with such a design is more costly? One criticism of the programmes has been that they are more demanding in terms of teaching resources than the traditional courses or programmes:

“Can we accept that? In mathematics we had two master’s theses last spring, and we will probably see one or two more this semester, and, furthermore, they were carried out by women in this programme. I mean, if you are interested in such matters, and if you think that they are important, it doesn’t matter if the programme is a bit more costly. If we can help students to produce master’s theses in mathematics, and if we believe that it is a good thing if women choose such careers, it must count for something.”¹⁶

(Male lecturer A, Scientific Problem Solving, Göteborg)

“Every women who takes her degree in mathematics or physics is a huge contribution.”

(Female lecturer A, Scientific Problem Solving, Göteborg)

In the interviews with the students they all agreed with their teachers that the programmes had recruited students who would not have chosen a career in mathematics or physics if they had not been offered the chance to try their competence in a supportive environment:

16. According to the annual report from the Department of Mathematics and Computing Sciences, 1999, a total of four master’s theses in mathematics were produced in 1999 at Göteborg University, two by male and two by female students. The latter two were both produced by students at the programme Scientific Problem Solving.

“I find it hard to believe that the women who have now chosen to become doctoral students in mathematics or physics would have done the same if they had not been offered this route.”

(Female student B, Scientific Problem Solving, Göteborg)

“I wonder what I had been doing today, if I had not chosen this programme. I don't remember what my second choice was, but it would not have been physics, that's for sure.”

*(Female student A, Scientific Problem Solving, Göteborg,
now a doctoral student in physics)*

“Well, we are a couple of women who have become doctoral students in mathematics. We were bold enough to apply.”

(Female student C, Scientific Problem Solving, Göteborg)

According to the students who were interviewed, classroom climate and activities play critical roles in determining which students persist, or do not persist within the subjects: group study and support, the awareness of their teachers' high expectations and the shared experience of success in solving problems of a progressively challenging nature are important factors for the process of building the self-confidence which eventually may make you “bold enough” to take up the challenges on an even higher level of achievement.

The Development of the Programmes within the Field of Computer Science and Engineering

Means and Ends

If mathematics and physics have problems recruiting female students, these problems are even more pronounced within computer engineering, with an average recruitment of 24 per cent women in 1999/2000 (SCB, 2001, Table 2). Among the programmes linked to the initiative, only the IT-Programme at Linköping University has been able to recruit women to an extent above or comparable to the national average. The other two programmes have remained on a much lower level of female recruitment.

One may wonder why women are so scarce in computer engineering. One reason may be that the culture nurtured at the traditional technical universities does not appeal to women. In the study of students who switched from S.M.E subjects to other fields of study (Seymour & Hewitt, 1997), the characteristics of this culture were described on the basis of interviews with a large number of American university students — a culture named ‘the Iceberg’. The features that the students pointed out as the most typical, and the most disheartening were the following:

- The rejection of S.M.E. careers or lifestyles is partly a rejection of the role models which S.M.E. faculty and graduate students present to undergraduates
- S.M.E. faculty are often represented as ‘unapproachable’ or unavailable for help with either academic or career planning concerns
- Students perceive the curve-grading system widely employed by S.M.E faculty as reflecting disdain for the worth or potential of most under-classmen. Their presumed purpose is to drive a high proportion of students away, rather than give realistic and useful feedback to students on their level of understanding, or conceptual progress
- Harsh grading systems, which are part of a traditional competitive S.M.E. culture, also preclude or discourage collaborative learning strategies, which many students view as critical to a good understand-

ding of the material, and to a deeper appreciation of concepts and their applications

- The experience of conceptual difficulty at particular points in particular classes, which might not constitute an insuperable barrier to progress if addressed in a timely way, commonly sets in motion a downward spiral of falling confidence, reduced class attendance, falling grades, and despair — leading to exit from the major
- Teaching assistants (whether American or foreign) bear a disproportionate responsibility for the teaching of fundamental material in basic S.M.E. classes that are over-enrolled given the pedagogical resources available
- Over-packed curricula which lengthen the time needed to complete an S.M.E. degree place extra financial burdens on the growing proportion of students who must pay for their education by employment or the accumulation of debt. Seniors express the suspicion that over-packing the syllabi of basic classes is maintained for ‘weed-out’, rather than for pedagogical purposes
- Curriculum overload (combined with the growing length and cost of S.M.E. majors) also supports the perception that the rewards (both material and personal) of S.M.E.-based careers are not worth the effort and costs required to secure them (*ibid*, pp. 34-35)

Many of the teachers engaged in the Government’s initiative would agree on these features as fairly accurate descriptions of the cultures at many Swedish technical universities. They also wanted to do something to change them. The IT-Programme at Linköping University, a 180 credit programme admitting 30 students each year, was the most radical attempt to challenge the traditional educational norms. Inspired by teaching methods developed within the field of health-care and medicine at Linköping University, the project leader drew up the lines for a development work founded on the basic principles of Problem Based Learning (PBL, see for instance Barrows & Tamblyn, 1980; Berkson, 1990; Egidius, 1991; Ingemarsson & Björk, 1999, pp. 89–96)¹⁷. These new forms of work are the distinguishing features of the programme:

17. See Nadjm-Tehrani, 1997; Herzog, Loborg, & Nadjm-Tehrani, 2001, Wistedt, 1996, pp. 41–48, for more elaborate descriptions of the programme.

“In terms of content it is a classical master of science in engineering programme. /.../ In my view the main focus of the development work was the educational changes, the changes in form, the creation of a new programme with an alternative pedagogical shape. We did not overlook the goal of recruiting more women, but the biggest priorities were educational.”

(Male lecturer A, the IT-programme, Linköping)

The new master's of engineering programme at Chalmers is a much larger programme, admitting about 160 students a year since 1999. At Chalmers the changes were more modest, mostly adapted to requests from the labour market, such as the need to further the students' communicative skills, their abilities to co-operate in work-groups, and to carry out projects in an independent way. The university also invested in a new building (which the students soon named 'The Nurd Centre') housing the student groups¹⁸. A few years prior to the Government's initiative, the Swedish master of science in engineering programmes were subjected to a national evaluation. The programmes were criticised for being too fragmented, consisting of a conglomerate of separate courses rather than coherent study programmes aiming at developing student competence. The project leader of the D++ (named after the programming language C++), who had been a member of the evaluation team, initiated the project and brought with him ideas about necessary changes to be made. The two plusses in the project title (D++) indicated that the improvements were designed to serve female interests as well as the interests of all students, male and female alike.

“Considering all the miseries this programme has been through in previous years, I'm incredibly pleased with the changes made, that the programme has been restructured. Earlier it was a total chaos.”

(Male lecturer A, Computer Science and Engineering, Chalmers)

“We have not forced our colleagues in the various subjects to teach in certain ways. We have tried to encourage them to use alternative methods and to utilise the student groups, but if there is no will among the departments or the teachers concerned, it's no use putting the pressure on them.”

(Male lecturer B, Computer Science and Engineering, Chalmers)

18. For a more elaborate description of the programme, see Jansson, 1998; Wistedt, 1996, pp. 33–41.

A more modest attempt to redesign a computer engineering programme is also a characteristic of Karlstad University, a 120 credit programme aiming at a Bachelor's degree in computer engineering. The recruitment campaign was the main objective, combined with efforts to help new students adjust to the university culture: support-groups for the female entrants, introductory courses for those students who felt that they lacked the necessary technological experience.

“During the last two years we have offered an introductory course to the engineering students. It is an integrated course where we bring up different matters. If the students lack the basic skills in technology which we expect from them, we have to provide them. We introduce them to group-dynamics, how to work in groups and on projects. Last year we introduced them to gender studies. It did not work out well. I guess it has to do with the character of the subject.”

(Female lecturer A, Karlstad University)

The Essentials of the Programmes from a Student Perspective

The IT-programme at Linköping University was evaluated favourably by all of the students who were interviewed. Of course, there were teething problems, they said, but most of these problems were sorted out in co-operation between the teachers and the students. When the programme was launched, the brochures that were sent out to the prospective applicants over-emphasised the differences between the IT-programme and the traditional engineering programmes. As a consequence, some of the students who were enrolled were disappointed:

“In their effort to recruit more and more students, since the Government obviously thinks that we should, you have to make the information more flashy and glossy. You lie about what the programmes really require. Those who know that they want to apply get irritated that they cannot get the correct information about the programmes, the others read the brochures and find them ‘awesome’, and get disappointed since the programmes do not meet with their expectations.”

(Male student A, The IT-Programme, Linköping)

But looking back on what the IT-programme has offered, the students were content. Their descriptions of the essentials of the programme resemble the

descriptions made by the students at Stockholm and Göteborg Universities. In the interviews the students stressed:

- The co-operative forms of work, and the problem-oriented approaches to learning, offering ways of studying the subjects which many of the students viewed as critical to a good understanding of the subject matter, and to a deeper appreciation of concepts and their applications. (*What would this programme be without PBL? Of course there are other things, such as the training in communicative skills, the group-dynamics of which we get three years of training in a non-stressful environment, but PBL is the distinguishing feature. ... The work within the tutorials has been very rewarding.*)
- The development of communicative skills. (*The programme develops the same expertise as other programmes do, but there are many other qualities that are developed at the programme. Not least such simple things as being able to write, and to make presentations. In fact, these qualities are enough to justify the programme. You will certainly need them later.*)
- The improved social climate. (*We have worked closely together, which is one essential thing about the programme. This creates a social situation very different from the big lecture halls, one hundred students in the same class. You get to know everyone.*)
- The opportunity to take personal responsibility for the learning process. (*You have to take a personal responsibility. Nothing will happen if you do not take the initiative. You have to get engaged. Of course this takes more effort than just doing what you are told: you appear at the exam, you write things down and you are done with them*)
- The efforts to integrate social science or humanistic elements. (*In the fifth semester we co-operated with students in psychology who functioned as consultants to the project groups. It was great! It worked out really well. You learn how to communicate with people who are not technicians. And the psychologists helped us with the group-dynamics and group-psychology, and aided us in understanding ourselves and how we worked. It was tremendously instructive.*)

However, the students pointed out that the new ways of working did not always fit with engineering education:

“The project leader had his visions, but the models did not work out entirely. Much was inspired by the Faculty of Health Sciences and how they work, but the models

didn't always fit in with us. We didn't really follow one single model all the time. What ran all through was the tutorials, but they were used differently. But since we had our group-meetings each week they gave the continuity, even if we did not follow any strict PBL-method."

(Male student A, The IT-programme, Linköping)

In the interviews the students mentioned four characteristics of engineering education which were inconsistent with the guiding principles of PBL:

- The groups were not always homogeneous in terms of the skills and knowledge required to carry out the tasks assigned to them, the so called 'vignettes'. In Swedish engineering education it is quite common for the students to have incomplete courses lagging behind. The number of credits that the students have earned can vary substantially within a group. As a consequence, some students may lack some prerequisite knowledge which, in turn, may disrupt the group-work. *(Yes, it was a disturbance, an obvious disturbance. The question is if we ever solved it, or if we just worked on disregarding it, that is, two or three group-members were not very active, and they ran the risk of failing, which means that the next semester they had yet another unfinished obligation to deal with.)*
- The PBL-method did not suit all of the subjects on the programme. *(There are, of course, different opinions about this, but I think that many of us students, and almost all of the mathematics teachers, agreed that it did not work in mathematics. I believe that you have to be sensitive to the subjects and see what methods will suit them. You cannot design a frame-work and try to squeeze everything into it.)*
- PBL is quite demanding in terms of faculty resources. Generally it has been hard to find experienced tutors to the groups. However, this has not always been a problem to the students, who have been given the opportunities to function as tutors to the lower classes. *(PBL is demanding in the sense that every group needs a tutor. But older students can help. I functioned as a tutor during one semester and it was very rewarding. It was an education. I became more attentive to the core principles of PBL, of understanding how we learn, and to be aware of the meta-cognitive questions. That was the finishing touch. Fun too.)* However, the problem of finding suitable tutors has led to another problem,
- The programme has not been in the position to expand to an extent comparable to other programmes within the sector, even if the

students think it should. (*The programme provides exactly what trade and industry demand and if I was in the position to hire people in a couple of years, I would not hesitate one second to hire someone from the IT-programme. Everything else being equal I would choose a person from this programme.*)

The Computer Science and Engineering Programme at Chalmers University of Technology was not described as positively in the interviews with the students on the programme. Many of the characteristics they mentioned were rather like the descriptions of “the Iceberg”.

“I’m glad that you sent me these questions in advance, otherwise it would not have been easy to answer them. When you study on this programme the tempo is very high, you seldom have the time to sit down and reflect on what you are doing, and what kind of an engineer they are trying to turn you into. Seven weeks, exam, seven weeks, exam. You seldom reflect. And when you choose among courses you say to yourself: This seems fun, so I’ll choose that. Others may say: That seems easy, I’ll take that one. We are all different.”

(Male student A, Computer Science and Engineering, Chalmers)

The first year of the programme, however, was described as a welcoming entrance to computer engineering. The students worked in groups of six to eight students in each; they had their own group-rooms and plenty of opportunities to communicate with their peers and tutors.

“The first year was great. It was soft, nice, and cosy all over. But the second year was like: ‘Lets go back to normal!’ Hard subjects, and really dull ones: physics, electrical circuits or whatever they were called!”

(Female student A, Computer Science and Engineering, Chalmers)

These mandatory courses took their toll:

“Well, frankly speaking, some of the mandatory courses were veritable sleeping pills. Insurmountably boring. And they have been in the programme since the Stone Age and looked exactly the same: In-circuit electronics, Physics C, Mechanics B, incredibly boring. I managed quite well in some of them, but others were so boring, in combination with being hard, that I simply couldn’t bring myself to cram for them. It was only a question of how many re-sits you were prepared to take. You could forget passing on the first exam, since you had two other courses, just as boring, running parallel to them and which took your time. On the other hand, it is good to have

some knowledge of physics. But I wonder if it has to be so in-depth. For instance, Physics C was, in principle, mostly semiconductor theory, which is relevant to computer science, but if you are not specialising in hardware you do not necessarily need the in-depth knowledge.”

(Male student B, Computer Science and Engineering, Chalmers)

One of the female students, who took a leave of absence from her studies during her third year on the programme, said that she was happy that she did not leave during the second year. If she had, she would not have returned, she said, and other students said the same:

“I think the concept is, that if you pass the second year you’re on the train. The courses get nicer in a way, at least as I experienced them. It may have to do with the fact that later there are many optional courses to choose among.”

(Male student A, Computer Science and Engineering, Chalmers)

To summarise, the students at the New Master of Science in Engineering Programme at Chalmers, seemed to experience a certain ambivalence toward the design of the programme:

- The co-operative work forms and the project based studies during the first year of the programme were viewed favourably by most of the students and seen as helpful to their learning (*It was an advantage to work in groups. It was a good thing. All courses were not adapted to these forms of work, though, mathematics for instance. It might have been useful, but it felt frustrating at times.*)
- However, the forms of work were not always consistent with the overall design of the courses (*The group part of the courses did not always harmonise with the course goals and, above all, with the exams. Sometimes it was more strategic and certainly more egotistic, not to give a damn about the group or the group assignments, but to concentrate on the exams, to get your credits and walk away, and count on the group not telling on you.*)
- Each group had access to a facilitating tutor, but since the students were new to the ways of working and the tasks were not always adapted to these methods, the students often lacked the necessary guidance. (*I think the concept was a bit rotten, because it was all based on the idea that the groups should be well-functioning. You couldn’t walk away from your group. And we were assigned a tutor who was respons-*

ible for three or four groups, and if the tutor got stuck in a group-room two doors away from us, we could sit for half an hour, inactive.)

- As a consequence the students sometimes felt that they had nowhere to turn with their problems. *(It was a good group, but we lacked a tutor, or a mentor of some kind, who could hold the group together. If we ran into problems we had nowhere to turn. You could perhaps change groups, but that would have taken a lot of effort. It was easier to say: 'It'll work out', and instead your studies suffered.)*
- The first year of the programme proffered an educational philosophy which was not followed up during the later years. *(In the second year of the programme the groups were all changed. I didn't have one single course in common with my new group. We were supposed to get to know each other while we, at the same time, were scattered around. We didn't even feel the need to get acquainted. During the first year there was a lot of D++, but where did it go? D++ meant group-work. But it all vanished during the second year and we moved into D- -.)*
- Curriculum overload was described as a problem at the programme, often conflicting with the co-operative work forms. *(We have 40 hours of scheduled work and labs til nine in the night. But, on the other hand, that is also why big companies, like Ericsson, turn to Chalmers when they are on the lookout for new employees. What this programme provides, more than anything else, is a 'literacy certificate': 'We give you these three thick files, and you will fix it, because we have this little problem to work out' .)*
- Another problem was the expansion of the programme, adding anonymity and over-crowding. The new building, designed for the students groups soon became too small. A barrack was built to house the increasing number of students. *(But it is not a barrack. You have to use the correct terminology. It's called a pavilion.)*
- The students were unanimous in their praise of the many possibilities for choosing among different special courses and seminars during the fourth year of study. *(On the one hand you had the courses which gave you further insight into the chosen area, but, above all, you had seminars where you could squeeze the little extra out of the subject.)*
- In the seminars co-operation between the teachers and the students became more frequent and intense. *(In general the contact between the students and the teachers on the programme could be much better. But the seminars were different. It even happened that one of the teachers*

went out for a lunch with us after a seminar. Just like that, and on his own initiative. That was one of the most rewarding projects we had.)

The students explained this mismatch between the ideals of the D++ and the reality of the programme as a result of the difficulty of changing the structure of an established programme at a prestigious institution like Chalmers. Even if they phrased their descriptions of the Chalmers culture differently, using attributes such as “stiff” and “rigid”, or “bureaucratic” they all gave a picture of an institution resistant to change:

“Despite the fact that things get changed in a lot of ways, basically they stay the same. It is fairly easy to make surface changes. You can easily introduce new courses and new content if the market asks for it. But it feels as if the underlying structure is moving very slowly.”

(Male student A, Computer Science and Engineering, Chalmers)

The Computer Engineering Programme at Karlstad University has struggled constantly with problems caused by a booming labour market within the IT-sector. The programme has expanded considerably, it has been short of staff, and the students sometimes leave the programme before they have taken their degrees, lost to the labour market and lucrative jobs outside of the university.

As mentioned above, the project “Women in engineering education” at Karlstad University was first and foremost a recruitment initiative, initially comprising three programmes¹⁹, one of which was the computer engineering programme. The project started in 1993. Four years later the funding ended and the project was closed down:

“It fizzled out. Those of us who were engaged in the project passed on to other positions and other tasks. I really don’t approve of the project form. I would have wished for a more long-term enterprise. When the four project years had ended we were in the position to become a university. We re-organised. This project suddenly had a very low priority. No money was allocated to it.”

(Female lecturer A, Karlstad University)

19. Later a fourth programme was linked to the project. For a more elaborate description of the project Women in engineering education, see Wistedt, 1996, pp. 48–54.

Those who had been engaged in the project were very disappointed to see their work come to a sudden end:

“We got a pat on the shoulder: ‘You’ve done a great job, but now it is time to move on to other matters’. I was very disappointed. And for a long time we got undeserved attention. People talked about the ‘Women in engineering’ project in a way that made me irritated at times. You could sit at meetings and hear them talk about the project as if it still existed, as if something was happening although it wasn’t. We didn’t get any money, and yet people talked about the project: Look how good they are.”

(Female lecturer A, Karlstad University)

For the female students at the computer-engineering programme, however, the project was very supportive while it lasted:

“Especially to me, since it gave me the opportunity to meet with women from other classes. I was the only female student in my class. Now they are not that few, and they are more active than we were.”

(Female student A, Computer Engineering, Karlstad University)

The possibility of socialising with other women within the computer engineering field also helped to build up the self-esteem necessary to cope with the assignments in the programme:

“The computer engineering programme is, to a large extent, based on laboratory work. You sit at the computer in groups of two. I worked with a male student and at the beginning he did most of the work. I did not have much self-confidence about these matters. He might not have been more proficient than I was, but the support was not too good at the time. I guess that was one of the reasons why many of the women left the programme. I had practically no experience of programming, and if you haven’t done it before the threshold is quite high. You have to think in a different way than you are used to. It took me a long time to get a grasp of it.”

(Female student A, Computer Engineering, Karlstad University)

However, some of the activities that were parts of the project ‘Women in engineering education’ remain, now on the initiatives of students and teachers, and they are still helpful to the students on the programme:

- **Female support groups** *(The female students at the computer engineering programme have created a group which they call MOUSE. Quite fun. They have planned to visit the upper secondary schools and tell the*

students about the programme, because they think that many girls are afraid to apply, afraid that they won't be up to it. Some of the female students can recognise such feelings in themselves.)

- **Remedial courses** *(On the request of the students, an evening class has started this year where we learn how to put a computer together. It's mostly for the female students, but some male students have also attended. Some of the teachers have offered their help showing the students how a computer is constructed, what different parts it consists of, and such things.)*
- **Female tutoring** *(The first-year reception is very important. One thing me and a friend of mine were talking about was that it is very important for the students to meet with female teachers early on the programme, to see that there actually are women who have succeeded in carrying it through.)*
- **Courses that will appeal to women** *(In a newly launched course we learn how to design databases. How you design the whole system, how you implement it, and such things. Many of the women find that course particularly interesting and fun.)*

Other things have changed for the worse. After the projects within the Government's initiative had started, yet another Government initiative was taken to enhance the recruitment of new groups of students to natural sciences and technology, called 'NTSvux'. Working people with the necessary entrance qualifications were granted the opportunity to keep their salaries if they chose to enter a university programme within the area of natural science or technology. This opportunity is no longer offered:

"It's a pity that they took away the NTSvux. I think they should reinstate it. When NTSvux started, a lot of women came, many of them were 30 or 40 years old, some were even 50. I think that it was a great initiative for older students and for students who live far from the university or who have a different social background."

(Female student A, Computer Engineering, Karlstad University)

The Development of the Projects

The teachers who were interviewed were all well aware of the problems mentioned by the student in the interviews. Over the years various measures had been taken to improve the design of the programmes. At Linköping university the radical form of PBL was moderated:

“We have sobered up. The initial design was carried out by a group of enthusiastic teachers, but over the years some teachers have left the programme and new teachers have come, new colleagues with unknown names. But the programme keeps rolling, it just has to work. And it takes a lot of effort to introduce these new teachers to the programme philosophy. Maybe we haven’t tried hard enough. They have been given a teaching assignment but none of us has taken the full responsibility for introducing them to the context of the programme.”

(Male lecturer B, The IT-programme, Linköping)

This also goes for the programme at Chalmers. The teachers were all well aware of the problems that the students encountered during their group work, and that too little had been done to introduce them to the new forms of work, and to the new ways of approaching the assignments. Not least too little had been done to aid teachers in handling the group-dynamics.

“There are still groups who function extremely poorly. And if we are to continue with this project we must educate ourselves to handle other sides of the of the students’ studies than those which are purely subject-related. This was discussed at the beginning of the project: Who has the competence? Who is responsible? Certain groups would need fundamental help in order to communicate properly and to approach the tasks in a fruitful way.”

(Male lecturer C, Computer Science and Engineering, Chalmers)

In terms of priorities, the introduction of new teachers to the programme philosophies was the first item on the teachers’ lists of things that needed to be done. Another item, much debated among the teachers, was the implementation of alternative forms of examining the students, assessment methods that would be more in tune with the overall goals of the programmes:

“This may be my special hobby-horse, but I don’t think that the examination has changed much. We know that assessment plays a key role in determining the quality of student learning, but as one of the students expressed it: ‘We start learning, and the group work is fun, but as the exam gets closer you become desperate, and you start cramming’. I have said this many times, and people think I’m nagging, but I still think that we are faced with a dilemma here.”

(Male lecturer A, The IT-programme, Linköping)

Another matter, mentioned by some of the teachers at the computer-science and engineering programmes, and closely linked to the issue of assessment procedures, was the extreme workload and time-pressure put on the students. Some teachers felt that this stressful situation ran counter to the ideals of the programmes: to enhance the students' possibilities of gaining an understanding of fundamental ideas, which the teachers of the courses themselves wanted their students to gain:

“The heavy workload is wrong. It doesn't serve anyone. The things that are learnt are learnt badly, if they are learnt at all. Some students drop out. There's an enormous time-pressure. The demands on understanding are not nearly as obvious as the demands on carrying out the work. And you become an expert at it. You don't have to understand. 'I know how to do this, and I'll settle with that'. And it is rewarding. They don't even recognise the feeling: 'I have insufficient knowledge about this'. They get rewarded for it.”

(Male lecturer C, Computer Science and Engineering, Chalmers)

There were many things that the teachers and the students appreciated about the programmes, and the projects have, no doubt, solved a lot of problems that previously were haunting the computer science programmes: the graduation rates are higher than they have been, the co-operation between the teachers on the programme has improved considerably even if it was not yet ideal, and the programmes have established themselves at the universities and are well regarded by colleagues and the university administrations. One problem has not, however, been solved to their satisfaction — the recruitment of female students.

“This is something that we are not particularly proud of, or happy about. We have not succeeded in reaching the goals that we hoped for: We have not been successful in recruiting female students, and we have not succeeded in taking care of those who come.”

(Male lecturer B, Computer Science and Engineering, Chalmers)

The Recruitment of Female Students

As previously mentioned, the initiative to increase the participation and retention rates of female students in computer science have yielded disappointing results despite considerable investments in terms of money and effort. How can this be explained?

One explanation was given in a newspaper article (*Göteborgs-Posten*, April 25, 2000), written by one of the students in the computer-science and engineering programme at Chalmers:

“During a meeting at Chalmers I was lucky enough to find myself sitting in the company of two nice gentlemen with a long history at Chalmers. As usual, when a female computer scientist meets with older men with an academic background, I was asked why so few women apply to Chalmers and other technical universities. Earlier I have always answered that I don’t know, but having discussed the matter with these two gentlemen I think that I have reached an insight. Young women do not want to study at a university with old traditions if these traditions tend to move the development of society backwards in terms of gender-equality. The reason is that these women are well aware of the fact that they run the risk of being treated just as women were treated when these traditions were established. At Chalmers they were founded at a time when women did not even have the right to vote.” (ibid, p.4, my translation)

The author was critical of the traditional recruitment measures, mostly directed towards young women at the upper secondary school and their attitudes towards technical education. Initiatives which aim at changing women’s attitudes are not only ineffective, but counterproductive, she argued:

“Every time the newspapers write about the shortage of women in technical education, someone says that women are too frightened of it. I have said it myself in a newspaper interview once: that women have to get tougher in order to dare to apply to Chalmers. I am ashamed of it. In my view it neither takes toughness nor pluck to succeed at Chalmers, it only takes motivation.” (ibid., my translation)

She urged university administrators and the student unions to scrutinise their own organisations and their own spheres of activity in order to identify genderised structures, and she invited them to take sides against discriminatory organisations, such as, for instance, men’s clubs who still exist at some universities.

The article stirred up a heated debate about the academic culture at Chalmers (see *Göteborgs-Posten* April 26, 2000, May 5, p.4 & May 8, 2000, p.4; *Ny Teknik*, 2000:18, p.3). Many of the students who were interviewed agreed with the author of the article, that the technological culture is predominately male, but they did not find the attitudes among the male teachers discriminatory:

“Actually I have met such attitudes more often among the female lecturers and tutors. Not in all of them, most of them are very good, but there are some. I don’t know if they

feel threatened or if they are trying to prove that they know it all themselves: 'Now we have to get extra mean and compose an extra tough assessment, and we do not need to help as much on the labs'.

(Female student A, Computer Science and Engineering, Chalmers)

Some of the teachers also agreed that the cultures at many technical universities may reject women:

"We are dominated by men, we live like men without knowing that we may be discriminate against women. We don't do it consciously, but we don't give them space because they are too few. Maybe they don't even have the right to take up space. The computer-science programme at Chalmers has tried to attract women, but they drop out, some maybe for other reasons, but it is not very encouraging. This means that there is no real opportunity to create a female environment for women to grow up in. And the traditions were already there when the programme started, and we cannot overlook that fact. The traditions are immanent, in the walls, in the internal structure of the unions, the student societies and so on."

(Male lecturer D, Chalmers)

On the other hand, cultural inertia cannot in itself explain the fact that fewer and fewer women apply to computer-science programmes. The university culture at Chalmers differs very much from the cultures at Linköping and Karlstad universities. Both of them have broader educational profiles: At Linköping University there are three faculties: The Faculty of Arts and Sciences with 10,500 students, the majority of them women, The Faculty of Health Sciences with 2,000 students, many of them women, and the University of Technology with 7,700 students. Karlstad University is dominated by the teacher-training programme, which started as early as 1843. Of the 10,000 students, 35 per cent are teacher trainees. Nursing education also has a long tradition at Karlstad, founded in 1907 and presently enrolling 30 per cent of the students. This means that the cultures at these two universities are not totally dominated by technological ideals and traditions:

"I think the environment at our university is very different from Chalmers, which is a technical university. Technology is a small part of our university and the technical education doesn't have the strong traditions that Chalmers has, and which may be hard to change. But, you're supposed to get drunk during the initiation period, the glorification of alcohol is present everywhere."

(Female student A, Computer Engineering, Karlstad)

Nevertheless, the programmes at Karlstad and Linköping have also had problems recruiting women to computer science which indicates that the issue is more complex. In the interviews the teachers and students pointed to several explanatory factors. Some of them they all agreed on:

- **Women tend to be attracted to programmes which are attractive to other women.** This makes female recruitment to male-dominated programmes a bit problematic since means and ends are intertwined.
- **Female students are sensitive to role models.** Thus, programmes with few female teachers and tutors will have problems recruiting women (probably the same argument holds in reverse for programmes who have problems recruiting male students, for instance nursing education)²⁰.
- **Public views of the subject field matters,** for instance views of computer science as masculine, hard, and competitive may come into conflict with female gender images.
- **Choosing a programme is more than choosing a professional or academic career.** All students are sensitive to the educational environment, to the possibility of building networks, finding friends and being accepted among equals, in short, to developing as a person. Few women find computer engineering attractive in all of these respects.

However, there was a lot of disagreement over factors that had to do with the importance of the pedagogical arrangements, such as gender preferences for certain teaching methods, or factors that had to do with female characteristics, such as lower self-esteem:

“I have always found it strange to generalise such attitudes. Most of the women in my class were hard-core careerists, which counters the general model. They knew that within four years they would take their degrees and start their own companies, while I didn’t have a clue. I found them more motivated, they didn’t care much about the snuggling, they went ahead cramming for the exams.”

(Male lecturer A, Computer Science and Engineering, Chalmers)

20. The observation that female students are more sensitive to an even distribution among male and female students on a university programme was also made in a survey comprising four computer programmes at Linköping University (Ström-bäck, Hagdahl, Nadjm-Tehrani, Svensson, 1998).

On the other hand, this harder image of women may be relevant to some of the female students who stayed in the programmes. The attitudes might have been different among those who dropped out.

The relative success of the IT-programme may, if the descriptions given by the teachers are correct, be explained by the fact that the programme in Linköping tried to come to grips with all of the aspects mentioned, while the other programmes had more modest ambitions. When the IT-programme was launched it was advertised as an inclusive programme combining studies of technology with studies in the humanities and social sciences. In the interviews the students said that many of the female applicants knew from these descriptions that there would be a lot of women in the programme. Some of the teachers and students later found that this dimension might have been over-stated, making some of the students disappointed²¹. Nevertheless, the programme attracted many female students during the implementation years. The project leader also made sure that there would be an equal number of male and female teachers on the programme. He applied, what he called 'Noah's Principle', to the task of choosing members to the group responsible for the planning of the programme, upholding the maxim that half of the them should be women. This meant that he had to seek collaborators outside of his immediate circle of acquaintances. As it happens, female members of staff seem to attract other women, which means that there are many competent lecturers and tutors at the programme, even in subjects where women in general are under-represented.

None of these factors were heeded at Chalmers or Karlstad. The ambition to create a more inclusive social environment was also more far-reaching in Linköping where the programme was built on the philosophy of Problem Based Learning. It was also, it must be added, easier to accomplish such a goal at the IT-programme, since it is much smaller than the pro-programmes at Chalmers and Karlstad.

The teachers at Chalmers had given up hope. The many initiatives to attract women to the programme, such as recruitment efforts, week-end seminars for young women, information brochures, and the efforts to make the entrance to the programme more in tune with the needs of the new students, had not paid off. If women choose not to come, should we keep

21. In later years the programme organisers have been more careful in pointing out that the programme demands an interest in mathematics, physics and technology: *"The information is more adequate, but at the same time female applications have decreased. It may be a coincidence but they correlate,"* said a male lecturer at the IT-programme.

on trying to convince them, one of the teachers asked. Next year a new programme will be launched at Chalmers, called the IT-programme:

“It’s quite similar to the computer science and engineering programme, but the softer sides will be more pronounced, such as human-computer interaction and social science aspects. We hope that it will attract women to a greater extent than the present programme which many regard as directed towards hard-ware.”

(Male lecturer B, Computer Science and Engineering, Chalmers)

However, all of the teachers and students who were interviewed expressed concern about this new venture. What if no women apply to the computer-science and engineering programme in the future, one of the female students said: *“IT sounds more attractive and fun, a bit flashy. Computer science at its best”*. Others expressed more radical ideas. One of the male lecturers suggested that they should reserve the IT-programme for women only. Wouldn’t that make the men green with envy, he said:

“Have you ever considered the idea that men and women should be educated separately? There are female conferences, and computer-science fairs for women. When we have discussed the low proportion of women in mathematics in Sweden compared to other countries such as France or Spain, the argument has been put forward that perhaps we should teach them separately. Of course, they have to be integrated later on. Integration is essential for the building of networks. But the more I look at this matter, the more important it seems for women to secure a foot-hold.”

(Male lecturer D, Chalmers)

The New Engineering Programmes

Means and Ends

Engineering education at Karlstad University comprises about ten different programmes of 120 credits (three years of full time studied) aiming at a Bachelor's degree. Three, later four, of these programmes were linked to the initiative 'Women in engineering education', two of which were quite successful in recruiting female students:

"Earlier we offered two hard variants: Energy & Installation traditionally with one or two female students, and Mechanical Engineering, also with one or two female students. When the project started we introduced Energy & Environmental Engineering, and Innovation & Design."

(Male lecturer A, Energy & Environmental Engineering, Karlstad)

The names of these new programmes were not only symbols of a rethinking of the content and design of the engineering programmes, the teachers also started a quite substantial educational reorientation. The staff at the Department of Energy & Environmental Engineering co-operated in developing a common vision of what each of them could contribute to the concept as a whole. One of the lecturers described this as a move towards a more scientific way of approaching the teaching problems facing them:

"What if science has prospered just because it has been based on the attitude of co-operation and critique. Then, not using it within the field of education is like saying: Well, we don't really want any development."

(Male lecturer A, Energy & Environmental Engineering, Karlstad)

However, development work does not mean that the implementation of the new goals always works smoothly. The teachers at the programme Energy & Environmental engineering started out by attending an in-service training course in Problem Based Learning (PBL) hoping that this would be the solution to their teaching problems:

“We bought the whole concept, which was damned foolish. Since we bought it unreflectively we drove straight into the ditch. And when we lay there floundering we realised that now we have the chance to learn something new.”

(Male lecturer A, Energy & Environmental Engineering, Karlstad)

The teachers worked out their own teaching methods in co-operation with an educationalist who helped them to raise the fundamental didactic questions: What should we teach? How should we do it, and why should it be done in this way? After five years, the teachers still work together closely:

“And we set a high goal for ourselves this autumn. We saw that a major shortcoming was that we had not concerned ourselves with documenting our work. So we set the goal that we should tell each other what we were doing. We decided that each teacher should be responsible for one pedagogical seminar at the department. We also decided to participate, as a department, in one seminar at the university, one national seminar, and in an international seminar that year.”²²

(Male lecturer A, Energy & Environmental engineering, Karlstad)

One of the female teachers described the educational initiative as firmly established within the department:

“The philosophy is established, and we will never let go. It will live on. I cannot vouch for the other programmes, though. There has been some resistance. For instance, if you suggest that courses should be integrated they say: ‘Humanities, what’s it really good for? We have three years, and they know very little when they leave, which means that we have a lot to teach them. How are we supposed to manage that in three years?’ I can understand such views. But you could turn the argument around: If we were to educate engineers by cultivating the technical aspects only, we have to be aware of what we do and what the consequences will be.”

(Female lecturer A, Energy & Environmental Engineering, Karlstad)

The Essentials of the Programmes

The programme Energy & Environmental Engineering has not only recruited many female students (50 per cent in 1999/2000), but also a lot of students with work experience (category C students, see p. 30 above). According to the teachers, these students often want to relate the subject

22. See Berghel, Beiron, Renström, Olin, Jansson & Ståhl, 2000; Olin, Beiron, Renström, 2000; Renström, 1999.

matter studied to their previous knowledge, and since the programme's philosophy states that you should start with practical matters and theorise from them, the concept is quite different from the traditional academic way of introducing new concepts and theories, where you present students with knowledge and skills relevant to their chosen branch of engineering. *"But we start in the refrigerator, we look into it to see what is happening there, and then we try to generalise"*, one of the lecturers explained.

Both of the programmes were described as having qualities consistent with a gender-inclusive policy:

- There are many women in the programmes, among the students as well as among the lecturers and tutors
- There is a variation in age, social background, and experience among the students
- The programmes are rather small, creating a social environment of close relations between the students and between the students and their teachers and tutors
- The forms of work are co-operative, and problem oriented, providing possibilities for the students to interact with each other and with their teachers. Joint problem solving is characteristic of the programmes.
- The programmes offer a combination of subjects, at least some of which are attractive to female applicants: humanistic or social-science subjects or natural-science subjects known to be attractive to women, such as for instance environmental studies.

However, the programme Innovation & Design was not described as altogether working smoothly. Last year the programme expanded, from 30 to 60 students admitted. In the interviews one of the students pointed out that the programme lacked the necessary means for this expansion, both in terms of equipment and in terms of teaching resources. The student was also a bit irritated that their programme was used by the university for publicity.

"And they do it without having any grounds for it, and we get very upset. We have too few resources, and we are not too happy about the design of the programme. And there is no communication at this university, which means that problems arise over trivial matters which make us students annoyed when they become too frequent. For the moment we have one full-time course running and another part-time course scheduled during the same period. That makes 150 per cent, and just because the departments cannot communicate."

(Female student A, Innovation & Design, Karlstad)

New forms of work and new subjects, not traditionally associated with natural-science or technology studies, cannot be introduced for recruitment purposes only. They also have to be integrated into the programmes, otherwise the students will become disappointed. The brochures that were sent out to prospective applicants to the programme Innovation & Design did not render an adequate picture of the programme:

“The catalogue is misleading in a way. It is evident that the male students had looked at the technical side of the programme, while many female students saw the design aspect, and it says ‘design’ in the text. Many of them hoped for more arts and aesthetics than there actually is. I know that there are problems with the first year students. Many want to leave the programme because of their disappointment. The text in the catalogue is true in many respects, but it should be clear that you will become an engineer, not a designer or an artist. You must want to be an engineer, otherwise you are in the wrong place.”

(Female student A, Innovation & Design, Karlstad)

The Development of the Programmes

Both of the programmes have, up to this point, been successful in recruiting female students. However, the teachers who were interviewed were a bit worried about the present recruitment situation. The competition among universities has become more pronounced over the years, and the programmes have to fight quite hard to recruit eligible students. As a consequence, resources have been allocated to activities which will not help the programmes to improve. Many of the teachers, not only at Karlstad university, were critical towards the many glossy advertising campaigns.

“Invest in the inner development of the programmes. Focus on the educational issues at all times instead of spending money on advertising and competing for students, that’s what I think. And such developmental work should be regarded as a merit to a university teacher. Why not introduce a master’s programme with an educational profile, or a 40 credit course on the national level, where teachers can meet and attend courses around the country. Maybe such a professional development could even be worth as much as a doctoral degree when you apply for an upgrading from a junior to a senior lecturer.”

(Male lecturer A, Energy & Environmental Engineering, Karlstad)

Another matter which concerned the teachers, and again, not only the teachers at Karlstad University, was the problem of reaching out to people not directly involved in the development work. The teachers at the programme Energy & Environmental Engineering described their own department as a fruitful environment for educational change and for discussions about pedagogical issues, but they found it hard to establish contacts with colleagues outside of the programme.

“It would be helpful if we could associate with other groups who could pose questions. We need to build networks, where people who are willing and interested in educational development can act and establish contacts. I asked my colleagues: Would you like to arrange a seminar and get some critical comments to your work? No, they said, and it makes me so tired. I would gladly accept resistance from those who are involved, people who can help me to improve my thinking. But resistance from people who just don’t bother or who are entirely unsympathetic is hard to take.”

(Male lecturer, Energy & Environmental Engineering, Karlstad)

Concluding Remarks

Educational change does not come easy. The teachers at the programmes who were successful in recruiting female students all described the development work as a process of in-service education. They had not only taken on the task of creating a fruitful environment for the students, they had also started a process of creating a productive environment for the teachers engaged in the development work, involving all lecturers and tutors, not just a small group of enthusiasts. They also expressed the beliefs that new-recruits, be they teachers or students, need to be introduced to the philosophy of the programmes. However, this had not always been easy to accomplish since such efforts take a great deal of time and energy. Nevertheless, we should add another aspect to the list of qualities characteristic of the programmes that were successful in meeting the educational goals:

- The teachers were deeply involved in the development work. The lecturers and tutors at the successful programmes viewed the educational initiative as an enterprise, as rewarding to them as their research activities, and not very different from them in organisation and aim.

In-service efforts are, of course, much harder to accomplish if the programme is large and involves a large number of students and teachers who may be far apart not only geographically but also culturally, representing different approaches to science and different attitudes to teaching. In the next chapter we will summarise the results from the study, and bring them together in a discussion of the outcomes of the Government's initiative. In the evaluation we will concentrate on the measures taken and results of these measures in the effort to recruit new groups of students to the programmes. As mentioned above, recruitment will be viewed in a broader perspective, not only as a matter concerning the task of attracting female students and students from non-traditional student groups to tertiary level programme traditionally dominated by certain categories of men. It will also be regarded as a matter of creating environments which will encourage these new students to stay and eventually take their degrees. Thus, the evaluation will focus on the outcomes of the Government's initiative as an effort to stimulate the creation of inclusive degree programmes.

4. Evaluation

Summary of the Results

Aims and Objectives of the Follow-up Study

In this study we have taken a second look at seven degree programmes launched in 1995 at five Swedish universities: Chalmers University of Technology (*Computer Science and Engineering*), Göteborg University (*Scientific Problem Solving*), Karlstad University (*Computer Engineering, Energy & Environmental Engineering and Innovation & Design*), Linköping University (*The IT-Programme*) and Stockholm University (*The Project Programme*). In 1993 these five universities received about 3 million Swedish crowns each within a Swedish Government initiative, funds allocated to promote change in the recruitment to male-dominated programmes within higher education. Above all the goal was to enhance the recruitment of female students to degree programmes traditionally dominated by men.

How has the recruitment of female students to these programmes developed over time? How have students from different categories succeeded in their studies? How have the educational reforms developed, that is, the inter-disciplinary efforts, the introduction of co-operative forms of work and of teaching methods designed to be sensitive to the needs of these new groups of students? How are the programmes regarded, and have the ideas from the initiative spread to other programmes at the respective universities? These were the questions asked in this follow-up study of the initiative. The data used to answer these questions comprise a census, covering all students entering the seven programmes in 1995, 1996, 1999 and 2000, 1,494 students in all. The study was also based on interviews with teachers and students at the respective universities, 20 teachers and 14 students, revisited five years after the implementation of the programmes.

How Has the Recruitment of Female Students Developed Over Time?

Three out of Seven Programmes Have Lived up to the Government's Expectations

The recruitment results have been summarised above (see p. 51). In short we found three of the programmes to be quite successful in recruiting and retaining female students: *Scientific Problem Solving* (Göteborg University),

Energy & Environmental Engineering and *Innovation & Design* (Karlstad University). The proportion of female students at these programmes was high (about 40–50 per cent), the drop-out rates were evenly distributed between the sexes, the examination rates were high compared to national statistics, and they all had a high proportion of female degrees as measured in October 2000, five years after the implementation of the programmes. The credit productivity was also high among the female students, relative to the credit productivity among the male students, even if we found a tendency for women to lose ground. We could note a slight reduction in an earlier female lead for students admitted during the academic year 1999. To summarise, these three programmes had succeeded in launching new degree programmes in accordance with the goals set for the initiative, despite a rather harsh recruiting environment.

Remaining Recruitment Problems at the Computer Science and Engineering Programmes

Four of the programmes were not as successful at living up to the Government's expectations. *The Project Programme* at Stockholm University was closed down in 2000. Even if the programme could be described as attractive to female students the overall recruitment had a very negative development. The applicants were too few and the drop-out rates too high to motivate a further investment in the programme. The three remaining programmes, all within the field of computer science and engineering, encountered problems in raising the proportion of women above the national average: *Computer Science and Engineering* at Chalmers University of Technology, *Computer Engineering* at Karlstad University and *The IT-programme* at Linköping University. Among these, the IT-programme was the most successful. During the implementation phase the proportion of women at this programme was quite promising (40–49 per cent), but it dropped drastically in the later years. The drop-out rates were found to be higher among female students at all of the computer science and engineering programmes compared to the male drop-out rates, and the credit productivity among women showed a negative development: Credit productivity among women comparable to or better than that of the male students during the implementation years (1995–96) later changed to the opposite — a significantly lower credit productivity among female students admitted to the programmes in 1999.

How Have Students from Different Student Categories Succeeded in their Studies?

Higher Drop-Out Rates among Non-traditional Students

In a previous evaluation of the initiative (Wistedt, 1998a) we found significantly higher drop-out rates among the female students admitted to the programmes in 1995 and 1996. Many of these students had a study background in the social sciences and humanities. Students with a non-traditional upper-secondary education (Category D students, see p. 30 above) who had acquired the necessary entrance qualification by attending supplementary natural-science courses also had significantly higher drop-out rates. Since women were over-represented in Category D we could not rule out the possibility that the higher drop-out rates among the female students was due to this co-variation of variables. The same pattern was seen in the present study: women were over-represented in Category D, and both groups, women and Category D students, were over-represented among those who left the programmes. Even when we controlled for the relatively lower grades from the upper secondary school among students with a non-traditional study background, we found that these students dropped out more frequently than other categories of students did. The tendency for non-traditional students to leave the programmes was most notable at the computer-science and engineering programmes, where the results were significant on the 5 per cent level.

Negative Development in the Recruitment of Non-traditional Students to the Computer-Science and Engineering Programmes

The computer-science and engineering programmes also showed a negative development in the recruitment of students from non-traditional student groups, whereas the other programmes increased their proportion of such students during the five-year period. Since one of the goals of the initiative was to broaden recruitment to categories of students who do not traditionally choose tertiary programmes within natural science and technology, these results give cause for concern.

Graduation Rates Comparable to (or well above) National Statistics at Five of the Seven Programmes

Five of the seven programmes: the programmes at Chalmers University of Technology, the programme at Göteborg University, and all of the three programmes at Karlstad University had graduation rates among students

admitted in 1995 comparable to, or well above, national average. The programmes at Linköping and Stockholm Universities both had poorer results compared to the figures available in the national statistics. However, the proportion of female degrees was about the same as the proportion of women on the programme at all seven programmes, which means that we did not find a general tendency for women to be less successful than men in terms of getting their degrees.

Comparable Credit Productivity among Different Categories of Students. Women and Non-traditional Students Lose Ground at the Computer-Science and Engineering Programmes

A first investigation also showed that neither women nor Category D students were over-represented in the group of low-achievers, that is, students with a credit productivity of less than 30 credits per year, drop-outs excluded (see definitions on p. 28). However, credit productivity among different categories of students varied a great deal across the programmes, and furthermore, it varied within each programme over time. As mentioned above, a further investigation showed a tendency for women to lose ground, and this tendency was the same for non-traditional students, even if less marked. Grades from the upper secondary school could not account for this relative change in credit productivity among different categories of students: female students versus male students, category D students versus other categories of students. This trend was also most notable at the computer science and engineering programmes, that is, the programmes at Chalmers, Linköping and Karlstad Universities.

How Have the Educational Reforms Developed? Creating Inclusive Environments Through Educational Change

One of the goals of the initiative was to enhance the recruitment of new groups of students, female students in particular. Another goal, perhaps more pronounced within the initiative was to enhance the quality of learning for all students by breaking away from traditional teaching methods and traditional ways of organising the content of natural-science or technological degree programmes. Interdisciplinary studies, co-operative and problem-oriented forms of work were implemented at all of the programmes, measures which were recommended by the Council for the

Renewal of Undergraduate Education which distributed the Government funds (see Wistedt, 1996, p. 8; Salminen-Karlsson, 1999, p. 101-112). These measures were also regarded as means to create a more inclusive educational environment.

Traditional Recruitment Measures Have Little Effect

The Council established the principle that the money should not be allocated to recruitment projects, but to promote pedagogical renewal. This seems to have been a wise decision. The recruitment efforts, which were smaller or larger parts of all of the projects, such as week-end seminars for female students at the upper-secondary school, information brochures and recruitment campaigns have not yielded the expected outcomes. Such efforts are also dependant upon a constant input of money and effort that is not in tune with the image of the initiative as a four-year project. Furthermore, such efforts build on the assumption that there is something wrong with women who either do not dare to choose programmes where men are in the majority or who lack the relevant information about these programmes on which to base a more rational choice. Such assumptions have been widely criticised (see p. 89 above, also e.g. Björkman, 2000, p. 54-55; Palm, 1999, p. 12-14). In fact, the leading principle of the initiative, adopted by most of the programme designers, was the conviction that there is something exclusionary about male-dominated programmes, something which calls for a more profound reform of their content and structure.

The Government's Initiative — An Incentive for Pedagogical Reform

All of the lecturers who were interviewed stressed the importance of the initiative as an incentive for pedagogical reform. Getting a large government grant for educational development is exceptional in a university context, and the teachers all felt privileged. The lecturers at the programmes that were successful in recruiting female students described the development work as a process of in-service education. Some of them even talked about this process as a move into a more scientific way of approaching teaching, including documentation of teaching efforts, participation in seminars with colleagues on educational matters and in national and international conferences with a pedagogical agenda. As an in-service effort, the initiative created opportunities for individual teachers, and for groups of teachers from different disciplines, to develop a deeper knowledge of their own educational intentions and frames of reference.

New Forms of Work Attract New Groups of Students

The co-operative forms of work implemented at all of the programmes helped to create a social environment different from the traditional academic setting. According to the students who were interviewed, classroom climate and activities play critical roles in determining which students persist, or do not persist with a subject: group study and support as well as project or problem-oriented approaches to learning offered ways of studying the subjects which the students viewed as critical to a good understanding of the subject matter and to a deeper appreciation of concepts and their applications. Some of the teachers and students who were interviewed were convinced that these alternative forms of work had attracted a new group of students, among them many women who could not envision themselves, as one of the students put it, sitting on their behinds for four years cramming.

Modest Changes Have Minor Impact

However, at two of the programmes, *Computer Science and Engineering* at Chalmers University of Technology, and *Computer Engineering* at Karlstad University, the educational changes were too modest to have any real impact. At Chalmers the alternative forms of work were described by the students as a first-year experience, smoothing the introduction to the programme. The second year on the programme was described as a move “back to normal”. The dilemma of living up to the image of a respectable engineering programme, providing the students with a ‘literacy certificate’, proof of having passed through demanding courses under considerable time-pressure, seemed to have come into conflict with the female-friendliness of the project ideals. At Linköping the radical PBL-philosophy had to be moderated to adjust to the values and traditions characteristic of engineering education (see p. 80–81). Most of the students and many of the teachers also stressed that the tutors were not always prepared for the challenges of monitoring group-work. One teacher pointed out that new forms of work call for new ways of approaching student learning, approaches which may come into conflict with traditional teaching styles. In answer to the question posed in chapter 2, above — Do we really know if the educational changes have taken place within the programmes? — we can conclude, that it seems reasonable to believe that in some instances the changes were implemented half-heartedly, or not at all, by tutors who were not fully socialised into the programme philosophies.

Changes Which Seem to Promote Inclusiveness

The programmes that were successful in recruiting and retaining female students were found to have some characteristics in common:

- There were many women in the programmes, among the students as well as among the lecturers and tutors
- There was a variation in age, social background, and experience among the students
- The programmes were rather small, creating a social environment of close relations between the students and between the students and their lecturers and tutors
- The forms of work were co-operative, and problem oriented, providing possibilities for the students to interact with each other and with their tutors. Joint problem-solving was a characteristic of the programmes.
- The programmes offered a combination of subjects, at least some of which would appeal to female students: humanistic or social-science subjects or natural-science subjects known to be attractive to women, such as environmental studies.
- The teachers were deeply involved in the work of development. The lecturers and tutors at the successful programmes viewed the educational initiative as an enterprise, equally rewarding to them as their research activities, and not very different from them in organisation and aim.

In the next section these characteristics will be discussed as means to create or to reform degree programmes in order to make them attractive to groups of students who do not traditionally choose to study mathematics, science or technology.

How are the Programmes Regarded, and Have the Ideas from the Initiative Spread to Other Programmes at the Respective Universities? Close Contacts Between Teachers Working on the New Degree Programmes

Of the seven programmes linked to the initiative, five concern new study programmes (*Scientific Problem Solving*, Göteborg University, *The Project Programmes*, Stockholm University, *The IT-programme*, Linköping University and *Energy & Environmental Engineering and Innovation & Design*,

both at Karlstad University), the first three offered as alternatives to traditional degree programmes at the respective faculties. All of these programmes are small, admitting about 30-40 students²³. The number of tutors involved in each project is also fairly small, creating an environment of close contacts with colleagues working within different disciplinary areas. The groups of people engaged in these five development projects have also been fairly stable over the years and have provided fruitful environments for pedagogical discussions, cultures of their own. Many of the teachers report difficulties in introducing new teachers to the programme philosophies. It is not an easy task to pass on the experience of five years of development, and it takes a lot of time and effort even to try to do so.

Two of the programmes are reformed programmes, both large and expanding (*Computer Science and Engineering*, Chalmers University of Technology, and *Computer Engineering*, Karlstad University), at present admitting about 130-160 students. It goes without saying that it is much harder to achieve support for reforms among tutors engaged in programmes comprising many tutors and lecturers. The pedagogical changes made at these programmes were also more modest, and there was no pressure on the tutors to comply with the ideologies set for the initiative, for instance to make use of co-operative forms of work.

Difficulties in Spreading the Ideas

All of the programmes encountered problems in reaching out to people outside of the immediate circle of colleagues directly or indirectly involved in the development work itself, some of the interviewees even reporting negative attitudes among lecturers at their own departments. However, most of the projects found support within the university administrations; additional funds were allocated to some of the projects, aiding the teachers in further development. The Project Programme at Stockholm University, and to some extent the IT-Programme at Linköping University were the only projects that met with problems at the faculty level (cf. Salminen-Karlsson, 1999, pp.171–173). The lack of institutional support, combined with an extremely harsh recruitment situation, were pointed out by the lecturers at Stockholm University as factors related to the closing of the programme. Other factors were also mentioned that will be discussed in the section below, where we focus on the reforms as means of creating a more inclusive educational environment.

23. The programme Innovation & Design later expanded and is now admitting 60 students. The question of expanding the IT-programme has also been raised but expansion is not yet a reality.

Creating an Inclusive Educational Environment

Was the Initiative Really a Gender-Inclusive Effort?

The Council for the Renewal of Undergraduate Education who distributed the Government funds did not choose to launch a large gender programme, with the aim of integrating dimensions of gender into undergraduate education. It has been argued that this interpretation of the initiative led to a process where gender issues were pushed into the back-ground — *a gender reform became a pedagogical reform* (Salminen-Karlsson, 1999, p. 101–112):

“From a feminist point of view the situation can also be interpreted as transforming the money destined to introduce gender perspectives into undergraduate education and thus promoting the understanding and, hopefully, consequent changes in mental and behavioural patterns of both female and male students and teachers in general. After the transformation the money was to strengthen a male-dominated area of education and those women who were interested in treading that male-dominated area.” (ibid., p. 105)

However, when viewing the results of this follow-up study we can conclude that the initiative in fact led to the creation of gender-inclusive programmes, if we define a gender-inclusive education as an education where the curriculum is constructed against the background of the needs and experiences of different students, and where the interaction between the students in the programme, and between the students and their tutors, is characterised by respectful attitudes, regardless of sex, age, study background or other traits that may differ among them (cf. Salminen-Karlsson, 1999, p. 217). Not all of programmes, but some, managed not only to recruit many women to subject areas traditionally chosen by men, they also helped these women to feel at home within these subjects, encouraging them to stay in the programmes and eventually get their degrees. Furthermore, at least one of the programmes managed to recruit a substantial proportion of women to doctoral studies within male-dominated subject areas, women who may, in the future, become role-models for other female students.

Below we will discuss the question of how *a pedagogical reform became a gender reform*. We will also discuss why some of the projects

managed to create inclusive educational environments while other projects succeeded less well. One issue will be central to the discussion: Are we to understand the integration of female students into male-dominated degree programmes as a process of changing existing academic cultures to suit new categories of students, i.e. a revisionist view of reform, or are we to understand the integrative effort as a process of creating alternative cultures, alternative, that is, to traditional academic degree programme within the fields of mathematics, natural sciences and technology, i.e. a revolutionary view of reform? The reformers seem to have had different views on this issue.

Open Entries to Male-Dominated Degree Programmes

One characteristic of the programmes that were successful in recruiting and retaining female students was that they offered what we may call ‘an open entry’ to male-dominated study programmes. The notion of such an open entry was emphasised in Stockholm and Göteborg in particular where the lecturers and students pointed to the possibilities for the students to get acquainted with various subject areas, such as mathematics, physics, and environmental science/mathematical statistics, without having to choose a single subject from the start.

The possibility to broaden the recruitment of students by offering such an ‘open entry’ has also been suggested in a report from the NyIng project, another Government initiative with the aim of renewing engineering education in Sweden (see Ingemarsson & Björck, 1999):

“Open entry” is an established possibility for postponing the choice of program. In NyIng’s view it should be used more often than has been the case. Furthermore, NyIng believes that the students should have more influence on their studies through increased possibilities to choose courses also in the lower years.” (ibid., 1999, p 8)

Traditionally we tend to take it for granted that students form views of what subjects to pursue very early in life, and that they at least have made up their minds when they are about to leave the upper secondary school. Thus, we tend to blame the students’ weak interest in natural science or technology studies on the compulsory school teachers for not offering their students an adequate view of mathematics, science or technology, or on the upper secondary school teachers for not nurturing their students’ interests in such subjects, female students in particular. However, as mentioned in the introduction to this study, university programmes are not merely the

receptors of students with pre-formed attitudes towards the academic subjects. They are actors on a social scene where these attitudes are formed and, hence, may change as a result of changes within the educational system. We know that many students are undecided when leaving upper secondary school. Many options are available to them and few have firm views about what subjects to choose. In such a situation cultural norms may strongly influence their choices. It is much easier to make a non-traditional career choice if you strongly believe that it is the right choice for you, much harder if you are hesitant. If women are to make non-traditional choices, such as choosing an academic career within a male-dominated subject area, an open entry may make such a choice less final and easier to argue for. Some researchers hold that women are more sensitive to cultural traditions than men in their academic choices:

“...changes of mind among women are more culturally supported than changes of mind among young men. This is especially the case where women initially proposed to enter fields which family, peers, faculty, or the wider community see as traditional male provinces. Among those whose first choice lies in the humanities and social sciences, women also exhibit (to a higher degree than do men) the liberal arts tradition of ‘trying out’ different majors before settling into a final choice.”

(Seymour & Hewitt, 1997, p. 23–24)

However, it does not seem to be enough just to postpone the inevitable choice. A recent evaluation of the programme *Female entry to computer science and engineering* (DTI) at Luleå Technical University, showed that few women were actually recruited from the general, introductory one-year ‘open entry’ (Wistedt, 2000, p. 21). What the programmes at Stockholm and Göteborg offered the students was not only the possibility of postponing the choice of one or another subject area, but the possibility of getting to know these subjects during two and a half years of study, not in a superficial way but in depth through examples, that is, through projects to work on in co-operation with their peers, and not least important, in co-operation with tutors and researchers who could inspire them and show them what it could mean to be a human being working within the areas in question.

Female Entry to Computer Science

The idea of an open entry also comprises the idea of offering the students the opportunity to try out their interests in and abilities to cope with

subjects that are new to them. One such entry to computer science and engineering was launched by a working group at Luleå University of Technology. In 1993 they applied for funds within the Government's initiative. The idea was to start a programme for women only, and furthermore, for women with an upper secondary education within the humanities or social sciences. They put together the university foundation year and the first year on the computer science and engineering programme to a two-year entry — *Female Entry to Computer Science and Engineering* (DTI) admitting 30 female students each year. They did not receive any funds from the Council. In 1995 the first students were admitted to the DTI-programme, despite the fact that the programme was not supported financially. However, in the first years of the initiative, tutors from the DTI-programme were invited to participate in seminars arranged by the Council where the working groups within the initiative met to discuss issues relevant to the development projects.

Why was the Luleå-project not invited to take an equal part in the initiative? One possible answer is that the programme was not in tune with the Council's idea of accomplishing gender-inclusiveness through educational change. The computer-science and engineering programme at Luleå University of Technology was not revised. At first glance it would seem as if the DTI-programme was based on the idea that women should adjust to fit into the current programme. The DTI-programme offered them two introductory years during which they could grow accustomed to the (male) technical culture. And this was certainly not a politically correct idea.

However, a closer look at the DTI-programme rendered a different picture of the project (Wistedt, 2000). It could rather be described as a radical solution to the recruitment problem. The DTI-programme accomplished what most of the computer-science programmes within the initiative did not manage — to raise the proportion of women in computer-science and engineering quite substantially, at Luleå University of Technology from 8 per cent female students to 21 per cent in the second year of the programme²⁴. But recruitment figures do not in themselves guarantee gender-inclusiveness. The DTI-programme could also be described as an attempt to create an alternative (female) computer science culture. Left alone for two years the women at the DTI-programme succeeded in creating a culture of their own, in many ways different from traditional technological setting (*ibid.*, p. 28–43) and characterised by close relations between the students

24. Figures relevant to students admitted in 1997.

and their tutors, a supportive environment where the students could try out their interests in the computer science field and where they dared to raise questions and reveal their own lack of knowledge. They were, as one of the lecturers at Chalmers put it, given the opportunity to “secure a foot-hold” (p. 93) within a particular area of interest, traditionally dominated by male norms and patterns of behaviour.

However, creating such an alternative culture was not an easy task. The DTI-programme could also be described as a social experiment, putting strain upon both teachers and students. The women at the DTI-programme had to put up with prejudiced attitudes from their fellow students, even from some of their lecturers who sometimes interpreted their willingness to pose questions as reflecting a lack of ability. The students also had to tackle conflicts within their own group. Members of minority groups are often caught in the dilemma of having to choose whether to be loyal to their own group, or to comply with the norms and customs of the majority. Many of the topics raised by the students in the interviews carried out as parts of the evaluation of the programme (*ibid*, p. 28-43) concerned problems that are common to minority groups who are to be integrated into a majority culture: prejudiced attitudes towards the ‘out-group’ in relation to the ‘in-group’, loyalty conflicts, dissension within the group regarding questions of how to accomplish the integrative effort, and so on, problems which had to be handled with sensitivity and followed by conscious efforts to help the women in the programme to handle these problems as they occurred.

Creating an alternative to the male-dominated culture of computer engineering is not accomplished easily. However, it may be one way to break “the gender contract of engineering education” (Salminen-Karlsson, 1999, p. 238), offering an opportunity to make more radical reforms than are possible within a revisionist approach to educational change (cf. Nissen, 1998). The results from this follow-up study of the programmes linked to the initiative show that the attempts to revise and reform existing programmes have not been fortuitous. The more radical attempts to launch new programmes with an alternative organisation of the subject matter in terms of structure and content, have been more successful. These results are also in accordance with the results from other studies on the recruitment and retention of under-represented groups in what has been called S.M.E. areas of study (Science, Mathematics, Engineering):

“The movement to increase the participation and retention of under-represented groups has yielded disappointing results despite considerable outlays of money and

*effort*²⁵. This can be explained, we suggest, by unresolved contradictions in its focus and strategy. If programs addressing under-representation are primarily shaped by a search for undiscovered talent, while the structural and cultural barriers to enrollment and persistence among under-represented groups remain obscure or unaddressed, such a program cannot succeed.”

(Seymour & Hewitt, 1997, p.8)

Why Did Some of the Projects Succeed Less Well?

Can such ‘unresolved contradictions’ account for the failure of some of the programmes in their ambitions to meet with the Government’s expectations? As mentioned above, two of the computer-science programmes made only modest reforms in order to become more attractive to female students. At Karlstad University the impact of the project “*Women in engineering education*” was mostly limited to recruitment efforts, such as participation in the various recruitment campaigns that were launched in co-operation between the departments involved in the initiative and remedial efforts directed towards the female students in the programme, such as work-groups and seminars for the female students at the university. The ‘structural and cultural barriers to enrollment’ that evidently exist within computer-engineering education were discussed within the project’s working group. They were addressed in an introductory course to engineering education which was not very well received by the students, but did not have any visible effect on the structure and content of the programme itself.

This also holds for the D++ project at Chalmers University of Technology. The programme was, no doubt, renewed, but the pedagogical reforms were not primarily motivated by gender considerations. The D++ project can be viewed as an effort to redesign the computer-science and engineering programme so as to make the first critical year in the programme less demanding on all students in terms of time-pressure and curriculum load, more in tune with the idea of the university as a work place, and more sensitive to the problems that some students may encounter in adjusting to a new culture:

25. “Retention among black, Hispanics, and native American students in S.M.E. majors has remained low, despite improved enrollments /.../. Women’s enrollment shows a twenty-year decline, despite enhanced recruitment efforts; and the retention rate of high ability entering women remains poor /.../.” (Seymour & Hewitt, 1997, p. 50)

“The most important overall goal of the D++ programme concerns getting students to take an active role in their own learning, so that they are involved in becoming engineers from the start. This can be compared and contrasted with the dominant and traditional approach to engineering education, in which the goal is to present students with knowledge and skills concerning their chosen branch of engineering. In the D++ model, the university is seen as the students’ workplace, learning is seen as taking place through active involvement in engineering activities, the teaching is seen as facilitating such learning, and the course-content is seen as meeting the learning needs of the students.”

(Jansson, 1998, p. 265-266)

The spirit of the quotation above seems to be that the educators should take a greater responsibility for the students’ socialisation into the engineering culture. The group-work and the introductory projects on issues relevant to computers in society could be viewed as means of helping students realise what computer engineering is about. However, the culture itself — and the barriers that exist there and may prevent some women from feeling at home within the culture — were not brought into focus. As one of the students put it: surface changes, such as changes in the forms of work or in the subject-matter, could be implemented quite easily within the institutional system, while the underlying structures remained the same.

At Stockholm University ‘unresolved contradictions’ within the projects group may be a factor, along with the poor support that the programme received at the faculty level and the recruitment problems that they encountered, which eventually contributed to the closing of the programme. The focus of the programme and the strategies to be adopted were discussed within the project’s working group, but the programme developers differed in their opinions about what the focus should be:

“We have had long discussions within the project group, if the programme should educate physicists and mathematicians or if we are supposed to produce something entirely new. We did not agree.”

(Male lecturer at the Project Programme, cited in Wistedt, 1996, p. 27)

These differences were never resolved. Some of the tutors wished for more radical changes in the content and structure of the mathematics and physics curriculum, some opted for moderate changes, mostly in terms of implementing new teaching methods and alternative forms of work: the projects, the co-operative work forms, and the interdisciplinary co-operation were,

in such a perspective, viewed as alternative means to ends that essentially were the same as usual.

Educational Change as Means to Accomplish Gender-Inclusiveness

It would seem as if it takes more than modest changes in the structure and content of male-dominated degree programmes in order to achieve gender-inclusiveness. Among the programmes linked to the Government's initiative more radical changes were implemented at the new programmes, and these programmes were, in general, the most successful in reaching the goals set for the initiative. These results contradict the results from a previous study of two of the programmes within the initiative (Salminen-Karlsson, 1999):

“Thus, while it can be expected that it is difficult to make changes in an established programme, it seems that doing something radical when creating a wholly new programme, which has to be established, is not much easier. In some cases it might even be safer to make gender reforms to a programme which has both a firm recruitment base and a certain industry ready to swallow the graduates.” (ibid., pp. 230-231)

True enough it may be safer, maybe even easier, but the results from this study show that a revisionist approach has not led to the desired results. The implementation of gender inclusive curricula is bound to question the “basic values and numerous traditions” of the existing programmes (*ibid.*, p. 183), and if you question the traditions you will have to prove your point. Why do they have to be changed? The argument that such changes would broaden the recruitment to mathematics, physics or technology studies did not seem have been an argument critical enough to motivate substantial curricular changes, at least not to those who did not foresee a severe decline in the general recruitment to the subjects. Hence, the gender argument would be a better argument, for instance, to physicists than to computer scientists. The computer science and engineering programmes were not facing any general recruitment problems, a fact which may account for their relatively mild interest in making radical changes of the current programmes. One exception is the IT-programme, which can be described as a daring attempt to create an alternative to the traditional engineering education. The changes were, however, first and foremost motivated by the projects leader's conviction that there are better ways to educate engineering students, whether these students happen to be male or female.

Creating Alternatives to Male-Dominated Degree Programmes

What can be learnt from the initiative? One lesson seems to be that the problem of achieving gender-inclusiveness may require more far-reaching solutions than modest changes in existing programmes; it may require a rethinking of the context in which the students are taught, allowing a greater variety of abilities and experiences to flourish in relation to the subject matter (cf. Perry & Greber, 1996). We have also found that such substantial changes in structure and content of the current curricula are not easy to implement. To suggest alternative ways of educating mathematicians, physicists or engineers is, in essence, to criticise the existing programmes. Such criticism is bound to stir up feelings among people not directly involved in the developmental work.

In order for these new programmes 'to gain a foot-hold' within the broader culture of their respective departments and universities, it seems to have been necessary for them to create strong internal cultures. The programmes that were successful in reaching the goals set for the initiative were all programmes where the lecturers generally agreed on the goals set for the development work, and where the projects offered them supportive environments where they could share their ideas and experiences with their colleagues. Such strong cultures are easier to create if the project-groups are fairly small. The successful projects were small, both in terms of the number of students enrolled and in terms of the number of tutors involved in the developmental work. Another factor seems to be staff continuity. If mobility among the tutors involved in the project is high, it is hard to build the further development of the programme on experiences which have become parts of the programme's history. *The Project Programme*, for instance, changed project leaders four times in four years, another factor which may have contributed to the negative development of the programme.

A strong internal culture may help the project participants to endure the ups and downs of developmental work. The numerous questions that arise concerning the changes made, not least questions that have to do with the academic status of the alternatives programmes, may eventually find answers if the tutors are allowed to try out their ideas in the company of critical friends²⁶. However, a negative side to building such strong internal cultures is that the projects may develop into closed circles with little contact with colleagues outside of them. Such tendencies were reported in the interviews. Isolation may, however, be countered if the project groups

26. See examples at pp. 68 and 96 above.

join forces with colleagues at other universities who are involved in similar efforts to renew higher education. The working group at the programme *Energy & Environmental Engineering* at Karlstad University is one example of such a process of building networks. The seminars organised by the Council, where the groups within the initiative could meet and discuss their works, is another example much appreciated by those who attended them.

In previous chapters we have discussed some characteristics of the programmes that succeeded in creating gender-inclusive study programmes (p. 109). One threat to the survival of these programmes is their current economic situation. At present, the established programmes are expanding their number of study places, and the prospective applicants are at the same time fewer than they used to be due to demographic fluctuations in the Swedish population. As a consequence, the newly launched programmes all report difficulties in recruiting students, an obvious result of the expansion since the marginal effects will hit them the hardest. In short this means that the Government's initiative to enhance the recruitment of women to tertiary programmes dominated by men, is blunted by another initiative launched by the same Government — the effort to enhance the recruitment of students to natural science and technology studies in general.

The recruitment situation is worse for some of the programmes, but they all have to lower their costs in order to save money. This means that they may have to give up on some of the courses specially designed for students in these programmes, courses which in many ways define them, but which are costly since the students are relatively few. This may, in turn, undermine the programme ideologies and in time lead to a situation where these programmes no longer stand out as alternatives to the programmes already offered at the universities.

From this follow-up study we have learnt that it takes time to design gender-inclusive programmes: time to create them, time to implement them, time to revise and refine them and, not least, to anchor them in their institutional settings. The initiative followed up in this report was launched in the form of a four-year project, too short a time to achieve fully the daring goal of turning the gender-preferences around. Nevertheless, it can be viewed as a worth while effort, putting gender issues on the agendas of universities and departments where many had little experience and knowledge of gender questions and perspectives. As such, the initiative can be viewed as a first step in a process which, hopefully, will survive the critical years ahead.

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5. Appendices

Appendix I

Interview Questions: Lecturers Questions Concerning the Goals of the development work

In the 1996 evaluation of the initiative to recruit women to science, mathematics, and technology (see Wistedt, 1996), the goals of the programme were described on the basis of interviews with lecturers engaged in the development work. (The interviewer gives a short summary of the goals of the programme in question.)

- What is your present view of these goals?
- Has your view of these goals changed since the programme started?
- If so, what are the most important changes?

Important Lessons Learned from the Development Work

- What are your most important experiences from the last five years of working on the project (such as experiences of the co-operative forms of work, of project or problem-based learning, of the interdisciplinary co-operation, the changes in the form and structure of the courses, a.s.o.)?
- Was anything particularly difficult to accomplish?
- What were the most rewarding or stimulating experiences?

Students' Knowledge and Attitudes

- Are the students in this programme different from students in traditional programmes? If so, in what ways?
- How well do the students succeed in their studies?
- Did you notice any differences between male and female students in this respect?

Important Tasks Today

- In your opinion, what are the most important tasks on the agenda today (future development work, changes to be made, a.s.o.)?

Views of the Programme

(Colleagues, Faculty Members, Administrators)

- How has the programme been received at the university (interest among colleagues, faculty members a.s.o.)?
- Have the ideas for this project carried over to other departments at the university or to other courses at your own department? (Please, give some examples)
- How has the co-operation between the different departments worked out?

Views of the Programme in a Broader Perspective

- Has the programme received any attention from the university (from colleagues, faculty) or from people outside of it?
- How do the university authorities view the programme?
- Have you received any financial support, apart from the funding from the 'Agency'?
- How has the programme been received among future employers (are there any differences in their views of prospective male and female employees)?

The Recruitment Aspect

- What is your view of the programme as a means to recruit new groups of students to science, mathematics or technology, female students in particular?
- What is the role of this university programme as one out of several course offerings?
- What is your opinion about the recruitment of female students to your subject area?
- What could, in a broader perspective, be the impact of this programme on the academic cultures of science (mathematics, or engineering)?

Appendix 2

Interview Questions: Students

Experiences of the Programme

In 1995 I interviewed lecturers engaged in developing this programme, and I asked them questions about the programme goals. (I give a short summary of the goals (see Wistedt, 1996))

- Is this an adequate description of the goals, as you understand them?
- Do you find them important?
- In what contexts could the competence that the lecturers described be useful?
- In your view, are there other goals that better describe the programme?
- What are the most important experiences you have gained from studying in the programme?
- What specialisation did you choose?
- Has the programme met your expectations?

What is Special About this Programme?

- How would you characterise studying in this programme?
- Are the students in this programme different from students in traditional programmes? If so, in what ways?
- Have you noticed any differences in your approach to studying compared to approaches adopted by students who have attend other programmes?

What Changes in the Programme are Needed?

- If you were given the opportunity to make changes in the programme, what changes would you make?
- Is there anything that you would like to keep as it is?

How is the Programme Viewed by People Outside of the Programme?

- What do people outside of the programme think of it (other students, lecturers not directly involved in the development work, employers, a.s.o.)?

Which Students are Attracted to this Programme?

- Which students does this programme suit? (Are there any students who this programme would not suit well?)

The Recruitment Effort

- What is your view of the programme as a means to recruit new groups of students to science, mathematics or technology, female students in particular?
- What is the role of this university programme as one out of several course offerings?
- What is your opinion about the recruitment of female students to your subject area?
- What could, in a broader perspective, be the impact of this programme on the academic cultures of science (mathematics, or engineering)?

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